IECC COMMERCIAL COMMITTEE ACTION REPORT ON THE RESULTS ON THE 2021 PUBLIC INPUT CHANGES TO THE INTERNATIONAL ENERGY CONSERVATION CODES

Introduction

On July 19, 2021, [Energy.cdpACCESScom]() was opened for 2021 Public Input Proposed Code Change submittals for consideration in the update to the 2024 International Energy Conservation Code and Chapter 11 of the International Residential Code. The submittal deadline was October 12, 2021. A total of 450 proposals were received (256 Commercial; 194 Residential). In addition, 17 committee proposals were submitted (7 Commercial; 10 Residential). Proposals are identified as follows:

- Commercial Energy Public Input (CEPI)
- Commercial Energy Committee Public Input (CECPI) (committee proposal)
- Residential Energy Public Input (REPI)
- Residential Energy Committee Public Input (RECPI) (committee proposal)
- Residential Energy IRC Public Input (IRCEPI)
- The "Part" listed after the code change indicates the respective items of the code change that involve possible coordination issues between the Commercial and Residential provisions. For example, CEPI – II - 21 Part I was a code change heard by the Commercial Consensus Committee and Part II was heard by the Residential Committee.

The process for consideration of the proposals included:

- Posting of the proposals on November 23, 2021.
- An open process of review by one of the Subcommittees established by the Consensus Committee, including interested parties
- Subcommittee recommended action on the proposals to the Consensus Committee
- Consensus Committee action on the proposals with an open process including posting of documents and participation by interested parties

This **Committee Action Report (CAR)** includes the following:

- A summary of the actions taken by the respective IECC Consensus Committee from November/2021 – June/2022 on each proposal. The Consensus Committee action is noted by one of the following: Approve (as submitted); Approved as Modified; or Disapproved along with the vote count and percentages for a successful action. In accordance with Section 9.3(d) of the ICC Consensus Procedures (ICC CP), the disposition of an item during the public input process required a simple majority. Those proposals that were withdrawn by the proponent are so noted.
- All approved proposals (approve and approved as modified) are included in the CAR in legislative format, including the reason(s) for the committee action. These proposals form the basis for the ballot process below.

The results of the balloting process by the Consensus Committee will be the basis for the next step in the process – issuance of Public Comment Draft #1. Public Comment Draft #1 will incorporate all text revisions to the 2021 IECC/Chapter 11 of the IRC based on those code changes which have achieved the voting majorities in Section 9.4 of the ICC CP (approval by at least a majority of the committee <u>and</u> at least two-thirds of those voting, excluding abstentions). Public Comment Draft #1 will be posted and open for code change submittals via Energy.cdpACCESS. Further information will be posted on ICC's Energy website.

Ballot Instructions

Ballot format

The ballot process will utilize a link to a single electronic ballot, structured below in accordance with Section 9.1 of the ICC CP. This ballot format will be used for subsequent ballots as well. On the signature page of the ballot, instructions will be included with direction for members to vote on the results of the approved code changes by selecting one of the following:

(*The annotation in italics will not be included in the ballot)*

- Affirmative (all code changes)
  - *An affirmative vote is a single vote to ratify approval of all the proposals approved by the committee.*

- Affirmative with comment (comments on separate file; send to Secretariat)
  - *An affirmative with comment vote is a single vote to ratify approval of all the proposals approved by the committee and allows the voting member to offer comments on specific proposals. Such comments must be identified by code change number on a separate file and sent to the Secretariat for reproduction as part of the recirculation ballot process for all committee members to view. Comments can be in favor, in opposition or neutral but in all cases such comments will not affect the single ratification vote cast on all the proposals. Comments provided with an affirmative vote are for information only, no action is required by the committee.*

- Negative, with reasons (the reasons for a negative vote shall be given and, if possible, should include specific wording or actions that would resolve the objection)
  - *This single vote identifies that the voting member has an objection to one or more of the approved proposals. On a separate file, the proposals must be identified by code change number and a reason for the negative vote on the proposal. If there are text revisions for the committee to consider that would resolve the negative vote, such revisions should be included as well. This file is to be sent to the Secretariat for reproduction as part of the recirculation ballot process for all committee members to view.*
  - *Negative votes to code changes without a reason "shall not be factored into the numerical requirements for consensus" (Section 2.7 (3); 2022 ANSI Essential Requirements).*
  - *Proposals not identified as receiving a negative vote are considered as an affirmative vote.*

In some cases, committee members may wish to abstain on voting on a specific proposal(s). If this is the case, be sure to vote as directed above and in a separate file identify the code change number(s) for which you are abstaining and send to the Secretariat for reproduction as part of the recirculation ballot process for all committee members to view. This abstention can be combined in the same file as an "Affirmative with comment" or "Negative, with reasons". See Section 9.4 of ICC CP for abstentions - such abstentions are excluded from numerical requirements for required voting majorities.

Ballot #1

The initial ballot, Ballot #1, initiates the balloting process of the CAR.

- Ballot #1 will be open for 30 days. The 30-day deadline requires both the completion of the online ballot as well as the submittal of any comments/reasons.
- Comments received with "Affirmative with comment" ballots will be compiled per proposal as well as reasons for abstentions.

- For each proposal receiving a negative comment, the reasons for the negative and any proposed text revisions to resolve the negative will be compiled per proposal, along with the vote tally on that proposal from Ballot #1.

Ballot #2

The results from Ballot #1 will be recirculated to the committee for review to give committee members an opportunity to review comments provided and, if they choose, to change their vote. See Section 9.6 of the ICC CP for a discussion on recirculation ballots.

- Ballot #2 will be open for 14 days. The 14-day deadline requires both the completion of the online ballot as well as the submittal of any comments/reasons.
- Unless a committee member records a vote change on a given proposal, that committee member's Ballot #1 vote is presumed to be unchanged. If additional comments are included with their ballot, these comments will be compiled and recirculated as done with Ballot #1.
- If the requisite majorities of Section 9.4 of the ICC CP are achieved on Ballot #2 with affirmative or affirmative with comment, this is final approval of the text revisions to be incorporated into Public Comment Daft #1. Ballot #3 and the remaining steps below are not required.
- If the requisite majorities of Section 9.4 are not achieved on Ballot #2 with affirmative or affirmative with comment, the negative votes and reasons and all other comments will be compiled per proposal, along with the vote tallies per proposal.

Ballot #3

The results from Ballot #2 will be recirculated to the committee for review to give committee members an opportunity to review comments provided and, if they choose, to change their vote.

- Ballot #3 will be open for 14 days. The 14-day deadline requires both the completion of the online ballot as well as the submittal of any comments/reasons.
- Unless a committee member records a vote change on a given proposal, that committee member's Ballot #2 vote is presumed to be unchanged. If additional comments are included with their ballot, these comments will be compiled and recirculated as done with Ballots #1 and #2.
- If the requisite majorities of Section 9.4 are achieved on Ballot #3 with affirmative or affirmative with comment, this is final approval of the text revisions to be incorporated into Public Comment Daft #1 and the remaining steps below are not required.
- If the requisite majorities of Section 9.4 are not achieved on Ballot #3 with affirmative or affirmative with comment, the negative votes and reasons and all other comments will be compiled per proposal, along with the vote tallies per proposal.
- Every code change that did do not achieve the requisite majorities of Section 9.4 will be considered at a Consensus Committee meeting for possible resolution. Meeting date to be determined.

Consensus Committee Meeting

The results of Ballot #3 for those code changes that did not achieve the requisite majorities of Section 9.4 will be compiled and distributed to the committee. These code changes will serve as the agenda for a meeting of the Consensus Committee. Any revisions to the code changes to be considered at the meeting must be developed and submitted at a time to be determined in advance of the meeting. The committee will discuss and vote on the code changes at this meeting. This meeting will be open to interested parties.

Ballot #4

The results of the Consensus Committee meeting will be compiled and sent to the committee. Ballot #4 will be a recirculation ballot sent to those not in attendance at the Consensus Committee meeting. This is the last step in the approval process of the CAR and the determination of the resulting text to be included in Public Comment Draft #1.

- The ballot will be open for 14 days. The 14-day deadline requires both the completion of the online ballot as well as the submittal of any comments/reasons.
- All code changes considered at the Consensus Committee meeting require the requisite majorities of Section 9.4 in order to be incorporated into Public Comment Draft #1.
- Code changes that do not meet these majorities will <u>not</u> be included in Public Comment Draft #1. Such code changes can be considered for submission as proposals to Public Comment Draft #1 at the discretion of the proponent with due regard for comments received and the outcomes of the ballot process.

Results of the Commercial Consensus Committee Public Input Process November 2021-June 2022

Proposal Number	Committee Action	Yes Vote	No Vote	Abstain	%
CECPI-1-21	approve	27	8	2	77%
CECPI-2-21	approve	24	8	1	75%
CECPI-3-21	approved as modified	32	0	1	100%
CECPI-4-21	approved as modified	24	9	4	73%
CECPI-5-21	approve	28	1	1	97%
CECPI-6-21	approve	28	0	1	100%
CECPI-7-21	approved as modified	30	0	1	100%
CEPI-001-21	disapproved	28	1	1	97%
CEPI-002-21	disapproved	35	4	1	90%
CEPI-003-21	disapproved	29	8		78%
CEPI-004-21	disapproved	20	11	1	65%
CEPI-005-21	withdrawn				
CEPI-006-21	withdrawn				
CEPI-007-21	approved as modified	23	13	0	64%
CEPI-008-21 Part I	approve	36	2	1	95%
CEPI-009-21	approved as modified	31	2	0	94%
CEPI-010-21	disapproved	23	4	3	85%
CEPI-011-21 Part I	disapproved	31	0	0	100%
CEPI-012-21 Part I	approved as modified	24	11	1	69%
CEPI-013-21 Part I	disapproved	32	0	0	100%
CEPI-014-21	approved as modified	32	0	0	100%
CEPI-015-21 Part I	approve	34	0	0	100%
CEPI-016-21 Part I	approved as modified	35	0	0	100%
CEPI-017-21 Part I	approve	26	2	4	93%
CEPI-018-21	disapproved	34	4		89%
CEPI-019-21 Part I	approved as modified	24	0	0	100%
CEPI-020-21	disapproved	28	6	0	82%
CEPI-021-21	disapproved	30	3	3	91%
CEPI-022-21	disapproved	16	13	1	55%
CEPI-023-21	approve	33	0	0	100%
CEPI-024-21 Part I	approved as modified	36	0	0	100%

Proposal Number	Committee Action	Yes Vote	No Vote	Abstain	%
CEPI-025-21	disapproved	24	10	1	71%
CEPI-026-21	withdrawn				
CEPI-027-21	approved as modified	32	0	1	100%
CEPI-028-21	approved as modified	37	0	0	100%
CEPI-029-21	approved as modified	34	0	0	100%
CEPI-030-21	disapproved	26	7	1	79%
CEPI-031-21	approved as modified	27	5	2	84%
CEPI-032-21	approved as modified	32	0	1	100%
CEPI-033-21	disapproved	34	2	1	94%
CEPI-034-21	approved as modified	34	0	0	100%
CEPI-035-21	approved as modified	33	0	0	100%
CEPI-036-21	approve	34	0	0	100%
CEPI-037-21	approve	34	0	0	100%
CEPI-038-21	approve	34	0	0	100%
CEPI-039-21	disapproved	21	17	0	55%
CEPI-040-21	disapproved	34	2	1	94%
CEPI-041-21	approved as modified	32	0	0	100%
CEPI-042-21	approved as modified	32	0	0	100%
CEPI-043-21	approved as modified	34	0	0	100%
CEPI-044-21	approved as modified	35	0	1	100%
CEPI-045-21	disapproved	34	2	1	94%
CEPI-046-21	approved as modified	30	0	1	100%
CEPI-047-21	approved as modified	34	0	0	100%
CEPI-048-21	approved as modified	35	0	0	100%
CEPI-049-21	disapproved	37	0	0	100%
CEPI-050-21	disapproved	20	16	1	56%
CEPI-051-21	withdrawn				
CEPI-052-21	withdrawn				
CEPI-053-21	disapproved	25	8	2	76%
CEPI-054-21	withdrawn				
CEPI-055-21	disapproved	33	0	0	100%
CEPI-056-21	disapproved	33	0	0	100%

Proposal Number	Committee Action	Yes Vote	No Vote	Abstain	%
CEPI-057-21	disapproved	33	0	0	100%
CEPI-058-21	approved as modified	34	0	0	100%
CEPI-059-21	withdrawn				
CEPI-060-21	approved as modified	37	0	0	100%
CEPI-061-21	approved as modified	32	0	1	100%
CEPI-062-21	withdrawn				
CEPI-063-21 Part I	disapproved	35	0	0	100%
CEPI-064-21	disapproved	33	0	0	100%
CEPI-065-21	approved as modified	33	0	0	100%
CEPI-066-21 Part I	withdrawn				
CEPI-067-21	withdrawn				
CEPI-068-21	approve	34	0	1	100%
CEPI-069-21	approved as modified	36	0	0	100%
CEPI-070-21	disapproved	33	0	0	100%
CEPI-071-21	approved as modified	29	0	1	100%
CEPI-072-21	approved as modified	29	0	0	100%
CEPI-073-21	disapproved	31	2	0	94%
CEPI-074-21	disapproved	17	14	2	55%
CEPI-075-21	approve	30	0	1	100%
CEPI-076-21	approved as modified	23	6	1	79%
CEPI-077-21	approved as modified	29	0	0	100%
CEPI-078-21	disapproved	26	0	1	100%
CEPI-079-21	approved as modified	30	0	0	100%
CEPI-080-21	approved as modified	31	0	1	100%
CEPI-081-21	disapproved	34	0	2	100%
CEPI-082-21 Part I	approved as modified	29	1	0	97%
CEPI-083-21	approved as modified	26	3	3	90%
CEPI-084-21	approved as modified	28	0	1	100%
CEPI-085-21	approve	30	0	1	100%
CEPI-086-21	approve	30	0	0	100%
CEPI-087-21	disapproved	32	1	1	97%

Proposal Number	Committee Action	Yes Vote	No Vote	Abstain	%
CEPI-088-21	disapproved	34	1	2	97%
CEPI-089-21	disapproved	34	1	1	97%
CEPI-090-21	disapproved	34	0	2	100%
CEPI-091-21	disapproved	35	0	2	100%
CEPI-092-21	disapproved	34	0	2	100%
CEPI-093-21	disapproved	33	0	3	100%
CEPI-094-21	disapproved	34	0	2	100%
CEPI-095-21	disapproved	19	14	6	58%
CEPI-096-21	disapproved	34	1	2	97%
CEPI-097-21	approved as modified	27	2	1	93%
CEPI-098-21	disapproved	29	1	2	97%
CEPI-099-21	approved as modified	29	0	1	100%
CEPI-100-21	approved as modified	35	0	1	100%
CEPI-101-21	disapproved	29	0	0	100%
CEPI-102-21	approved as modified	36	1	0	97%
CEPI-103-21	approved as modified	31	0	0	100%
CEPI-104-21	disapproved	32	0	0	100%
CEPI-105-21	disapproved	29	0	2	100%
CEPI-106-21	approved as modified	28	0	0	100%
CEPI-107-21	approve	29	2	0	94%
CEPI-108-21	approved as modified	23	3	1	88%
CEPI-109-21	disapproved	34	0	0	100%
CEPI-110-21	approved as modified	34	0	0	100%
CEPI-111-21	withdrawn				
CEPI-112-21	approve	29	0	1	100%
CEPI-113-21	approved as modified	25	1	1	96%
CEPI-114-21	disapproved	32	0	0	100%
CEPI-115-21	disapproved	32	0	0	100%
CEPI-116-21	approve	31	0	0	100%
CEPI-117-21	disapproved	29	0	0	100%
CEPI-118-21	approve	29	0	0	100%
CEPI-119-21	approved as modified	28	3	1	90%
CEPI-120-21	approved as modified	33	1	0	97%

Proposal Number	Committee Action	Yes Vote	No Vote	Abstain	%
CEPI-121-21	approved as modified	30	2	0	94%
CEPI-122-21	disapproved	22	4	2	85%
CEPI-123-21	approved as modified	31	0	0	100%
CEPI-124-21	approve	27	0	1	100%
CEPI-125-21	approved as modified	28	3	1	90%
CEPI-126-21	disapproved	26	1	2	96%
CEPI-127-21	approved as modified	28	0	2	100%
CEPI-128-21	approved as modified	32	0	1	100%
CEPI-129-21	disapproved	17	12	3	59%
CEPI-130-21	approved as modified	31	0	1	100%
CEPI-131-21	approved as modified	27	0	2	100%
CEPI-132-21	withdrawn				
CEPI-133-21	approved as modified	36	0	0	100%
CEPI-134-21	approve	32	0	1	100%
CEPI-135-21	approved as modified	33	0	0	100%
CEPI-136-21	disapproved	20	14	2	59%
CEPI-137-21	approved as modified	26	5	4	84%
CEPI-138-21	approved as modified	22	17	0	56%
CEPI-139-21	disapproved	31	7	0	82%
CEPI-140-21	approved as modified	24	7	0	77%
CEPI-141-21	disapproved	29	8	1	78%
CEPI-142-21	approved as modified	31	0	1	100%
CEPI-143-21	withdrawn				
CEPI-144-21	withdrawn				
CEPI-146-21 Part I	disapproved	36	0	0	100%
CEPI-147-21	approve	26	0	0	100%
CEPI-148-21	approved as modified	38	1	0	97%
CEPI-149-21	disapproved	31	0	0	100%
CEPI-150-21	approve	29	1	0	97%
CEPI-151-21	withdrawn				
CEPI-152-21	approved as modified	37	0	0	100%

Proposal Number	Committee Action	Yes Vote	No Vote	Abstain	%
CEPI-153-21	disapproved	27	2	2	93%
CEPI-154-21	approve	33	0	1	100%
CEPI-155-21	withdrawn				
CEPI-156-21	approved as modified	34	1	0	97%
CEPI-157-21	withdrawn				
CEPI-158-21	withdrawn				
CEPI-159-21	withdrawn				
CEPI-160-21	withdrawn				
CEPI-161-21	approve	32	0	0	100%
CEPI-162-21	disapproved	35	0	1	100%
CEPI-163-21	withdrawn				
CEPI-164-21	approved as modified	33	2	0	94%
CEPI-165-21	withdrawn				
CEPI-166-21	approve	32	0	0	100%
CEPI-167-21	approve	36	0	0	100%
CEPI-168-21	approved as modified	32	0	0	100%
CEPI-169-21	approved as modified	35	3	1	92%
CEPI-170-21	withdrawn				
CEPI-171-21	disapproved	25	3	0	89%
CEPI-172-21	approve	26	0	1	100%
CEPI-173-21	approve	25	1	0	96%
CEPI-174-21	disapproved	25	4	1	86%
CEPI-175-21	disapproved	27	7	3	79%
CEPI-176-21	approved as modified	29	5	1	85%
CEPI-177-21	approved as modified	36	0	0	100%
CEPI-178-21	withdrawn				
CEPI-179-21	withdrawn				
CEPI-180-21	disapproved	27	2	0	93%
CEPI-181-21	approved as modified	30	0	0	100%
CEPI-182-21	withdrawn				
CEPI-183-21	withdrawn				
CEPI-184-21	disapproved	26	6	0	81%
CEPI-185-21	approve	31	1		97%
CEPI-186-21	withdrawn				
CEPI-187-21	approved as modified	38	0		100%

Proposal Number	Committee Action	Yes Vote	No Vote	Abstain	%
CEPI-188-21	approved as modified	30	0	1	100%
CEPI-189-21	approved as modified	27	1	1	96%
CEPI-190-21	withdrawn				
CEPI-191-21	withdrawn				
CEPI-192-21	approve	34	0	2	100%
CEPI-193-21	approved as modified	31	3	2	91%
CEPI-194-21	withdrawn				
CEPI-195-21	withdrawn				
CEPI-196-21	withdrawn				
CEPI-197-21	withdrawn				
CEPI-198-21	withdrawn				
CEPI-199-21	withdrawn				
CEPI-200-21	withdrawn				
CEPI-201-21	withdrawn				
CEPI-202-21	withdrawn				
CEPI-203-21	approved as modified	16	11	0	59%
CEPI-204-21	disapproved	20	10	0	67%
CEPI-205-21	disapproved	27	4	0	87%
CEPI-206-21	disapproved	31	0	1	100%
CEPI-207-21	approved as modified	35	0	1	100%
CEPI-208-21	approve	33	0	0	100%
CEPI-209-21	approved as modified	35	0	0	100%
CEPI-210-21	disapproved	19	12	2	61%
CEPI-211-21	approved as modified	28	0	1	100%
CEPI-212-21	approved as modified	34	0	0	100%
CEPI-213-21	disapproved	31	0	0	100%
CEPI-214-21	withdrawn				
CEPI-215-21	approve	34	4	0	89%
CEPI-216-21	withdrawn				
CEPI-217-21	approved as modified	17	11	2	61%
CEPI-218-21 Part I	disapproved	25	1	2	96%
CEPI-219-21	approved as modified	27	1	2	96%
CEPI-220-21	approve	39	0		100%

Proposal Number	Committee Action	Yes Vote	No Vote	Abstain	%
CEPI-221-21	approved as modified	31	1	1	97%
CEPI-222-21	disapproved	29	0	1	100%
CEPI-223-21	disapproved	31	0	0	100%
CEPI-224-21	disapproved	30	0	1	100%
CEPI-225-21	approved as modified	24	1	1	96%
CEPI-226-21	approved as modified	37	2		95%
CEPI-227-21	approved as modified	28	1	1	97%
CEPI-228-21	approved as modified	23	7	0	77%
CEPI-229-21	approved as modified	33	1	1	97%
CEPI-230-21	disapproved	29	3	2	91%
CEPI-231-21	disapproved	33	1	2	97%
CEPI-232-21	approved as modified	23	2	4	92%
CEPI-233-21	disapproved	35	1	0	97%
CEPI-234-21	withdrawn				
CEPI-235-21	withdrawn				
CEPI-236-21	withdrawn				
CEPI-237-21	withdrawn				
CEPI-238-21	withdrawn				
CEPI-239-21	withdrawn				
CEPI-240-21	withdrawn				
CEPI-241-21	disapproved	22	7	0	76%
CEPI-242-21	withdrawn				
CEPI-243-21	withdrawn				
CEPI-244-21	withdrawn				
CEPI-245-21	withdrawn				
CEPI-246-21	withdrawn				
CEPI-247-21	withdrawn				
CEPI-248-21	withdrawn				
CEPI-249-21	withdrawn				
CEPI-250-21	withdrawn				
CEPI-251-21	withdrawn				
CEPI-252-21	withdrawn				
CEPI-253-21	withdrawn				
CEPI-254-21	approve	38	0		100%
CEPI-255-21 Part I	disapproved	28	3	1	90%
CEPI-256-21	disapproved	32	5	0	86%

Proposal Number	Committee Action	Yes Vote	No Vote	Abstain	%
CEPI-257-21	approved as modified	33	4	0	89%

Proposal Number	Committee Action	Yes Vote	No Vote	Abstain	%
CEPI-258-21 Part I	withdrawn				

CECPI-1-21

Proponents: Michael Jouaneh, representing IECC Commercial Electrical Power, Lighting, Renewables SC (ieccceelectrical@iccsafe.org)

2021 International Energy Conservation Code

Add new definition as follows:

AUTOMOBILE PARKING SPACE. A space within a building or private or public parking lot, exclusive of driveways, ramps, columns, office and work areas, for the parking of an automobile.

ELECTRIC VEHICLE (EV). An automotive-type vehicle for on-road use, such as passenger automobiles, buses, trucks, vans, neighborhood electric vehicles, and electric motorcycles, primarily powered by an electric motor that draws current from a building electrical service, EVSE, a rechargeable storage battery, a fuel cell, a photovoltaic array, or another source of electic current.

ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE). Equipment for plug-in power transfer including the ungrounded, grounded and equipment grounding conductors, and the *electric vehicle* connectors, attachment plugs, personal protection system and all other fittings, devices, power outlets or apparatus installed specifically for the purpose of transferring energy between the premises wiring and the *electric vehicle*.

ELECTRIC VEHICLE SUPPLY EQUIPMENT INSTALLED SPACE (EVSE space). An *automobile parking space* that is provided with a dedicated *EVSE* connection.

ELECTRIC VEHICLE CAPABLE SPACE (EV CAPABLE SPACE). A designated *automobile parking space* that is provided with electrical infrastructure, such as, but not limited to, raceways, cables, electrical capacity, and panelboard or other electrical distribution equipment space, necessary for the future installation of an *EVSE*.

ELECTRIC VEHICLE READY SPACE (EV READY SPACE). An *automobile parking space* that is provided with a branch circuit and either an outlet, junction box or receptacle, that will support an installed *EVSE*.

Add new text as follows:

C405.13 **Electric Vehicle Power Transfer Infrastructure.** New parking facilities shall be provided with *electric vehicle* power transfer infrastructure in compliance with Sections C405.13.1 through C405.13.6.

C405.13.1 **Quantity.** The number of required *EV spaces*, *EV capable spaces* and *EV ready spaces* shall be determined in accordance with this Section and Table C405.13.1 based on the total number of *automobile parking spaces* and shall be rounded up to the nearest whole number. For R-2 buildings, the Table requirements shall be based on the total number of dwelling units or the total number of automobile parking spaces, whichever is less.

1. Where more than one parking facility is provided on a building site, the number of required *automobile parking spaces* required to have *EV* power transfer infrastructure shall be calculated separately for each parking facility.
2. Where one shared parking facility serves multiple building occupancies, the required number of spaces shall be determined proportionally based on the floor area of each building occupancy.
3. Installed *EVSE* spaces that exceed the minimum requirements of this section may be used to meet minimum requirements for *EV ready spaces* and *EV capable spaces*.
4. Installed *EV ready spaces* that exceed the minimum requirements of this section may be used to meet minimum requirements for *EV capable spaces*.
5. Where the number of *EV ready spaces* allocated for R-2 occupancies is equal to the number of dwelling units or to the number of *automobile parking spaces* allocated to R-2 occupancies, whichever is less, requirements for *EVSE spaces* for R-2 occupancies shall not apply.
6. Requirements for a Group S-2 parking garage shall be determined by the occupancies served by that parking garage. Where new automobile spaces do not serve specific occupancies, the values for Group S-2 parking garage in Table C405.13.1 shall be used.

Exception: Parking facilities, serving occupancies other than R2 with fewer than 10 automobile parking spaces.

Table C405.13.1 REQUIRED EV POWER TRANSFER INFRASTRUCTURE

OCCUPANCY	EVSE SPACES	EV READY SPACES	EV CAPABLE SPACES
GROUP A	10%	0%	10%
GROUP B	15%	0%	30%
GROUP E	2%	0%	5%
GROUP F	2%	0%	5%
GROUP H	1%	0%	0%
GROUP I	2%	0%	5%
GROUP M	10%	0%	10%
GROUP R-1	20%	5%	75%
GROUP R-2	20%	5%	75%
GROUP R-3 AND R-4	2%	0%	5%
GROUP S exclusive of parking garages	1%	0%	0%
GROUP S-2 parking garages	1%	0%	0%

C405.13.2 EV Capable Spaces. Each *EV capable space* used to meet the requirements of Section C405.13.1 shall comply with all of the following:

1. A continuous raceway or cable assembly shall be installed between an enclosure or outlet located within 3 feet (914 mm) of the *EV capable space* and a suitable panelboard or other onsite electrical distribution equipment.
2. Installed raceway or cable assembly shall be sized and rated to supply an minimum circuit capactiy in accordance with C405.13.5
3. The electrical distribution equipment to which the raceway or cable assembly connects shall have sufficient dedicated space and spare electrical capacity for a 2-pole circuit breaker or set of fuses.
4. The electrical enclosure or outlet and the electrical distribution equipment directory shall be marked: "For future *electric vehicle supply equipment* (EVSE)."
5. Reserved capacity shall be no less than 4.1 kVA (20A 208/240V) for each *EV capable space.*

C405.13.3 EV Ready Spaces. Each branch circuit serving EV ready spaces used to meet the requirements of Section C405.13.1 shall comply with all of the following:

1. Terminate at an outlet or enclosure, located within 3 feet (914 mm) of each *EV ready space* it serves.
2. Have a minimum circuit capacity in accordance with C405.13.5.
3. The panelboard or other electrical distribution equipment directory shall designate the brach circuit as "For electric vehicle supply equipment (EVSE)" and the outlet or enclosure shall be marked "For electric vehicle supply equipment (EVSE)."

C405.13.4 EVSE Spaces. An installed *EVSE* with multiple output connections shall be permitted to serve multiple *EVSE spaces*. Each *EVSE* installed to meet the requirements of Section C405.13.1, serving either a single *EVSE space* or multiple *EVSE spaces*, shall comply with all of the following:

1. Have a minimum circuit capacity in accordance with C405.13.5.
2. Have a minimum charging rate in accordance with C405.13.4.1.
3. Be located within 3 feet (914 mm) of each *EVSE space* it serves.
4. Be installed in accordance with Section C405.13.6.

C405.13.4.1 EVSE Minimum Charging Rate. Each installed EVSE shall comply with one of the following:

1. Be capable of charging at a minimum rate of 6.2 kVA (or 30A at 208/240V).
2. When serving multiple *EVSE spaces* and controlled by an energy management system providing load management, be capable of simultaneously charing each *EVSE space* at a minimum rate of no less than 3.3 kVA.
3. When serving *EVSE spaces* allowed to have a minimum circuit capacity of 2.7 kVA in accordance with C405.13.5.1 and controlled by an energy management system providing load management, be capable of simultaneously charging each *ESVE space* at a minimum rate of no less than 2.1 kVA.

C405.13.5 Circuit Capacity. The capacity of electrical infrastructure serving each *EV capable space*, *EV ready space*, and *EVSE space* shall comply with one of the following:

1. A branch circuit shall have a rated capacity not less than 8.3 kVA (or 40A at 208/240V) for each *EV ready space* or *EVSE space* it serves.
2. The requirements of C405.13.5.1.

C405.13.5.1 Circuit Capacity Management. The capacity of each branch circuit serving multiple EVSE spaces, EV ready spaces or EV capable spaces designed to be controlled by an energy management system providing load management in accordance with NFPA 70, shall comply with one of the following:

1. Have a minimum capacity of 4.1 kVA per space.
2. Have a minimum capacity of 2.7 kVA per space when serving *EV ready spaces* or *EVSE space* for R-2 occupancies when all (100%) of the automobile parking spaces designated for R-2 occupancies are designed to be *EV ready spaces* or *EVSE spaces*.
3. Have a minimum capacity of 2.7 kVA per space when serving *EV ready spaces* or *EVSE spaces* for a building site when all (100%) of the automobile parking spaces are designed to be *EV ready* or *EVSE spaces*.

C405.13.6 EVSE Installation. *EVSE* shall be installed in accordance with NFPA 70 and shall be listed and labeled in accordance with UL 2202 or UL 2594. *EVSE* shall be accessible in accordance with International Building Code Section 1107.

Add new standard(s) as follows:

UL

UL LLC
333 Pfingsten Road
Northbrook, IL 60062

UL 2202-2009	*Electric Vehicle (EV) Charging System- with revisions through February 2018*
UL 2594-2016	*Standard for Electric Vehicle Supply Equipment*

Reason: Consensus proposal combines four EV proposals provided this cycle and will improve the effective use of energy supplied to a building by providing electrical connections for automobile spaces

Cost Impact: The code change proposal will increase the cost of construction.
The code change proposal will increase the cost of construction

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: based on reason statement by subcommittee

Proposal # 589

CECPI-2-21

Proponents: Michael Jouaneh, representing IECC Commercial Electrical Power, Lighting, Renewables SC (ieccceelectrical@iccsafe.org)

2021 International Energy Conservation Code

Revise as follows:

C103.2 Information on construction documents. Construction documents shall be drawn to scale on suitable material. Electronic media documents are permitted to be submitted where *approved* by the *code official*. Construction documents shall be of sufficient clarity to indicate the location, nature and extent of the work proposed, and show in sufficient detail pertinent data and features of the building, systems and equipment as herein governed. Details shall include, but are not limited to, the following as applicable:

1. Energy compliance path.
2. Insulation materials and their *R*-values.
3. Fenestration *U*-factors and solar heat gain coefficients (SHGCs).
4. Area-weighted *U*-factor and solar heat gain coefficient (SHGC) calculations.
5. Mechanical system design criteria.
6. Mechanical and service water-heating systems and equipment types, sizes and efficiencies.
7. Economizer description.
8. Equipment and system controls.
9. Fan motor horsepower (hp) and controls.
10. Duct sealing, duct and pipe insulation and location.
11. Lighting fixture schedule with wattage and control narrative.
12. Location of *daylight* zones on floor plans.
13. Air barrier and air sealing details, including the location of the air barrier.
14. Location of pathways for routing of raceways or cable from the on-site renewable energy system to the electrical distribution equipment.

Add new definition as follows:

COMMUNITY RENEWABLE ENERGY FACILITY. A facility that produces energy harvested from *renewable energy resources* and is qualified as a community energy facility under applicable jurisdictional statutes and rules.

FINANCIAL RENEWABLE ENERGY POWER PURCHASE AGREEMENT. A financial arrangement between a renewable electricty generator and a purchaser wherein the purchaser pays or guarantees a price to the generator for the project's renewable generation. Also known as a "financial power purchase agreement" and "virtual power purchase agreement."

PHYSICAL RENEWABLE ENERGY POWER PURCHASE AGREEMENT. A contract for the purchase of renewable electricity from a specific renewable electricity generator to a purchaser of renewable electricity.

RENEWABLE ENERGY CERTIFICATE (REC). A market-based instrument that represents and conveys the environmental, social, and other non-power attributes of one megawatt hour of renewable electricity generation and could be sold separately from the underlying physical electricity associated with *renewable energy resources*, also known as "energy attribute" and "energy attribute certificate" (EAC).

Revise as follows:

C405.1 General. Lighting system controls, the maximum lighting power for interior and exterior applications, and electrical energy consumption and generation shall comply with this section. *Sleeping units* shall comply with Section C405.2.5 and with either Section C405.1.1 or C405.3. *General lighting* shall consist of all lighting included when calculating the total connected interior lighting power in accordance with Section C405.3.1 and which does not require specific application controls in accordance with Section C405.2.5.
Transformers, uninterruptable power supplies, motors and electrical power processing equipment in data center systems shall comply with Section 8 of ASHRAE 90.4 in addition to this code.

Add new text as follows:

C405.13 Renewable energy systems. *Buildings* in *Climate Zones* 0-7 shall comply with C405.13.1 through C405.13.4.

C405.13.1 On-site renewable energy systems. *Buildings* shall install equipment for on-site renewable electricity generation with a direct current (DC) nameplate power rating of not less than 0.75 W/ft^2 (8.1 W/m^2) multiplied by the sum of the gross conditioned floor area of all floors not to exceed the combined gross conditioned floor area of the three largest floors.

Exception: The following *buildings* or *building sites* shall comply with Section C405.13.2:

1. A *building site* located where an unshaded flat plate collector oriented toward the equator and tilted at an angle from horizontal equal to the latitude receives an annual daily average incident solar radiation less than 1.1 kBtu/ft2 - day (3.5 kWh/m2 - day).
2. A *building* where more than 80% of the roof area is covered by any combination of permanent obstructions such as, but not limited to, mechanical equipment, vegetated space, access, pathways, or occupied roof terrace.
3. Any *building* where more than 50% of roof area is shaded from direct-beam sunlight by natural objects or by structures that are not part of the buildng for more than 2500 annual hours between 8:00 a.m. and 4:00 p.m.
4. A *building* with gross conditioned floor area less than 5,000 square feet (465 m^2).

C405.13.2 Off-site renewable energy. *Buildings* that qualify for one or more of the exceptions to Section 405.13.1 and do not meet the requirements of Section 405.13.1 either in part or in full, with an *on-site renewable energy system*, shall procure off-site renewable electrical energy, in accordance with C405.13.2.1 and C405.13.2.2, that shall not be less than the total off-site renewable electrical energy determined in accordance with Equation 4-12.

$TRE_{off} = (REN_{off} * 0.75\ W/ft2 * FLRA - IRE_{on}) *15$ **(Equation 4-12)**

where:

TRE_{off} = Total off-site renewable electrical energy in kilowatt-hours (kWh) to be procured in accordance with Table C405.13.2

REN_{off} = Annual off-site renewable electrical energy from Table C405.13.2, in units of kilowatt-hours per watt of array capacity

FLRA = the sum of the gross conditioned floor area of all floors not to exceed the combined floor area of the three largest floors

IRE_{on} = Annual *on-site* renewable electrical energy generation of a new *on-site renewable energy system*, to be installed as part of the *building* project, whose rated capacity is less than the rated capacity required in Section C405.13.1

Table C405.13.2 Annual Off-site Renewable Energy Requirement

Climate Zone	Annual Off-site Renewable Electrical Energy (kWh/W)
1A, 2B, 3B, 3C, 4B, and 5B	1.75 kWh/W
0A, 0B, 1B, 2A, 3A, and 6B	1.55 kWh/W
4A, 4C, 5A, 5C, 6A, and 7	1.35 kWh/W

C405.13.2.1 Off site procurement. The building owner as defined in the *International Building Code* shall procure and be credited for the total amount of off-site renewable electrical energy, not less than required in accordance with Equation 4-12, with one or more of the following:

1. A *physical renewable energy power purchase agreement*
2. A *financial renewable energy power purchase agreement*
3. A *community renewable energy facility*
4. Off-site renewable energy system owned by the building property owner

C405.13.2.2 Off-site contract. The renewable energy shall be delivered or credited to the *building site* under an energy contract with a duration of not less than 10 years. The contract shall be structured to survive a partial or full transfer of ownership of the building property. The total required off-site renewable electrical energy shall be procured in equal installments over the duration of the off-site contract.

C405.13.3 Renewable energy certificate documentation. The property owner or owner's authorized agent shall demonstrate that where RECs or EACs are associated with on-site and off-site renewable energy production required by Sections C405.13.1 and C405.13.2 all of the following criteria for RECs and EACs shall be met:

1. Are retained and retired by or on behalf of the property owner or tenant for a period of not less than 15 years or the duration of the contract in C405.13.2.2 whichever is less;
2. Are created within a 12-month period of the use of the REC; and
3. Are from a generating asset constructed no more than 5 years before the issuance of the certificate of occupancy.

C405.13.4 Renewable energy certificate purchase. A *building* that qualifies for one or more of the exceptions to Section C405.13.1 and where it can be demonstrated to the code official that the requirements of Section C405.13.2 cannot be met, the building owner shall contract for renewable electricity products complying with the Green-e Energy National Standard for Renewable Electricity products equivalent to five times the amount of total off-site renewable energy calculated in accordance with Equation 4-12.

Revise as follows:

C406.5.1 Basic renewable credit. The total minimum ratings of on-site renewable energy systems, not including systems used for credits under Sections C406.7.2 or installed systems used for compliance with Section C405.13.1, shall be one of the following:

1. Not less than 0.86 Btu/h per square foot (2.7 W/m^2) or 0.25 watts per square foot (2.7 W/m^2) of *conditioned floor area*.
2. Not less than 2 percent of the annual energy used within the building for building mechanical and service water-heating equipment and lighting regulated in Section C405.

C406.5.2 Enhanced renewable credit. Where the total minimum ratings of on-site renewable energy systems exceeds the rating in Section C406.5.1, additional energy efficiency credits shall be determined based on Equation 4-14, rounded to the nearest whole number.

$$AEEC_{RRa} = AEEC_{2.5} \times (RR_a - RR_{REQ} - RR_{WH}) / RR_1$$ **(Equation 4-14)**

where:

$AEEC_{RRa}$ = Section C406.5.2 additional energy efficiency credits.
$AEEC_{2.5}$ = Section C406.5 credits from Tables C406.1(1) through C406.1(5).
RRa = Actual total minimum ratings of *on-site renewable energy* systems (in Btu/h, watts per square foot or W/m^2).
RR_1 = Minimum ratings of *on-site renewable energy* systems required by Section C406.5.1 (in Btu/h, watts per square foot or W/m^2).
RR_{REW} = Minimum rating of installed on-site renewable energy systems required by Section C405.13 (in BTU/h, watts per square foot or W/m^2).
RR_{WH} = Minimum rating of installed on-site renewable energy systems used for credits under Section C406.7.2.

TABLE C407.4.1(1) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

BUILDING COMPONENT CHARACTERISTICS	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Space use classification	Same as proposed	The space use classification shall be chosen in accordance with Table C405.3.2(1) or C405.3.2(2) for all areas of the building covered by this permit. Where the space use classification for a building is not known, the building shall be categorized as an office building.
Roofs	Type: insulation entirely above deck	As proposed
	Gross area: same as proposed	As proposed
	U-factor: as specified in Table C402.1.4	As proposed
	Solar absorptance: 0.75	As proposed
	Emittance: 0.90	As proposed
Walls, above-grade	Type: same as proposed	As proposed
	Gross area: same as proposed	As proposed
	U-factor: as specified in Table C402.1.4	As proposed
	Solar absorptance: 0.75	As proposed
	Emittance: 0.90	As proposed
Walls, below-grade	Type: mass wall	As proposed
	Gross area: same as proposed	As proposed
	U-Factor: as specified in Table C402.1.4 with insulation layer on interior side of walls	As proposed
Floors, above-grade	Type: joist/framed floor	As proposed
	Gross area: same as proposed	As proposed
	U-factor: as specified in Table C402.1.4	As proposed
Floors, slab-on-grade	Type: unheated	As proposed
	F-factor: as specified in Table C402.1.4	As proposed
Opaque doors	Type: swinging	As proposed
	Area: Same as proposed	As proposed
	U-factor: as specified in Table C402.1.4	As proposed
Vertical fenestration other than opaque doors	Area 1. The proposed vertical fenestration area; where the proposed vertical fenestration area is less than 40 percent of above-grade wall area. 2. 40 percent of above-grade wall area; where the proposed vertical fenestration area is 40 percent or more of the above-grade wall area.	As proposed
	U-factor: as specified in Table C402.4	As proposed
	SHGC: as specified in Table C402.4 except that for climates with no requirement (NR) SHGC = 0.40 shall be used	As proposed
	External shading and PF: none	As proposed
Skylights	Area 1. The proposed skylight area; where the proposed skylight area is less than that permitted by Section C402.1. 2. The area permitted by Section C402.1; where the proposed skylight area exceeds that permitted by Section C402.1	As proposed

BUILDING COMPONENT CHARACTERISTICS	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
	that permitted by Section C402.1.	
	U-factor: as specified in Table C402.4	As proposed
	SHGC: as specified in Table C402.4 except that for climates with no requirement (NR) SHGC = 0.40 shall be used.	As proposed
Lighting, interior	The interior lighting power shall be determined in accordance with Section C405.3.2. Where the occupancy of the building is not known, the lighting power density shall be 1.0 watt per square foot based on the categorization of buildings with unknown space classification as offices.	As proposed
Lighting, exterior	The lighting power shall be determined in accordance with Tables C405.5.2(1), C405.5.2(2) and C405.5.2(3). Areas and dimensions of surfaces shall be the same as proposed.	As proposed
Internal gains	Same as proposed	Receptacle, motor and process loads shall be modeled and estimated based on the space use classification. End-use load components within and associated with the building shall be modeled to include, but not be limited to, the following: exhaust fans, parking garage ventilation fans, exterior building lighting, swimming pool heaters and pumps, elevators, escalators, refrigeration equipment and cooking equipment.
Schedules	Same as proposed **Exception:** Thermostat settings and schedules for HVAC systems that utilize radiant heating, radiant cooling and elevated air speed, provided that equivalent levels of occupant thermal comfort are demonstrated by means of equal Standard Effective Temperature as calculated in Normative Appendix B of ASHRAE Standard 55.	Operating schedules shall include hourly profiles for daily operation and shall account for variations between weekdays, weekends, holidays and any seasonal operation. Schedules shall model the time-dependent variations in occupancy, illumination, receptacle loads, thermostat settings, mechanical ventilation, HVAC equipment availability, service hot water usage and any process loads. The schedules shall be typical of the proposed building type as determined by the designer and approved by the jurisdiction.
Mechanical ventilation	Same as proposed	As proposed, in accordance with Section C403.2.2.
Heating systems	Fuel type: same as proposed design	As proposed
	Equipment type[a]: as specified in Tables C407.4.1(2) and C407.4.1(3)	As proposed
	Efficiency: as specified in the tables in Section C403.3.2.	As proposed
	Capacity[b]: sized proportionally to the capacities in the proposed design based on sizing runs, and shall be established such that no smaller number of unmet heating load hours and no larger heating capacity safety factors are provided than in the proposed design.	As proposed
Cooling systems	Fuel type: same as proposed design	As proposed
	Equipment type[c]: as specified in Tables C407.4.1(2) and C407.4.1(3)	As proposed
	Efficiency: as specified in Tables C403.3.2(1), C403.3.2(2) and C403.3.2(3)	As proposed
	Capacity[b]: sized proportionally to the capacities in the proposed design based on sizing runs, and shall be established such that no smaller number of unmet cooling load hours and no larger cooling capacity safety factors are provided than in the proposed design.	As proposed
	Economizer[d]: same as proposed, in	As proposed

BUILDING COMPONENT CHARACTERISTICS	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
	accordance with Section C403.5.	As proposed
	Fuel type: same as proposed	As proposed
Service water heating[e]	Efficiency: as specified in Table C404.2	~~For Group R, as proposed multiplied by SWHF.~~ For other than Group R, as proposed multiplied by efficiency as provided by the manufacturer of the DWHR unit.
	Capacity: same as proposed	As proposed
	Where no service water hot water system exists or is specified in the proposed design, no service hot water heating shall be modeled.	
On-site Renewable Energy	Where a *system* providing *on-site renewable energy* has been modeled in the *proposed design* the same system shall be modeled identically in the *standard reference design* except the rated capacity shall meet the requirements of Section C405.13.1 Where no system is designed or included in the proposed design, model an unshaded photovoltaic system with the following characteristics: **Size**: Rated capacity per Section C405.13.1 **Module Type**: Crystalline Silicone Panel with glass cover, 19.1% nominal efficiency and temperature coefficient of -0.35%/°C, Performance shall be based on a reference temperature of 77°F (25°C), airmass of 1.5 atmosphere and irradiance of 317 Btu/h x ft^2 (1000 W/m^2). **Array Type**: Rack mounted array with installed nominal operating cell temperature (INOCT) of 103°F (45°C). **Total System Losses** (DC output to AC output): 11.3%. **Tilt**: 0-degrees (mounted horizontally). **Azimuth**: 180 degrees.	As proposed

For SI: 1 watt per square foot = 10.7 w/m^2.

SWHF = Service Water Heat Recovery Factor, DWHR = Drain Water Heat Recovery.

a. Where no heating system exists or has been specified, the heating system shall be modeled as fossil fuel. The system characteristics shall be identical in both the standard reference design and proposed design.

b. The ratio between the capacities used in the annual simulations and the capacities determined by sizing runs shall be the same for both the standard reference design and proposed design.

c. Where no cooling system exists or no cooling system has been specified, the cooling system shall be modeled as an air-cooled single-zone system, one unit per thermal zone. The system characteristics shall be identical in both the standard reference design and proposed design.

d. If an economizer is required in accordance with Table C403.5(1) and where no economizer exists or is specified in the proposed design, then a supply-air economizer shall be provided in the standard reference design in accordance with Section C403.5.

e. The SWHF shall be applied as follows:

1. Where potable water from the DWHR unit supplies not less than one shower and not greater than two showers, of which the drain water from the same showers flows through the DWHR unit then SWHF = [1 – (DWHR unit efficiency × 0.36)].
2. Where potable water from the DWHR unit supplies not less than three showers and not greater than four showers, of which the drain water from the same showers flows through the DWHR unit then SWHF = [1 – (DWHR unit efficiency × 0.33)].
3. Where potable water from the DWHR unit supplies not less than five showers and not greater than six showers, of which the drain water from the same showers flows through the DWHR unit, then SWHF = [1 – (DWHR unit efficiency × 0.26)].
4. Where Items 1 through 3 are not met, SWHF = 1.0.

Add new text as follows:

C502.3.7 Renewable energy systems. Additions shall comply with Section C405.13 for the addition alone.

Green-e

Green-e
c/o Center for Resource Solutions
1012 Torney Ave., Second Floor
San Francisco, CA 94129

Green-e. Version 1.0, July 7, 2017
Green-e Energy National Standard for Renewable Electricity Products

Reason: This proposal adds on-site renewables to the IECC for reduced consumer cost and societal protection

Cost Impact: The code change proposal will increase the cost of construction.
The code change proposal will increase the cost of construction

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Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: This proposal adds on-site renewables to the IECC for reduced consumer cost and societal protection

Proposal # 592

CECPI-3-21

Proponents: Tom Culp, representing IECC Commercial Envelope and Embodied Energy Subcommittee (ieccceenvelope@iccsafe.org)

2021 International Energy Conservation Code

Revise as follows:

~~C402.5.5~~ C402.1.3 Rooms containing fuel-burning appliances. In *Climate Zones* 3 through 8, where combustion air is supplied through openings in an exterior wall to a room or space containing a space-conditioning fuel-burning appliance, one of the following shall apply:

1. The room or space containing the appliance shall be located outside of the *building thermal envelope*.
2. The room or space containing the appliance shall be enclosed and isolated from conditioned spaces inside the *building thermal envelope*. Such rooms shall comply with all of the following:

   2.1. The walls, floors and ceilings that separate the enclosed room or space from conditioned spaces shall be insulated to be not less than equivalent to the insulation requirement of below-grade walls as specified in Table C402.1.3 or Table C402.1.4.

   2.2. The walls, floors and ceilings that separate the enclosed room or space from conditioned spaces shall be sealed in accordance with Section ~~C402.5.1.1~~ C402.5.1.2.

   2.3. The doors into the enclosed room or space shall be shall be fully gasketed.

   2.4. ~~Water lines and~~ Piping serving as part of a heating or cooling system and ducts in the enclosed room or space shall be insulated in accordance with Section C403. Service water piping shall be insulated in accordance with Section C404.

   2.5. Where an air duct supplying combustion air to the enclosed room or space passes through *conditioned space*, the duct shall be insulated to an *R*-value of not less than R-8.

Exception: Fireplaces and stoves complying with Sections 901 through 905 of the International Mechanical Code, and Section 2111.14 of the International Building Code.

C402.5 Air leakage—thermal envelope. The *building thermal envelope* shall comply with Sections C402.5.1 through Section C402.5.8.1 ~~C402.5.11.1, or the building *thermal envelope* shall be tested in accordance with Section C402.5.2 or C402.5.3. Where compliance is based on such testing, the building shall also comply with Sections C402.5.7, C402.5.8 and C402.5.9.~~

C402.5.1 Air barriers. A continuous air barrier shall be provided throughout the *building thermal envelope*. The ~~continuous air barriers shall be located on the inside or outside of the building thermal envelope, located within the assemblies composing the building thermal envelope, or any combination thereof. The air barrier shall comply with Sections C402.5.1.1, and C402.5.1.2.~~ *air barrier* is permitted to be any combination of inside, outside, or within the building thermal envelope. The *air barrier* shall comply with Sections C402.5.1.1, and C402.5.1.2. The *air leakage* performance of the *air barrier* shall be verified in accordance with Section C402.5.2.

Exception: *Air barriers* are not required in buildings located in *Climate Zone* 2B.

Add new text as follows:

C402.5.1.1 Air barrier design and documentation requirements. Design of the continuous *air barrier* shall be documented in the following manner:

1. Components comprising the continuous *air barrier* and their position within each *building thermal envelope* assembly shall be identified.
2. Joints, interconnections, and penetrations of the continuous *air barrier* components shall be detailed.
3. The continuity of the *air barrier* building element assemblies that enclose conditioned space or provide a boundary between conditioned space and unconditioned space shall be identified.
4. Documentation of the continuous air barrier shall detail methods of sealing the air barrier such as wrapping, caulking, gasketing, taping or other *approved* methods at the following locations:

   4.1 Joints around fenestration and door frames.

   4.2 Joints between walls and floors, between walls at building corners, between walls and roofs including parapets and copings, where above-grade walls meet foundations, and similar intersections.

   4.3 Penetrations or attachments through the continuous *air barrier* in building envelope roofs, walls, and floors.

   4.4 Building assemblies used as ducts or plenums.

   4.5 Changes in continuous *air barrier* materials and assemblies.

5. Identify where testing will or will not be performed in accordance with Section C402.5.2 Where testing will not be performed, a plan for field inspections required by C402.5.2.3 shall be provided that includes the following:
   5.1 Schedule for periodic inspection,
   5.2 Continuous air barrier scope of work,
   5.3 List of critical inspection items,
   5.4 Inspection documentation requirements, and
   5.5 Provisions for corrective actions where needed.

Revise as follows:

C402.5.1.1 2 Air barrier construction. The *continuous air barrier* shall be constructed to comply with the following:

1. The *air barrier* shall be continuous for all assemblies that are compromise the *building thermal envelope* of the building and across the joints and assemblies.
2. Air barrier joints and seams shall be sealed, including sealing transitions in places and changes in materials. The joints and seals shall be securely installed in or on the joint for its entire length so as not to dislodge, loosen or otherwise impair its ability to resist positive and negative pressure differentials such as those from design wind loads, stack effect and mechanical ventilation.
3. Penetrations of the *air barrier* shall be caulked, gasketed or otherwise sealed in a manner compatible with the construction materials and location. Sealing shall allow for expansion, contraction and mechanical vibration. Sealing materials shall be securely installed around the penetration so as not to dislodge, loosen or otherwise impair the penetrations' ability to resist positive and negative pressure. ~~Joints and seams associated with penetrations shall be sealed in the same manner or taped. Sealing materials shall be securely installed around the penetration so as not to dislodge, loosen or otherwise impair the penetrations' ability to resist positive and negative pressure from wind, stack effect and mechanical ventilation.~~ Sealing of concealed fire sprinklers, where required, shall be in a manner that is recommended by the fire sprinkler manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.
4. Recessed lighting fixtures shall comply with Section ~~C402.5.10~~ C402.5.1.2.1. Where similar objects are installed that penetrate the *air barrier*, provisions shall be made to maintain the integrity of the *air barrier*.
5. Electrical and communication boxes shall comply with C402.5.1.2.2.

C402.5.10 1.2.1 Recessed lighting. Recessed luminaires installed in the *building thermal envelope* shall be all of the following:

1. IC-rated.
2. Labeled as having an air leakage rate of not ~~more~~ greater than 2.0 cfm (0.944 L/s) ~~when~~ where tested in accordance with ASTM E283 at a 1.57 psf (75 Pa) pressure differential.
3. Sealed with a gasket or caulk between the housing and interior wall or ceiling covering.

Add new text as follows:

C402.5.1.2.2 Electrical and communication boxes. Electrical and communication boxes that penetrate the air barrier of the *building thermal envelope*, and that do not comply with C402.5.1.2.2.1, shall be caulked, taped, gasketed, or otherwise sealed to the air barrier element being penetrated. All openings on the concealed portion of the box shall be sealed. Where present, insulation shall rest against all concealed portions of the box.

C402.5.1.2.2.1 Air-sealed boxes. Where air-sealed boxes are installed, they shall be marked in accordance with NEMA OS 4. Air-sealed boxes shall be installed in accordance with the manufacturer's instructions.

Revise as follows:

C402.5.1.2 Air leakage compliance. ~~A continuous air barrier for the opaque building envelope shall comply with the following:~~ Air leakage of the *building thermal envelope* shall be tested by an *approved* third party in accordance with C402.5.2.1. The measured air leakage shall not be greater than 0.35 cfm/ft^2 (1.8 L/s x m^2) of the *building thermal envelope* area at a pressure differential of 0.3 inch water gauge (75 Pa) with the calculated *building thermal envelope* surface area being the sum of the above- and below-grade *building thermal envelope*.

Exceptions:

1. Where the measured *air leakage* rate is greater than 0.35 cfm/ft^2 (1.8 L/s x m^2) but is not greater than 0.45 cfm/ft2 (2.3 L/s x m^2), the *approved* third party shall perform a diagnostic evaluation using smoke tracer or infrared imaging. The evaluation shall be condued while the building is pressurized along with a visual inspection of the *air barrier* in accordance with ASTM E1186. All identified leaks shall be sealed where such sealing can be made without damaging existing building components. A report specifying the corrective actions taken to seal leaks shall be deemed to establish compliance with the requirements of this section where submitted to the code official and the building owner. Where the measured *air leakage* rate is greater than 0.45 cfm/ft^2 (2.3 L/s x m^2), corrective actions must be made to the building and an additional test completed for which the results are 0.45 cfm/ft2 (2.3 L/s x m^2), or less.

2. Buildings in Climate Zones 2B.
3. Buildings larger than 25,000 square feet (2300 m2) floor area in Climate Zones 0 through 4, other than Group R and I occupancies, that comply with C402.5.2.3
4. As an alternative, buildings or portions of building, containing Group R and I occupancies, shall be permitted to be tested by an *approved* third party in accordance with C402.5.2.2. The reported *air leakage* of the *building thermal envelope* shall not be greater than 0.27 cfm/ft2 (1.4 L/s x m2) of the *testing unit enclosure* area at a pressure differential of 0.2 inch water gauge (50 Pa).

1. ~~Buildings or portions of buildings, including Group R and I occupancies, shall meet the provisions of Section C402.5.2.~~

   ~~**Exception:** Buildings in Climate Zones 2B, 3C and 5C.~~

2. ~~Buildings or portions of buildings other than Group R and I occupancies shall meet the provisions of Section C402.5.3.~~

   ~~**Exceptions:**~~

   1. ~~Buildings in Climate Zones 2B, 3B, 3C and 5C.~~
   2. ~~Buildings larger than 5,000 square feet (464.5 m^2) floor area in Climate Zones 0B, 1, 2A, 4B and 4C.~~
   3. ~~Buildings between 5,000 square feet (464.5 m^2) and 50,000 square feet (4645 m^2) floor area in Climate Zones 0A, 3A and 5B.~~

3. ~~Buildings or portions of buildings that do not complete air barrier testing shall meet the provisions of Section C402.5.1.3 or C402.5.1.4 in addition to Section C402.5.1.5.~~

C402.5.~~3~~ 2.1 ~~Building thermal envelope testing~~ Whole building test method and reporting. The *building thermal envelope* shall be tested for *air leakage* in accordance with ~~ASTM E779, ANSI/RESNET/ICC 380,~~ ASTM E3158 ~~or ASTM E1827~~ or an equivalent *approved* method ~~approved by the code official~~. ~~The measured air leakage shall not exceed 0.40 cfm/ft^2 (2.0 L/s × m^2) of the *building thermal envelope* area at a pressure differential of 0.3 inch water gauge (75 Pa). Alternatively, portions of the building shall be tested and the measured air leakages shall be area weighted by the surface areas of the building envelope in each portion. The weighted average test results shall not exceed the whole building leakage limit. In the alternative approach, the following portions of the building shall be tested:~~ A report that includes the tested surface area, floor area, air by volume, stories above grade, and leakage rates shall be submitted to the code official and the building owner.

1. ~~The entire envelope area of all stories that have any spaces directly under a roof.~~
2. ~~The entire envelope area of all stories that have a building entrance, exposed floor, or loading dock, or are below grade.~~
3. ~~Representative above-grade sections of the building totaling at least 25 percent of the wall area enclosing the remaining conditioned space.~~

Exceptions: ~~Where the measured air leakage rate exceeds 0.40 cfm/ft^2 (2.0 L/s × m^2) but does not exceed 0.60 cfm/ft^2 (3.0 L/s × m^2), a diagnostic evaluation using smoke tracer or infrared imaging shall be conducted while the building is pressurized along with a visual inspection of the air barrier. Any leaks noted shall be sealed where such sealing can be made without destruction of existing building components. An additional report identifying the corrective actions taken to seal leaks shall be submitted to the code official and the building owner, and shall be deemed to comply with the requirements of this section.~~

1. For buildings less than 10,000 ft^2 (1000 m^2) the entire *building thermal envelope* shall be permitted to be tested in accordance with ASTM E779, ASTM E3158, or ASTM E1827 or an equivalent *approved* method.

2. For buildings greater than 50,000 ft^2 (4645 m^2), portions of the building shall be permitted to be tested and the measured *air leakage* shall be area-weighted by the surface areas of the *building thermal envelope* in each portion. The weighted average tested *air leakage* shall not be greater than the whole building leakage limit. The following portions of the building shall be tested:

   2.1. The entire *building thermal envelope* area of stories that have any conditioned spaces directly under a roof.

   2.2 The entire *building thermal envelope* area of stories that have a building entrance, a floor over unconditioned space, a loading dock, or that are below grade.

   2.3 Representative above-grade portions of the building totaling not less than 25 percent of the wall area enclosing the remaining conditioned space.

C402.5.2.2 Dwelling and sleeping unit enclosure test~~ing~~ method and reporting. The *building thermal envelope* shall be tested for *air leakage* in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E1827 or an equivalent *approved* method~~ approved by the *code official*. The measured air leakage shall not exceed 0.30 cfm/ft² (1.5 L/s m²) of the testing unit enclosure area at a pressure differential of 0.2 inch water gauge (50 Pa).~~ Where multiple dwelling units or sleeping units or other occupiable conditioned spaces are contained within one *building thermal envelope*, each unit shall be considered an individual testing unit, and the building air leakage shall be the weighted average of all testing unit results, weighted by each *testing unit~~'s~~ enclosure area*. Units shall be tested ~~separately with an unguarded blower door test as follows:~~ without simultaneously pressuring adjacent units and shall be separately tested as follows:

1. Where buildings have ~~fewer~~ less than eight testing units, each testing unit shall be tested.
2. ~~For~~ Where buildings ~~with~~ have eight or more testing units, the greater of seven units or 20 percent of the testing units in the building shall be tested, including a top floor unit, a middle floor unit, a ground floor unit and a unit with the largest testing *unit enclosure area*. For each tested unit that exceeds the maximum *air leakage* rate, an additional ~~two~~ three units shall be tested, including a mixture of testing unit types and locations.

C402.5.~~1.5~~ 2.3 Building envelope design and construction ~~performance~~ verification criteria. Where Sections C402.5.2.1 and C402.5.2.2 are not applicable, ~~T~~ the installation of the continuous *air barrier* shall be verified by the *code official*, a *registered design professional* or *approved* agency in accordance with the following:

1. A review of the construction documents and other supporting data shall be conducted to assess compliance with the requirements in Section C402.5.1.
2. Inspection of continuous air barrier components and assemblies shall be conducted during construction ~~while the air barrier is still accessible for inspection and repair~~ to verify compliance with the requirements of Sections C402.5.~~1.3~~ 2.3.1 ~~and~~ or C402.5.~~1.4.~~ 2.3.2. The *air barrier* shall remain accessible for inspection and repair.
3. A final ~~commissioning~~ inspection report shall be provided for inspections completed by the *registered design professional* or *approved* agency. The ~~commissioning~~ inspection report shall be provided to the building owner or owner's authorized agent and the *code official*. The report shall identify deficiencies found during inspection ~~the review of the construction documents and inspection~~ and details of corrective measures taken.

C402.5.~~1.3~~ 2.3.1 Materials. Materials with an air permeability not greater than 0.004 cfm/ft^2 (0.02 L/s × m^2) under a pressure differential of 0.3 inch water gauge (75 Pa) when tested in accordance with ASTM E2178 shall comply with this section. Materials in Items 1 through 16 below shall be deemed to comply with this section, provided that joints are sealed and materials are installed as air barriers in accordance with the manufacturer's instructions.

1. Plywood with a thickness of not less than $^3/_8$ inch (10 mm).
2. Oriented strand board having a thickness of not less than $^3/_8$ inch (10 mm).
3. Extruded polystyrene insulation board having a thickness of not less than $^1/_2$ inch (12.7 mm).
4. Foil-back polyisocyanurate insulation board having a thickness of not less than $^1/_2$ inch (12.7 mm).
5. Closed-cell spray foam having a minimum density of 1.5 pcf (2.4 kg/m^3) and having a thickness of not less than $1^1/_2$ inches (38 mm).
6. Open-cell spray foam with a density between 0.4 and 1.5 pcf (0.6 and 2.4 kg/m^3) and having a thickness of not less than 4.5 inches (113 mm).
7. Exterior or interior gypsum board having a thickness of not less than $^1/_2$ inch (12.7 mm).
8. Cement board having a thickness of not less than $^1/_2$ inch (12.7 mm).
9. Built-up roofing membrane.
10. Modified bituminous roof membrane.
11. Single-ply roof membrane.
12. A Portland cement/sand parge, or gypsum plaster having a thickness of not less than $^5/_8$ inch (15.9 mm).

13. Cast-in-place and precast concrete.
14. Fully grouted concrete block masonry.
15. Sheet steel or aluminum.
16. Solid or hollow masonry constructed of clay or shale masonry units.

C402.5.~~1.4~~ 2.3.2 Assemblies. Assemblies of materials and components with an average *air leakage* not greater than 0.04 cfm/ft^2 (0.2 L/s × m^2) under a pressure differential of 0.3 inch of water gauge ~~(w.g.)~~(75 Pa) ~~when~~ where tested in accordance with ASTM E2357, ASTM E1677 , ASTM D8052 or ASTM E283 shall comply with this section. Assemblies listed in Items 1 through 3 below shall be deemed to comply, provided that joints are sealed and the requirements of Section C402.5.1.1 are met.

1. Concrete masonry walls coated with either one application of block filler or two applications of a paint or sealer coating.
2. Masonry walls constructed of clay or shale masonry units with a nominal width ~~of~~ greater than or equal to 4 inches (102 mm) ~~or more~~.
3. A Portland cement/sand parge, stucco or plaster not less than $^1/_2$ inch (12.7 mm) in thickness.

C402.5.~~4~~ 3 Air leakage of fenestration. The *air leakage* of fenestration assemblies shall ~~meet~~ comply with ~~the provisions of~~ Table C402.5.~~4~~ 3. Testing shall be conducted ~~in accordance with the applicable reference test standard in Table C402.5.4~~ by an accredited, independent testing laboratory in accordance with applicable reference test standad in Table C402.5.3 and *labeled* by the manufacturer.

Exceptions:

1. Field-fabricated fenestration assemblies that are sealed in accordance with Section C402.5.1.2.
2. Fenestration in buildings that ~~comply with the testing alternative of~~ are tested for air leakage in accordance with Section C402.5 .2 are not required to meet the air leakage requirements in Table C402.5.~~4~~ 3.

TABLE C402.5.~~4~~ 3 MAXIMUM AIR LEAKAGE RATE FOR FENESTRATION ASSEMBLIES

FENESTRATION ASSEMBLY	MAXIMUM RATE (CFM/FT^2)	TEST PROCEDURE
Windows	0.20[a]	AAMA/WDMA/CSA101/I.S.2/A440 or NFRC 400
Sliding doors	0.20[a]	
Swinging doors	0.20[a]	
Skylights—with condensation weepage openings	0.30	
Skylights—all other	0.20[a]	
Curtain walls	0.06	NFRC 400 or ASTM E283 at 1.57 psf (75 Pa)
Storefront glazing	0.06	
Commercial glazed swinging entrance doors	1.00	
Power-operated sliding doors and power operated folding doors	1.00	
Revolving doors	1.00	
Garage doors	0.40	ANSI/DASMA 105, NFRC 400, or ASTM E283 at 1.57 psf (75 Pa)
Rolling doors	1.00	
High-speed doors	1.30	

For SI: 1 cubic foot per minute = 0.47 L/s, 1 square foot = 0.093 m^2.

a. The maximum rate for windows, sliding and swinging doors, and skylights is permitted to be 0.3 cfm per square foot of fenestration or door area when tested in accordance with AAMA/WDMA/CSA101/I.S.2/A440 at 6.24 psf (300 Pa).

C402.5.~~6~~ 4 Doors and access openings to shafts, chutes, stairways and elevator lobbies. Doors and *access* openings from conditioned space to shafts, chutes stairways and elevator lobbies not within the scope of the fenestration assemblies covered by Section C402.5.~~4~~ 3 shall be gasketed, weather-stripped or sealed.

Exceptions:

1. Door openings required to comply with Section 716 of the *International Building Code*.
2. Doors and door openings required ~~to comply with UL 1784~~ by the *International Building Code* to comply with UL 1784.

C402.5.~~7~~ 5 Air intakes, exhaust openings, stairways and shafts. Stairway enclosures, elevator shaft vents and other outdoor air intakes and exhaust openings integral to the building envelope shall be provided with dampers in accordance with Section C403.7.7.

C402.5.~~9~~ 6 Vestibules. Building entrances shall be protected with an enclosed vestibule~~,~~ . ~~with all d~~ Doors opening into and out of the vestibule equipped with self-closing devices. Vestibules shall be designed so that in passing through the vestibule it is not necessary for the interior and exterior doors to open at the same time. The installation of one or more revolving doors in the *building entrance* shall not eliminate the requirement that a vestibule be provided on any doors adjacent to revolving doors.

Exceptions: Vestibules are not required for the following:

1. Buildings in *Climate Zones* 0 through 2.
2. Doors not intended to be used by the public, such as doors to mechanical or electrical equipment rooms, or intended solely for employee use.
3. Doors opening directly from a *sleeping unit* or dwelling unit.
4. Doors that open directly from a space less than 3,000 square feet (298 m^2) in area.
5. Revolving doors.
6. Doors used primarily to facilitate vehicular movement or material handling and adjacent personnel doors.
7. Doors that have an air curtain with a velocity of not less than 6.56 feet per second (2 m/s) at the floor that have been tested in accordance with ANSI/AMCA 220 and installed in accordance with the manufacturer's instructions. Manual or automatic controls shall be provided that will operate the air curtain with the opening and closing of the door. Air curtains and their controls shall comply with Section C408.2.3.

C402.5.~~8~~ 7 Loading dock weather seals. Cargo door openings and loading door openings shall be equipped with weather seals that restrict ~~infiltration~~ air leakage and provide direct contact along the top and sides of vehicles that are parked in the doorway.

C402.5.~~11~~ 8 Operable openings interlocking. Where occupancies utilize operable openings to the outdoors that are larger than 40 square feet (3.7 m^2) in area, such openings shall be interlocked with the heating and cooling system ~~so as~~ to raise the cooling setpoint to 90°F (32°C) and lower the heating setpoint to 55°F (13°C) whenever the operable opening is open. The change in heating and cooling setpoints shall occur ~~within 10 minutes of opening the operable opening.~~when the operable opening has been open for a period not to exceed 10 minutes.

Exceptions:

1. Operable openings into s~~S~~eparately zoned areas associated with the preparation of food that contain appliances that contribute to the HVAC loads of a restaurant or similar type of occupancy.
2. Storage occupancies ~~Warehouses~~ that utilize overhead doors for the function of the occupancy, where *approved* ~~by the code official~~.
3. ~~The first entrance d~~ Doors ~~where~~ located in the exterior wall ~~and~~ that are part of a vestibule system.

C402.5.~~11.1~~ 8.1 Operable controls. Controls shall comply with Section C403.1~~4~~ 3.

C406.9 Reduced air ~~infiltration~~ leakage. *Air* ~~infiltration~~*leakage of the building thermal envelope* shall be ~~verified~~ tested by an *approved* third party ~~whole-building pressurization testing conducted~~ in accordance with ~~ASTM E779 or ASTM E1827 by an independent third party~~ Section C402.5.2.1. The measured *air-leakage* ~~rate of the building envelope~~ shall not exceed 0.2~~5~~ 2 cfm/ft^2 (~~2.0~~ 1.1 L/s × m^2) of the *building thermal envelope* ~~under~~ at a pressure differential of 0.3 inches water column (75 Pa), with the calculated surface area being the sum of the above- and below-grade *building thermal envelope*. ~~A report that includes the tested surface area, floor area, air by volume, stories above grade, and leakage rates shall be submitted to the code official and the building owner.~~

~~**Exception:** For buildings having over 250,000 square feet (25 000 m^2) of *conditioned floor area*, air leakage testing need not be conducted on the whole building where testing is conducted on representative above-grade sections of the building. Tested areas shall total not less than 25 percent of the conditioned floor area and shall be tested in accordance with this section.~~

Reason: Reason: This proposal is a merged proposal based on parts or all of proposals CEPI-55, CEPI-56, CEPI-57, CEPI-58, CEPI-63 Pt1, and CEPI-70 aimed primarily at reorganizing the structure of Section C402.5 to reduce redundancy and improve the clarity of the section. Section C402.5 is currently one of the most intricate and potentially confusing sections of the code, and this proposal seeks to simplify it by improving the flow of the text. Reorganization focused on the re-structure of the existing testing requirements to have clear performance requirements, testing criteria requirements and whole building testing exceptions. Specifically:

· The restructuring separates sections specifying the air leakage maximum values from sections specifying the methods by which these values are tested and verified. This allows for the enhanced air leakage option in Section C406 to be tested by the same by the same test method as the basic requirements in Section C402.5. This will enable consistency between the two sections and reduce divergence as the code is developed in future code cycles. Furthermore, this section separation will allow an easier revision of the code as new technology are deployed in the industry.

· Adding a clarification that the Group R & I sleeping and dwelling unit testing is optional. Group R & I buildings are permitted to use whole building testing.

· Removes overlapping exceptions, and repeated testing references.

Some additional requirements contained in CEPI-57 and CEPI-58 are included.

Summary of changes in merged, re-structure proposal:

The restructure is shown in the table below.

· Referenced Section and Table numbers is shown in the proposal text in green to aid in review.

· Clauses/requirements/exceptions dealing with the performance level stringency and climate zone and building size test exceptions that were recommended by the SC action on overlay proposals (CEPI-71, CEPI-61 & CEPI-62) are highlighted in red. Changes in stringency from CEPI-71 are shown below.

IECC-2021

Based on CEPI-71

Whole Building leakage limit

0.40 cfm/ft^2 (2.0 L/s × m^2) @0.3 inch water gauge (75 Pa)

0.35 cfm/ft^2 (1.8 L/s × m2) @ 0.3 inch water gauge (75 Pa)

Oops clause upper limit

0.60 cfm/ft^2 (2.3 L/s × m^2) @0.3 inch water gauge (75 Pa)

0.45 cfm/ft^2 (2.3 L/s × m^2) @0.3 inch water gauge (75 Pa)

Dwelling unit leakage limit

0.30 cfm/ft^2 (1.5 L/s x m^2) @ 0.2 inch water gauge (50 Pa).

0.27 cfm/ft^2 (1.4 L/s x m^2) @ 0.2 inch water gauge (50 Pa).

C406.9 Energy credit (whole building)

0.25 cfm/ft^2 (2.0 L/s × m^2) @ 0.3 inches water column (75 Pa)

0.22 cfm/ft^2 (1.1 L/s × m^2) @ 0.3 inches water column (75 Pa)

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The restructuring aspect of this code change proposal will neither increase nor decrease the cost of construction as written, because it is just rearranging the current requirements for better clarity and usability. This reorganization also includes changes from other approved proposals (CEPI-32, CEPI-60, CEPI-68 and CEPI-69), whose cost impact statements also indicate that they will neither increase nor decrease the cost of construction.

As part of the restructuring and cleanup, this code proposal does include the results of other air leakage proposals previously approved by the envelope subcommittee that do increase the cost of construction. Please see the associated cost statements for CEPI-61 and CEPI-71, both as modified.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: The restructuring aspect of this code change proposal will neither increase nor decrease the cost of construction as written, because it is just rearranging the current requirements for better clarity and usability. This reorganization also includes changes from other approved proposals (CEPI-32, CEPI-60, CEPI-68 and CEPI-69), whose cost impact statements also indicate that they will neither increase nor decrease the cost of construction

Proposal # 594

CECPI-4-21

Proponents: Tom Culp, representing IECC Commercial Envelope and Embodied Energy Subcommittee (ieccceenvelope@iccsafe.org)

2021 International Energy Conservation Code

Revise as follows:

C103.2 Information on construction documents. Construction documents shall be drawn to scale on suitable material. Electronic media documents are permitted to be submitted where *approved* by the *code official*. Construction documents shall be of sufficient clarity to indicate the location, nature and extent of the work proposed, and show in sufficient detail pertinent data and features of the building, systems and equipment as herein governed. Details shall include, but are not limited to, the following as applicable:

1. Energy compliance path.
2. Insulation materials and their *R*-values.
3. Fenestration *U*-factors and solar heat gain coefficients (SHGCs).
4. Area-weighted *U*-factor and solar heat gain coefficient (SHGC) calculations.
5. Mechanical system design criteria.
6. Mechanical and service water-heating systems and equipment types, sizes and efficiencies.
7. Economizer description.
8. Equipment and system controls.
9. Fan motor horsepower (hp) and controls.
10. Duct sealing, duct and pipe insulation and location.
11. Lighting fixture schedule with wattage and control narrative.
12. Location of *daylight* zones on floor plans.
13. Air barrier and air sealing details, including the location of the air barrier.
14. *Thermal bridges* as identified in Section C402.6.

F-FACTOR. The perimeter heat loss factor per unit perimeter length of ~~for~~ slab-on-grade floors (Btu/h × ft × °F) [W/(m × K)].

Add new definition as follows:

PSI-FACTOR (Ψ-FACTOR). the heat loss factor per unit length of a *thermal bridge* characterized as a linear element of a *building thermal envelope* (Btu/h x ft x °F)[W/(m x K)].

CHI-FACTOR (χ-FACTOR). The heat loss factor for a single *thermal bridge* characterized as a point element of a *building thermal envelope* (Btu/h x °F)[W/K].

THERMAL BRIDGE. An element or interface of elements that has higher thermal conductivity than the surrounding *building thermal envelope*, which creates a path of least resistance for heat transfer.

Revise as follows:

C402.1 General. *Building thermal envelope* assemblies for buildings that are intended to comply with the code on a prescriptive basis in accordance with the compliance path described in Item 1 of Section C401.2.1shall comply with the following:

1. The opaque portions of the *building thermal envelope* shall comply with the specific insulation requirements of Section C402.2 and the thermal requirements of either the *R*-value-based method of Section C402.1.3; the *U*-, *C*- and *F*-factor-based method of Section C402.1.4; or the component performance alternative of Section C402.1.5.
2. Roof solar reflectance and thermal emittance shall comply with Section C402.3.
3. Fenestration in building envelope assemblies shall comply with Section C402.4.
4. Air leakage of building envelope assemblies shall comply with Section C402.5.
5. *Thermal bridges* in *above-grade walls* shall comply with Section C402.6.

Alternatively, where buildings have a vertical fenestration area or skylight area exceeding that allowed in Section C402.4, the building and *building thermal envelope* shall comply with Item 2 of Section C401.2.1 or Section C401.2.2.

Walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with Section C403.11.

C402.1.5 Component performance alternative. Building envelope values and fenestration areas determined in accordance with Equation 4-2 shall be an alternative to compliance with the *U*-, *F*- , *psi*-, *chi*-, and *C*-factors in Tables C402.1.4 , C402.1.5, and C402.4 and the maximum allowable fenestration areas in Section C402.4.1. *Fenestration* shall meet the applicable SHGC requirements of Section C402.4.3.

A+B+C+D+E+T≤Zero **(Equation 4-2)**
where:

A = Sum of the (UA Dif) values for each distinct assembly type of the *building thermal envelope*, other than slabs on grade and below-grade walls.

UA Dif = UA Proposed – UA Table.

UA Proposed = Proposed *U*-value × Area.

UA Table = (*U*-factor from Table C402.1.3, C402.1.4 or C402.4) × Area.

B = Sum of the (FL Dif) values for each distinct slab-on-grade perimeter condition of the *building thermal envelope*.

FL Dif = FL Proposed – FL Table.

FL Proposed = Proposed *F*-value × Perimeter length.

FL Table = (*F*-factor specified in Table C402.1.4) × Perimeter length.

C = Sum of the (CA Dif) values for each distinct *below-grade wall* assembly type of the *building thermal envelope*.

CA Dif = CA Proposed – CA Table.

CA Proposed = Proposed *C*-value × Area.

CA Table = (Maximum allowable *C*-factor specified in Table C402.1.4) × Area.

Where the proposed vertical glazing area is less than or equal to the maximum vertical glazing area allowed by Section C402.4.1, the value of D (Excess Vertical Glazing Value) shall be zero. Otherwise:

D = (DA × UV) – (DA × U Wall), but not less than zero.

DA = (Proposed Vertical Glazing Area) – (Vertical Glazing Area allowed by Section C402.4.1).

UA Wall = Sum of the (UA Proposed) values for each opaque assembly of the exterior wall.

U Wall = Area-weighted average *U*-value of all above-grade wall assemblies.

UAV = Sum of the (UA Proposed) values for each vertical glazing assembly.

UV = UAV/total vertical glazing area.

Where the proposed skylight area is less than or equal to the skylight area allowed by Section C402.4.1, the value of E (Excess Skylight Value) shall be zero. Otherwise:

E = (EA × US) – (EA × U Roof), but not less than zero.EA = (Proposed Skylight Area) – (Allowable Skylight Area as specified in Section C402.4.1).U Roof = Area-weighted average *U*-value of all roof assemblies.UAS = Sum of the (UA Proposed) values for each skylight assembly.US = UAS/total skylight area.
T= Sum of the (ΨL Dif) and (χN Dif) values for each type of *thermal bridge* condition of the *building thermal envelope* as identified in Section C402.6. For the purposes of this section, the ΨL Dif and χN Dif values for *thermal bridges* caused by materials with a thermal conductivity less than or equal to 3.0 Btu-in/h-ft^2-F shall be assigned as zero. For buildings or structures located in Climate Zones 0 through 3, the value of T shall be assigned as zero.
ΨL Dif=ΨL Proposed -ΨL Table.
ΨL Proposed = Proposed *psi-factor* x length of the *thermal bridge* elements in the proposed *building thermal envelope*.

ΨL Table = (*psi-factor* specified as "compliant" in Table C402.1.5) x length of the *thermal bridge* linear elements.

χN Dif=χN Proposed-χN Table.

χN Proposed = Proposed *chi-factor* x number of the *thermal bridge* point elements other than fasteners, ties, or brackets in the proposed *building thermal envelope.*

χN Table=(*chi-factor* specified as "compliant" in Table C402.1.5) x number of the *thermal bridge* point elements.

A proposed *psi-* or *chi-factor* for each *thermal bridge* shall comply with one of the following as applicable:

1. Where the proposed mitigation of a *thermal bridge* is compliant with the requirements of Section C402.6, the value identified as compliant in Table C402.1.5 shall be used for the proposed *psi-* or *chi-factors*.
2. Where a *thermal bridge* is mitigated such that it does not comply with Section C402.6, the values identified as non-compliant in Table C402.1.5 shall be used for the proposed *psi-* or *chi-factors*.
3. Where the proposed mitigation of a *thermal bridge* provides a *psi-* or *chi-factor* less than the values identified as compliant in Table C402.1.5, the proposed *psi-* or *chi-factor* shall be determined by thermal analysis, testing, or other *approved* methods.

Add new text as follows:

Table C402.1.5 PSI- and CHI-FACTORS TO DETERMINE THERMAL BRIDGES FOR THE COMPONENT PERFORMANCE ALTERNATIVE

Thermal Bridge per Section C402.6	Thermal Bridge Compliant with Section C402.6		Thermal Bridge Non-Compliant with Section C402.6	
	psi-factor (Btu/h-ft-°F)	chi-factor (Btu/h-ft-°F)	psi-factor (Btu/h-ft-°F)	chi-factor (Btu/h-ft-°F)
C402.6.1 Balconies, slabs, and decks	0.2	n/a	0.5	n/a
C402.6.2 Cladding supports	0.2	n/a	0.3	n/a
C402.6.3 Structural beams and columns	n/a	1.0-carbon steel 0.3-concrete	n/a	2.0-carbon steel 1.0-concrete
C402.6.4 Vertical fenestration	0.15	n/a	0.3	n/a
C402.6.5 Parapets	0.2	n/a	0.4	n

For SI: W/m-K = 0.578 Btu/h-ft-°F; 1 W/K = 1.90 Btu/h-°F

n/a = not applicable

C402.6 Thermal bridges in above-grade walls. *Thermal bridges* in *above-grade walls* shall comply with the section or an *approved* design.

Exceptions:

1. Buildings and structures located in Climate Zones 0 through 3.
2. Any thermal bridge with a material thermal conductivity not greater than 3.0 Btu/h-ft-°F.
3. Blocking, coping, flashing, and other similar materials for attachment of roof coverings.
4. *Thermal bridges* accounted for in the *U-factor* or *C-factor* for a *building thermal envelope*.

C402.6.1 Balconies and floor decks. Balconies and concrete floor decks shall not penetrate the *building thermal envelope*. Such assemblies shall be separately supported or shall be supported by structural attachments or elements that minimize thermal bridging through the building thermal envelope.

Exceptions: Balconies and concrete floor decks shall be permitted to penetrate the *building thermal envelope* where:

1. an area-weighted *U-factor* is used for *above-grade wall* compliance which includes a *U-factor* of 0.8 Btu/h-°F-ft2 for the area of the *above-grade wall* penetrated by the concrete floor deck, or
2. an *approved* thermal break device of not less than R-10 is installed in accordance with the manufacturer's instructions.

C402.6.2 Cladding supports. Linear elements supporting opaque cladding shall be off-set from the structure with attachments that allow the *continuous insulation*, where present, to pass behind the cladding support element.

Exceptions:

1. An *approved* design where the *above-grade wall U-factor* used for compliance accounts for the cladding support element *thermal bridge*.
2. Anchoring for *curtain wall* and window wall systems.

C402.6.3 Structural beams and columns. Structural steel and concrete beams and columns that project through the *building thermal envelope* shall be covered with not less than R-5 insulation for not less than 2-feet (610 mm) beyond the interior or exterior surface of an insulation component within the *building thermal envelope*.

Exceptions:

1. Where an *approved* thermal break device is installed in accordance with the manufacturer's instructions.
2. An *approved* design where the *above-grade wall U-factor* used to demonstrate compliance accounts for the beam or column *thermal bridge*.

C402.6.4 Vertical fenestration. Vertical fenestration intersections with *above grade walls* shall comply with one or more of the following:

1. Where *above-grade* walls include *continuous insulation*, the plane of the exterior glazing layer or, for metal frame fenestration, a non-metal thermal break in the frame shall be positioned within 2 inches (610 mm) of the interior or exterior surface of the *continuous insulation*.

2. Where *above-grade walls* do not include *continuous insulation*, the plane of the exterior glazing layer or, for metal frame fenestration, a non-metal thermal break in the frame shall be positioned within the thickness of the integral or *cavity insulation*.
3. The surface of the rough opening, not coved by the fenestration frame, shall be insulated with insulation of not less than R-3 material or covered with a wood buck that is not less than 1.5 inch (457 mm) thick.
4. For the intersection between vertical fenestration and opaque spandrel in a shared framing system, manufacturer's data for the spandrel *U-factor* shall account for *thermal bridges*.

Exceptions:

1. Where an *approved* design for the *above-grade wall U-factor* used for compliance accounts for *thermal bridges* at the intersection with the vertical fenestration.
2. Doors

C402.6.5 Parapets. Parapets shall comply with one or more of the following as applicable:

1. Where continuous insulation is installed on the exterior side of the *above-grade wall* and the roof is insulated with insulation entirely above deck, the continuous insulation shall extend up both sides of the parapet not less than 2 feet (610 mm) above the roof covering or to the top of the parapet, whichever is less. Parapets that are an integral part of a fire-resistance rated wall, and the exterior *continuous insulation* applied to the parapet, shall comply with the fire resistance ratings of the building code.
2. Where *continuous insulation* is installed on the exterior side of the above-grade wall and the roof insulation is below the roof deck, the *continuous insulation* shall extend up the exterior side of the parapet to not less than the height of the top surface of the roof assembly.
3. Where *continuous insulation* is not installed on the exterior side of the *above-grade wall* and the roof is insulated with insulation entirely above deck, the wall cavity or integral insulation shall extend into the parapet up to the exterior face of the roof insulation or equivalent R-value insulation shall be installed not less than 2 feet (610 mm) horizontally inward on the underside of the roof deck.
4. Where *continuous insulation* is not installed on the exterior side of the *above-grade wall* and the roof insulation is below the roof deck, the wall and roof insulation components shall be adjacent to each other at the roof-ceiling-wall intersection.

Exception: An *approved* design where the *above-grade wall U-factor* used for compliance accounts for the parapet *thermal bridge*.

Revise as follows:

TABLE C407.4.1(1) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

BUILDING COMPONENT CHARACTERISTICS	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Space use classification	Same as proposed	The space use classification shall be chosen in accordance with Table C405.3.2(1) or C405.3.2(2) for all areas of the building covered by this permit. Where the space use classification for a building is not known, the building shall be categorized as an office building.
Roofs	Type: insulation entirely above deck	As proposed
	Gross area: same as proposed	As proposed
	U-factor: as specified in Table C402.1.4	As proposed
	Solar absorptance: 0.75	As proposed
	Emittance: 0.90	As proposed
Walls, above-grade	Type: same as proposed	As proposed
	Gross area: same as proposed	As proposed
	U-factor: as specified in Table C402.1.4	As proposed
	Thermal bridges: Account for heat transfer consistent with "compliant" *psi-* and *chi-factors* from Table C402.1.5 for *thermal bridges* as identified in Section C402.6 that are present in the *proposed design.*	As proposed; *psi-* and *chi-factors* for proposed *thermal bridges* shall be determined in accordance with requirements in Section C402.1.5.
	Solar absorptance: 0.75	As proposed
	Emittance: 0.90	As proposed
Walls, below-grade	Type: mass wall	As proposed
	Gross area: same as proposed	As proposed
	U-Factor: as specified in Table C402.1.4 with insulation layer on interior side of walls	As proposed
Floors, above-grade	Type: joist/framed floor	As proposed
	Gross area: same as proposed	As proposed
	U-factor: as specified in Table C402.1.4	As proposed
Floors, slab-on-grade	Type: unheated	As proposed
	F-factor: as specified in Table C402.1.4	As proposed
Opaque doors	Type: swinging	As proposed
	Area: Same as proposed	As proposed
	U-factor: as specified in Table C402.1.4	As proposed
Vertical fenestration other than opaque doors	Area 1. The proposed vertical fenestration area; where the proposed vertical fenestration area is less than 40 percent of above-grade wall area. 2. 40 percent of above-grade wall area; where the proposed vertical fenestration area is 40 percent or more of the above-grade wall area.	As proposed
	U-factor: as specified in Table C402.4	As proposed
	SHGC: as specified in Table C402.4 except that for climates with no requirement (NR) SHGC = 0.40 shall be used	As proposed
	External shading and PF: none	As proposed
	Area The proposed skylight area; where the	

BUILDING COMPONENT CHARACTERISTICS	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Skylights	1. The proposed skylight area, where the proposed skylight area is less than that permitted by Section C402.1. 2. The area permitted by Section C402.1; where the proposed skylight area exceeds that permitted by Section C402.1.	As proposed
	U-factor: as specified in Table C402.4	As proposed
	SHGC: as specified in Table C402.4 except that for climates with no requirement (NR) SHGC = 0.40 shall be used.	As proposed
Lighting, interior	The interior lighting power shall be determined in accordance with Section C405.3.2. Where the occupancy of the building is not known, the lighting power density shall be 1.0 watt per square foot based on the categorization of buildings with unknown space classification as offices.	As proposed
Lighting, exterior	The lighting power shall be determined in accordance with Tables C405.5.2(1), C405.5.2(2) and C405.5.2(3). Areas and dimensions of surfaces shall be the same as proposed.	As proposed
Internal gains	Same as proposed	Receptacle, motor and process loads shall be modeled and estimated based on the space use classification. End-use load components within and associated with the building shall be modeled to include, but not be limited to, the following: exhaust fans, parking garage ventilation fans, exterior building lighting, swimming pool heaters and pumps, elevators, escalators, refrigeration equipment and cooking equipment.
Schedules	Same as proposed **Exception:** Thermostat settings and schedules for HVAC systems that utilize radiant heating, radiant cooling and elevated air speed, provided that equivalent levels of occupant thermal comfort are demonstrated by means of equal Standard Effective Temperature as calculated in Normative Appendix B of ASHRAE Standard 55.	Operating schedules shall include hourly profiles for daily operation and shall account for variations between weekdays, weekends, holidays and any seasonal operation. Schedules shall model the time-dependent variations in occupancy, illumination, receptacle loads, thermostat settings, mechanical ventilation, HVAC equipment availability, service hot water usage and any process loads. The schedules shall be typical of the proposed building type as determined by the designer and approved by the jurisdiction.
Mechanical ventilation	Same as proposed	As proposed, in accordance with Section C403.2.2.
Heating systems	Fuel type: same as proposed design	As proposed
	Equipment type[a]: as specified in Tables C407.4.1(2) and C407.4.1(3)	As proposed
	Efficiency: as specified in the tables in Section C403.3.2.	As proposed
	Capacity[b]: sized proportionally to the capacities in the proposed design based on sizing runs, and shall be established such that no smaller number of unmet heating load hours and no larger heating capacity safety factors are provided than in the proposed design.	As proposed
Cooling systems	Fuel type: same as proposed design	As proposed
	Equipment type[c]: as specified in Tables C407.4.1(2) and C407.4.1(3)	As proposed
	Efficiency: as specified in Tables C403.3.2(1), C403.3.2(2) and C403.3.2(3)	As proposed
	Capacity[b]: sized proportionally to the capacities in the proposed design based on sizing runs,	

BUILDING COMPONENT CHARACTERISTICS	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
	and shall be established such that no smaller number of unmet cooling load hours and no larger cooling capacity safety factors are provided than in the proposed design.	As proposed
	Economizer[d]: same as proposed, in accordance with Section C403.5.	As proposed
Service water heating[e]	Fuel type: same as proposed	As proposed
	Efficiency: as specified in Table C404.2	For Group R, as proposed multiplied by SWHF. For other than Group R, as proposed multiplied by efficiency as provided by the manufacturer of the DWHR unit.
	Capacity: same as proposed	As proposed
	Where no service water hot water system exists or is specified in the proposed design, no service hot water heating shall be modeled.	

For SI: 1 watt per square foot = 10.7 w/m^2.

SWHF = Service Water Heat Recovery Factor, DWHR = Drain Water Heat Recovery.

a. Where no heating system exists or has been specified, the heating system shall be modeled as fossil fuel. The system characteristics shall be identical in both the standard reference design and proposed design.

b. The ratio between the capacities used in the annual simulations and the capacities determined by sizing runs shall be the same for both the standard reference design and proposed design.

c. Where no cooling system exists or no cooling system has been specified, the cooling system shall be modeled as an air-cooled single-zone system, one unit per thermal zone. The system characteristics shall be identical in both the standard reference design and proposed design.

d. If an economizer is required in accordance with Table C403.5(1) and where no economizer exists or is specified in the proposed design, then a supply-air economizer shall be provided in the standard reference design in accordance with Section C403.5.

e. The SWHF shall be applied as follows:

1. Where potable water from the DWHR unit supplies not less than one shower and not greater than two showers, of which the drain water from the same showers flows through the DWHR unit then SWHF = [1 – (DWHR unit efficiency × 0.36)].
2. Where potable water from the DWHR unit supplies not less than three showers and not greater than four showers, of which the drain water from the same showers flows through the DWHR unit then SWHF = [1 – (DWHR unit efficiency × 0.33)].
3. Where potable water from the DWHR unit supplies not less than five showers and not greater than six showers, of which the drain water from the same showers flows through the DWHR unit, then SWHF = [1 – (DWHR unit efficiency × 0.26)].
4. Where Items 1 through 3 are not met, SWHF = 1.0.

Reason: As requested by the sub-committee, this proposal is a combination of CEPI-33, 40, 45 which now provides prescriptive, component performance alternative and total building performance compliance paths and a requirement to note thermal bridges on the construction documents. It combines the best of the individual proposals, plus improvements and modifications provided by the subcommittee and other interested parties. It also adds language for the component performance alternative compliance path, which was not present in the individual proposals.
The key rationale for specifying the minimum performance of thermal bridges at key interfaces is that currently they are ignored in the IECC, which therefore assumes no thermal performance degradation at assembly interfaces and penetrations of the building thermal envelope.

Ignoring thermal bridges at interfaces leads us to believe that our building thermal envelopes perform much better than they do, and to the widely recognized performance gap between as-designed/code compliant design and as-built [1]. According to the Building Envelope Thermal Bridging Guide created by Morrison Hershfield for BC Housing [2], thermal bridging can reduce the thermal performance of the opaque building envelope by between 20-70%. Non-thermally broken cladding attachments can degrade the thermal performance of opaque panel assemblies by 50% [2]. Morrison Hershfield have also found that 13% of the heat loss through a typical steel stud wall with punched opening windows is due to the window to wall transition and they found it to be even higher with poorer edge details. This is a huge degradation in performance that the code is currently ignoring and must be addressed to improve the energy performance of as-built structures.

Also, in the 2021 IECC, the definition for above-grade wall (shown below) was changed in a way that supports a need to address thermal bridging at intersections of above-grade walls with floors, roofs, and fenestration, which were previously ignored.

"WALL, ABOVE-GRADE. A wall associated with the building thermal envelope that is more than 15 percent above grade and is on the exterior of the building or any wall that is associated with the building thermal envelope that is not on the exterior of the building. **This includes, but is not limited to, between-floor spandrels, peripheral edges of floors, roof knee walls, dormer walls, gable end walls, walls enclosing a mansard roof and skylight shafts."**[bold added for emphasis]

In order to achieve net-zero performance we need to address these significant energy losses through thermal bridges at the building thermal envelope. This proposal seeks to take a small step towards recognizing and accounting for thermal bridges that are typically present in conventional construction. It seeks to recognize and account for current design and construction practices, not to drive a large change in construction practices. The proponents believe that this is a good first step to move building thermal envelope performance and to get the design and construction industry thinking about thermal bridges in the design process.

Inclusion in construction documents

The inclusion of thermal bridge details on construction documents will encourage design teams to identify and address thermal bridging. The requirements for what thermal bridges to identify on the construction documents is referenced to section C402.6 where the types of thermal bridges are identified. This will ensure that only the main thermal bridges need be shown. A definition for thermal bridges is also proposed to support the proposal.

Definitions

New definitions psi-factor and chi-factor are introduced to describe linear and point thermal bridges in the *building thermal envelope* in a similar way to the existing F-factor for heat loss for slab-on-grade floors. These definitions are used in the component performance alternative and the performance compliance paths. We have chosen to call them psi and chi-factors as this is how they are commonly referred to, and we wanted to avoid confusion.

A new definition for thermal bridges is included and incorporates comments from the subcommittee.

Prescriptive path

In the prescriptive path, we have taken the route of CEPI-33 in creating a simple yet flexible approach, focusing on a few thermal bridge conditions that have the most impact, and which have practical and available means to effectively manage the bridging. In every case, alternative means and methods are permitted with an approved design to avoid any unnecessary restriction or inflexibility. The proponents feel that this is an appropriately abbreviated and enforceable way to address this topic in the energy code.

The goal was to create a simple, prescriptive, effective, and flexible means to begin to address and reasonably mitigate the effects of major thermal bridges which are now identified in the new definition (IECC 2021) for above-grade walls. To inform the proposed prescriptive requirements, various thermal bridging studies, detailing guides, and provisions developed domestically and internationally were reviewed [2-7].

Component performance alternative

In this section the linear and point thermal bridges (psi-, chi- factors) are included in the formula in a similar way to the existing U-, F- and C- factors. A table of psi- and chi-factors are provided to be used in this section, for the five prescriptive categories of thermal bridges. There are values proposed for thermal bridges compliant or non-compliant with the prescriptive path. The values provided for thermal bridges compliant with the prescriptive path are reflective of those details (which are not very stringent). The values provided for non-compliant are reflective of poorer interface details. The psi- and chi-factors of thermal bridges which exceed the prescriptive requirement are permitted to be determined by thermal analysis, testing or other approved sources.

Including values of thermal bridging in this section will ensure that any trade-offs in between envelope assemblies will account for thermal bridging.

Note that this section will need to be rationalized with CEPI-46 which addresses a problem with the current component performance alternative equation, if both are accepted by the committee.

Performance path

The performance path language ensures that the reference design accounts for thermal bridging rather than assuming no thermal bridges exist and that the interfaces are “perfect”. This allows for good thermal bridging details in the proposed design to show improved energy performance.

The reference design uses the psi- and chi-factors from the component performance alternative section for those thermal bridges which are present in the proposed design. The proposed building uses psi- and chi- factors for thermal bridges calculated according to the methods allowed in the component performance alternative.

Cost Impact: The code change proposal will increase the cost of construction.
The code change proposal will increase the cost of construction.

Perfect mitigation or no thermal bridging at interfaces is implied by code. However, current practice is to ignore them or provide no or little mitigation. So, any proposal to reduce thermal bridging will increase the cost of construction relative to current practices. This proposal provides a way of practical mitigation which does not require significant changes to current practices, setting a relatively low performance bar.

We could also consider there to be no change in construction cost (or even a reduction in cost) as this proposal enforces the intent of code and closes the gap between what is being built today and what code intends to be built. But, of course, perfect mitigation is not representative of current practices. By quantifying the impact of thermal bridges, we provide the option to address them, albeit not perfectly, in each compliance path.

Bibliography: [1] https://en.wikipedia.org/wiki/Performance gap
[2] BC Housing, Thermal Bridging Guide, Version 1.5, 2020, https://www.bchousing.org/research-centre/library/residential-design-construction/building-envelope-thermal-bridging-guide

[3] Morrison Hershfield Ltd. (2011)

[4] ASHRAE 1365-RP Thermal Performance of Building Envelope Construction Details for Mid- and High-Rise Buildings. Atlanta, GA: American Society of Heating, Refrigeration and Air-Conditioning Engineers Inc

[5] ISO Standard 14683: 2007, Thermal Bridges in Building Construction – Linear thermal transmittance (simplified methods and default Chi-factors).

[6] AISC/SEI, Thermal Bridging Solutions: Minimizing Structural Steel’s Impact on Building Envelope Energy Transfer, A Supplement to Modern Steel Construction, March 2012, American Institute for Steel Construction (AISC) & Structural Engineering Institute (SEI).

[7] USACE, “Development of Thermal Bridging Factors for Use in Energy Models,” ERDC/CERL TR-15-10, June 2015, U.S. Army Corp of Engineers, Engineer Research and Development Center, Construction Engineering Research Laboratory.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: In addition to the detailed reason statement in the proposal, CECPI-4 addresses a significant thermal performance degradation which is currently ignored and impacts the energy performance of buildings.

CECPI-5-21

Proponents: Greg Eades, representing IECC CE Economics, Modeling, Metrics Subcommittee (iecccemodeling@iccsafe.org)

2021 International Energy Conservation Code

Revise as follows:

CC101.1 Purpose. The purpose of this appendix is to supplement the *International Energy Conservation Code* and require renewable energy systems of adequate capacity to achieve net zero ~~carbon~~ energy.

Add new definition as follows:

COMMUNITY RENEWABLE ENERGY FACILITY. A facility that produces energy from renewable energy systems and is qualified as a community energy facility under applicable jurisdictional statutes and rules.

DIRECT ACCESS TO WHOLESALE MARKET. An agreement by the owner and a renewable energy developer to purchase renewable energy from the wholesale market.

DIRECT OWNERSHIP. An *off-site renewable energy system* under the ownership or control of the building project owner.

Revise as follows:

~~**ENERGY UTILIZATION INTENSITY (EUI).** The site energy for either the baseline building or the proposed building divided by the gross *conditioned floor area* plus any semiheated floor area of the building. For the baseline building, the EUI can be divided between regulated energy use and unregulated energy use.~~

Add new definition as follows:

FINANCIAL RENEWABLE ENERGY POWER PURCHASE AGREEMENT (FPPA). A financial arrangement between a renewable electricity generator and a purchaser wherein the purchaser pays or guarantees a price to the generator for the project's renewable generation. Also known as a "financial power purchase agreement" and "virtual power purchase agreement."

GREEN RETAIL PRICING. A program by the retail electricity provider to provide 100-percent renewable energy to the buildng project owner.

MINIMUM RENEWABLE ENERGY REQUIREMENT. the minimum amount of on-site or adjusted off-site renewable energy needed to comply with this appendix.

Revise as follows:

OFF-SITE RENEWABLE ENERGY SYSTEM. Renewable energy system ~~not located on the building project.~~ which serves the building project and is not an *on-site renewable energy system*.

ON-SITE RENEWABLE ENERGY SYSTEM. Renewable energy systems ~~on the building project.~~ located on any of the following:
1. the building.
2.the property upon which the building is located.
3. a property that shares a boundary with and is under the same ownership or control as the property on which the building is located, or
4. a property that is under the same ownership or control as the property on which the building is located and is separated only by a public right-of-way on which the building is located.

Add new definition as follows:

PHYSICAL RENEWABLE ENERGY POWER PURCHASE AGREEMENT (PPPA). A contract for the purchase of renewable electricity from a specific renewable electricity generator to a purchaser of renewable electricity.

RENEWABLE ENERGY CERTIFICATE (REC). A market-based instrument that represents and conveys the environmental, social, and other non-power attributes of one megawatt hour of renewable electricity generation and could be sold separately from the underlying physical electricity associated with renewable energy systems; also known as an energy attribute and energy attribute certificate (EAC).

RENEWABLE ENERGY INVESTMENT FUND (REIF). A fund established by the local government or other entity to accept payment from building owners to construct or acquire qualifying renewable energy (along with RECs) on their behalf.

Revise as follows:

RENEWABLE ENERGY SYSTEM. Photovoltaic, solar thermal, geothermal energy extracted from hot fluid or steam, ~~and~~ wind , or other approved renewable energy production systems used to generate energy.

~~**ZERO ENERGY PERFORMANCE INDEX (ZEPIPB,EE).**~~ ~~The ratio of the proposed building EUI without renewables to the baseline building EUI, expressed as a percentage.~~

CC103.1 Renewable energy. On-site renewable energy systems shall be installed, or adjusted off-site renewable energy shall be procured to meet the *minimum renewable energy requirement* ~~offset the building energy as calculated in Equation CC-1~~.

$$RE_{onsite} + RE_{offsite} \geq E_{building}$$ **(Equation CC-1)**

$$RE_{onsite} + RE_{offsite} \geq RE_{min}$$ ~~building~~

where:

RE_{onsite} = Annual site energy production from on-site renewable energy systems (see Section CC103.2) , including installed *on-site renewable energy systems* for compliance with C405.13.1 and C406.5.

$RE_{offsite}$ = Adjusted annual ~~site~~ energy production from *off-site renewable energy systems* that may be credited against ~~building energy use~~ the *minimum renewable energy requirement* (see Section CC103.3) , including off-site renewable energy purchased for compliance with C405.13.2.

RE_{min} ~~building~~ = Minimum renewable energy requirement ~~Building energy use without consideration of renewable energy systems~~.

When Section C401.2.1(1) is used for compliance with the *International Energy Conservation Code*, the *minimum renewable energy requirement* ~~building energy~~ shall be determined by multiplying the gross *conditioned floor area* plus the gross semiheated floor area of the proposed building by the prescriptive renewable energy requirement ~~an EUI selected~~ from Table CC103.1. An area ~~Use a~~ weighted average shall be used for mixed-use buildings.

When Section C401.2.1, Item 2 or Section C401.2.2 is used for compliance with the *International Energy Conservation Code*, the *minimum renewable energy requirement* shall be equal to the building energy ~~shall be~~ as determined from energy simulations.

~~TABLE CC103.1 ENERGY UTILIZATION INTENSITY FOR BUILDING TYPES AND CLIMATES (kBtu/ft^2 – yr)~~

~~BUILDING AREA TYPE~~	~~CLIMATE ZONE~~																
	~~0A/1A~~	~~0B/1B~~	~~2A~~	~~2B~~	~~3A~~	~~3B~~	~~3C~~	~~4A~~	~~4B~~	~~4C~~	~~5A~~	~~5B~~	~~5C~~	~~6A~~	~~6B~~	~~7~~	~~8~~
	~~kBtu/ft^2 – yr~~																
~~Healthcare/hospital (I-2)~~	~~119~~	~~120~~	~~119~~	~~113~~	~~116~~	~~109~~	~~106~~	~~116~~	~~109~~	~~106~~	~~118~~	~~110~~	~~105~~	~~126~~	~~116~~	~~131~~	~~142~~
~~Hotel/motel (R-1)~~	~~73~~	~~76~~	~~73~~	~~68~~	~~70~~	~~67~~	~~65~~	~~69~~	~~66~~	~~65~~	~~71~~	~~68~~	~~65~~	~~77~~	~~72~~	~~81~~	~~89~~
~~Multiple-family (R-2)~~	~~43~~	~~45~~	~~41~~	~~41~~	~~43~~	~~42~~	~~36~~	~~45~~	~~43~~	~~41~~	~~47~~	~~46~~	~~41~~	~~53~~	~~48~~	~~53~~	~~59~~
~~Office (B)~~	~~31~~	~~32~~	~~30~~	~~29~~	~~29~~	~~28~~	~~25~~	~~28~~	~~27~~	~~25~~	~~29~~	~~28~~	~~25~~	~~33~~	~~30~~	~~32~~	~~36~~
~~Restaurant (A-2)~~	~~389~~	~~426~~	~~411~~	~~408~~	~~444~~	~~420~~	~~395~~	~~483~~	~~437~~	~~457~~	~~531~~	~~484~~	~~484~~	~~589~~	~~538~~	~~644~~	~~750~~
~~Retail (M)~~	~~46~~	~~50~~	~~45~~	~~46~~	~~44~~	~~44~~	~~37~~	~~48~~	~~44~~	~~44~~	~~52~~	~~50~~	~~46~~	~~60~~	~~52~~	~~64~~	~~77~~
~~School (E)~~	~~42~~	~~46~~	~~42~~	~~40~~	~~40~~	~~39~~	~~36~~	~~39~~	~~40~~	~~40~~	~~39~~	~~43~~	~~37~~	~~44~~	~~40~~	~~45~~	~~54~~
~~Warehouse (S)~~	~~9~~	~~12~~	~~9~~	~~11~~	~~12~~	~~11~~	~~10~~	~~17~~	~~13~~	~~14~~	~~23~~	~~17~~	~~15~~	~~32~~	~~23~~	~~32~~	~~32~~
~~All others~~	~~55~~	~~58~~	~~54~~	~~53~~	~~53~~	~~51~~	~~48~~	~~54~~	~~52~~	~~51~~	~~57~~	~~54~~	~~50~~	~~63~~	~~57~~	~~65~~	~~73~~

Add new text as follows:

TABLE CC103.1 PRESCRIPTIVE RENEWABLE ENERGY REQUIREMENT FOR BUILDING TYPES AND CLIMATES (Wh/ft^2-yr)

	Building Area Type												
Climate Zone	Multifamily (R-2)	Healthcare/hospital (I-2)	Hotel/Motel (R-2)	Office (B)	Restaurant (A-2)	Retail (M)	School (E)	Warehouse (S)	Grocery Store (M)	Laboratory (B)	Assembly (A)	All others
0A	13	35	23	10	129	17	16	3	27	41	5	17
0B	12	34	22	10	123	17	15	3	26	40	5	16
1A	11	32	20	9	113	14	13	3	24	36	4	15
1B	11	32	20	9	118	15	14	3	24	37	5	15
2A	11	32	20	8	114	13	12	3	22	34	4	14
2B	11	30	18	8	108	12	11	3	22	33	4	13
3A	11	30	18	8	117	13	11	3	21	31	4	13
3B	10	29	18	8	110	12	10	3	20	31	4	13
3C	9	28	18	7	100	10	9	2	18	27	3	12
4A	12	31	18	8	123	15	11	6	21	32	4	14
4B	11	29	18	7	113	12	10	4	20	30	4	13
4C	10	28	17	7	111	13	10	4	18	28	3	13
5A	12	31	19	8	133	17	11	8	22	34	4	15
5B	11	29	18	8	125	14	11	5	21	31	4	14
5C	10	29	17	7	116	13	10	4	18	27	3	13
6A	14	33	20	10	151	20	13	11	26	39	5	17
6B	13	33	19	8	137	17	11	7	22	34	4	16
7	14	37	21	9	164	20	13	10	25	37	5	18
8	15	40	22	11	190	23	16	10	28	43	5	20

Revise as follows:

CC103.2 Calculation of on-site renewable energy. The annual energy production from on-site renewable energy systems shall be determined using ~~the PVWatts software or other~~ software approved by the code official.

Add new text as follows:

CC103.2.1 Renewable energy certificates. renewable energy certificates and other environmental attributes associated with the *on-site renewable energy system* shall be assigned to the initial and subsequent building owner(s) for a period of not less than 15 years. The building owner(s) may transfer renewable energy certificates to building tenants while they are occupying the building.

Revise as follows:

CC103.3.1 Qualifying off-site procurement methods. The following are ~~considered~~ qualifying off-site renewable energy procurement methods:

1. *Community renewables energy facility*~~: an off-site renewable energy system for which the owner has purchased or leased renewable energy capacity along with other subscribers.~~
2. *Renewable energy investment fund*~~: an entity that installs renewable energy capacity on behalf of the owner.~~
3. *Financial renewable energy* ~~Virtual~~ *power purchase agreement*~~: a power purchase agreement for off-site renewable energy where the owner agrees to purchase renewable energy output at a fixed price schedule.~~
4. Direct ownership~~: an off-site renewable energy system owned by the building project owner.~~
5. Direct access to wholesale market~~: an agreement between the owner and a renewable energy developer to purchase renewable energy.~~
6. *Green retail pricing* ~~tariffs: a program by the retail electricity provider to provide 100-percent renewable energy to the owner.~~
7. *Unbundled Renewable Energy Certificates (RECs)*~~: certificates purchased by the owner representing the environmental benefits of renewable energy generation that are sold separately from the electric power.~~
8. *Physical renewable energy power purchase agreement*

CC103.3.2 Requirements for all procurement methods. The following requirements shall apply to all off-site renewable energy procurement methods:

1. The building owner shall sign a legally binding contract or other approved agreement to procure qualifying *off-site renewable energy*.

2. The procurement contract shall have duration of not less than 15 years and shall be structured to survive a partial or full transfer of ownership of the property.

3. RECs and other environmental attributes associated with the procured *off-site renewable energy* shall meet all of the following requirements: ~~be assigned to the building project for the duration of the contract.~~

   3.1 Are retained or retired by or on behalf of the property owner or tenant for a period of not less than 15 years.

   3.2 Are created within a 12-month period of use of the REC; and

   3.3 Are from a generating asset constructed no more than 5 years before the issuance of the certificate of occupancy.

4. The ~~*renewable energy*~~ generating source shall be a *renewable energy system.* ~~include one or more of the following: photovoltaic systems, solar thermal power plants, geothermal power plants and wind turbines.~~

5. The generation source shall be located where the energy can be delivered to the *building site* by any of the following: ~~the same utility or distribution entity, the same independent system operator (ISO) or regional transmission organization (RTO), or within integrated ISOs (electric coordination council).~~

   5.1 By direct connection to the off-site renewable energy facility.

   5.2 By the local utility or distribution entity

   5.3 By an interconnected electrical network where energy delivery capacity between the generator and the building site is available

6. ~~The *off-site renewable energy* producer shall maintain transparent accounting that clearly assigns production to the building.~~ Records on power sent to or purchased by the building project shall be retained by the building owner and made available for inspection by the code official upon request.

CC103.3.3 Adjusted off-site renewable energy. The process for calculating the adjusted *off-site renewable energy* is shown in Equation 2.

$$RE_{offsite} = \sum_{i=1}^{n} PF_i \times RE_i = PF_1 \times RE_1 + PF_2 \times RE_2 + ... + PF_n \times RE_n$$ **(Equation CC-2)**

where:

$RE_{offsite}$ = Adjusted off-site renewable energy.

PF_i = Procurement factor for the i^{th} renewable energy procurement method ~~or class taken from~~ per~~Table~~ Section CC103.3.3.1.

RE_i = Annual energy production for the i^{th} renewable energy procurement method ~~or class~~.

n = The number of renewable energy procurement ~~options or classes~~ methods considered.

Add new text as follows:

CC103.3.3.1 Procurement factors. When installed on-site renewable energy capacity is 7.5 W/ft2 of roof area or greater, the procurement factor is 1.00, otherwise, the procurement factor is 0.75, except for unbundled renewable energy certificates which shall have a procurement factor of 0.20. A procurement factor of 1.0 may also be used when the conditions of exceptions 1, 2, or 3 to C405.13.1 are satisfied.

Revise as follows:

~~TABLE CC103.3.3 DEFAULT OFF-SITE RENEWABLE ENERGY PROCUREMENT METHODS, CLASSES AND COEFFICIENTS~~

~~CLASS~~	~~PROCUREMENT FACTOR (PF)~~	~~PROCUREMENT OPTIONS~~	~~ADDITIONAL REQUIREMENTS (see also Section CC103.3.2)~~
~~1~~	~~0.75~~	~~Community solar~~	—
		~~REIFs~~	~~Entity must be managed to prevent fraud or misuse of funds.~~
		~~Virtual PPA~~	—
		~~Self-owned off-site~~	~~Provisions shall prevent the generation from being sold separately from the building.~~
~~2~~	~~0.55~~	~~Green retail tariffs~~	~~The offering shall not include the purchase of unbundled RECs.~~
		~~Direct access~~	~~The offering shall not include the purchase of unbundled RECs.~~
~~3~~	~~0.20~~	~~Unbundled RECs~~	~~The vintage of the RECs shall align with building energy use.~~

Reason: Revises Appendix CC to align with CECPI-2-21 (Section 405.13), updates prescriptive minimum renewable energy requirements, revises offsite renewable energy procurement factors and makes miscellaneous simplifications and language cleanups.

Cost Impact: The code change proposal will increase the cost of construction.
This code change will increase the cost of construction

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: Revises Appendix CC to align with CECPI-2-21 (Section 405.13), updates prescriptive minimum renewable energy requirements, revises offsite renewable energy procurement factors and makes miscellaneous simplifications and language cleanups.

Proposal # 601

CECPI-6-21

Proponents: Blake Shelide, representing IECC CE HVACR & Water Heating Subcommittee (iecccehvacr@iccsafe.org)

2021 International Energy Conservation Code

Add new definition as follows:

PARKING GARAGE SECTION. A part of a parking garage that is separated from all other parts of the garage by full-height solid walls or operable openings that are intended to remain closed during normal operation and where vehicles cannot pass to other parts of the garage. It may include multiple floors if there are ramps to allow vehicles to pass between the floors.

Revise as follows:

C403.7.2 ~~Enclosed p~~ Parking garage ventilation systems ~~controls~~. ~~Enclosed~~ Ventilation systems employed in parking garages ventilation systems used for storing or handling automobiles operating under their own power shall ~~employ~~ meet all of the following: ~~carbon monoxide detectors applied in conjunction with nitrogen dioxide detectors and automatic controls configured to stage fans or modulate fan average airflow rates to 50 percent or less of design capacity, or intermittently operate fans less than 20 percent of the occupied time or as required to maintain acceptable contaminant levels in accordance with International Mechanical Code provisions. Failure of contamination-sensing devices shall cause the exhaust fans to operate continuously at design airflow.~~

1. Separate ventilation systems and control systems shall be provided for each *parking garage section*.
2. Control systems for each *parking garage section* shall automatically detect and control contaminant levels in accordance with the *International Mechanical Code*, and shall be capable of and configured to reduce fan airflow to 20% or less of design capacity.
3. The ventilation system for each *parking garage section* shall have controls and devices that result in fan motor demand of no more than 30% of design wattage at 50% of the design airflow.

Exception~~s~~:

1. Garage ventilation systems serving a single *parking garage section* having a total ventilation system motor nameplate horsepower (ventilation system motor nameplate kilowatt) not exceeding 5 hp (3.7 kW) at fan system design conditions and where the *parking garage section* has no mechanical cooling or mechanical heating. ~~Garages with a total exhaust capacity less than 8,000 cfm (3,755 L/s) with ventilation systems that do not utilize heating or mechanical cooling.~~
2. ~~Garages that have a garage area to ventilation system motor nameplate power ratio that exceeds 1,125 cfm/hp (710 L/s/kW) and do not utilize heating or mechanical cooling.~~

Reason: The current requirements for garage ventilation are lenient. The changes to C403.7.2 are based on addendum d to ASHRAE 90.1-2019 for parking garage ventilation. This proposal increases stringency for these systems, with additional requirements for pollutant sensors and fan variable speed drives that SSPC 90.1 has determined to be cost-effective.

Cost Impact: The code change proposal will increase the cost of construction.
determined to be cost-effective.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: The current requirements for garage ventilation are lenient. The changes to C403.7.2 are based on addendum d to ASHRAE 90.1-2019 for parking garage ventilation. This proposal increases stringency for these systems, with additional requirements for pollutant sensorsand fan variable speed drives that SSPC 90.1 has determined to be cost-effective.

Proposal # 602

CECPI-7-21

Proponents: Michael Jouaneh, IECC CE Electrical Power, Storage, Renewables Subcommittee, representing IECC Commercial Electrical Power, Lighting, Renewables SC (ieccceelectrical@iccsafe.org)

2021 International Energy Conservation Code

Revise as follows:

TABLE C405.3.2(1) INTERIOR LIGHTING POWER ALLOWANCES: BUILDING AREA METHOD

BUILDING AREA TYPE	LPD (w/ft^2)
Automotive facility	~~0.75~~ 0.73
Convention center	0.64
Courthouse	~~0.79~~ 0.75
Dining: bar lounge/leisure	~~0.80~~ 0.74
Dining: cafeteria/fast food	~~0.76~~ 0.70
Dining: family	~~0.71~~ 0.65
Dormitory~~[a, b]~~	~~0.53~~ 0.52
Exercise center	0.72
Fire station~~[a]~~	0.56
Gymnasium	~~0.76~~ 0.75
Health care clinic	~~0.81~~ 0.77
Hospital~~[a]~~	~~0.96~~ 0.92
Hotel/Motel~~[a, b]~~	~~0.56~~ 0.53
Library	0.83
Manufacturing facility	0.82
Motion picture theater	~~0.44~~ 0.43
Multiple-family~~[c]~~	~~0.45~~ 0.46
Museum	~~0.55~~ 0.56
Office	~~0.64~~ 0.62
Parking garage	~~0.18~~ 0.17
Penitentiary	~~0.69~~ 0.65
Performing arts theater	~~0.84~~ 0.82
Police station	~~0.66~~ 0.62
Post office	~~0.65~~ 0.64
Religious building	~~0.67~~ 0.66
Retail	~~0.84~~ 0.78
School/university	~~0.72~~ 0.70
Sports arena	~~0.76~~ 0.73
Town hall	~~0.69~~ 0.67
Transportation	~~0.50~~ 0.56
Warehouse	0.45
Workshop	~~0.91~~ 0.86

For SI: 1 watt per square foot = 10.76 w/m^2.

~~a. Where sleeping units are excluded from lighting power calculations by application of Section R404.1, neither the area of the sleeping units nor the wattage of lighting in the sleeping units is counted.~~

~~b. Where dwelling units are excluded from lighting power calculations by application of Section R404.1, neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.~~

~~c. Dwelling units are excluded. Neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.~~

TABLE C405.3.2(2) INTERIOR LIGHTING POWER ALLOWANCES: SPACE-BY-SPACE METHOD

COMMON SPACE TYPES[a]	LPD (watts/ft²)
Atrium	
Less than 40 feet in height	~~0.48~~ 0.41
Greater than 40 feet in height	~~0.60~~ 0.51
Audience seating area	
In an auditorium	~~0.61~~ 0.57
In a gymnasium	0.23
In a motion picture theater	0.27
In a penitentiary	~~0.67~~ 0.56
In a performing arts theater	~~1.16~~ 1.09
In a religious building	0.72
In a sports arena	~~0.33~~ 0.27
Otherwise	0.33
Banking activity area	~~0.61~~ 0.56
Breakroom (See Lounge/breakroom)	
Classroom/lecture hall/training room	
In a penitentiary	~~0.89~~ 0.74
Otherwise	~~0.71~~ 0.72
Computer room, data center	~~0.94~~ 0.75
Conference/meeting/multipurpose room	~~0.97~~ 0.88
Copy/print room	~~0.31~~ 0.56
Corridor	
In a facility for the visually impaired (and not used primarily by the staff)[b]	0.71
In a hospital	~~0.71~~ 0.61
Otherwise	~~0.41~~ 0.44
Courtroom	~~1.20~~ 1.08
Dining area	
In bar/lounge or leisure dining	~~0.86~~ 0.76
In cafeteria or fast food dining	~~0.40~~ 0.36
In a facility for the visually impaired (and not used primarily by the staff)[b]	~~1.27~~ 1.22
In family dining	~~0.60~~ 0.52
In a penitentiary	~~0.42~~ 0.35
Otherwise	~~0.43~~ 0.42
Electrical/mechanical room	~~0.43~~ 0.71
Emergency vehicle garage	~~0.52~~ 0.51
Food preparation area	~~1.09~~ 1.19
~~Guestroom[c, d]~~	~~0.41~~
Laboratory	
In or as a classroom	~~1.11~~ 1.05
Otherwise	~~1.33~~ 1.21
Laundry/washing area	~~0.53~~ 0.51
Loading dock, interior	0.88
Lobby	
For an elevator	~~0.65~~ 0.64
In a facility for the visually impaired (and not used primarily by the staff)[b]	~~1.69~~ 1.44
In a hotel	~~0.51~~ 0.48

COMMON SPACE TYPES	LPD (watts/ft²)
In a motion picture theater	~~0.23~~ 0.20
In a performing arts theater	~~1.25~~ 1.21
Otherwise	~~0.84~~ 0.80
Locker room	~~0.52~~ 0.43
Lounge/breakroom	
In a healthcare facility	~~0.42~~ 0.77
Mother's Wellness Room	0.68
Otherwise	~~0.59~~ 0.55
Office	
Enclosed	~~0.74~~ 0.73
Open plan	~~0.61~~ 0.56
Parking area daylight transition zone	1.06
Parking area, interior	~~0.15~~ 0.11
Pharmacy area	~~1.66~~ 1.59
Restroom	
In a facility for the visually impaired (and not used primarily by the staff[b]	~~1.26~~ 0.96
Otherwise	~~0.63~~ 0.74
Sales area	~~1.05~~ 0.85
Seating area, general	~~0.23~~ 0.21
Security screening general areas	0.64
Security screening in transportation facilities	0.93
Security screening transportation waiting area	0.56
Stairwell	~~0.49~~ 0.47
Storage room	~~0.38~~ 0.35
Vehicular maintenance area	~~0.60~~ 0.59
Workshop	~~1.26~~ 1.17
BUILDING TYPE SPECIFIC SPACE TYPES[a]	**LPD (watts/ft²)**
Automotive (see Vehicular maintenance area)	
Convention Center—exhibit space	~~0.61~~ 0.50
~~Dormitory—living quarters[c, d]~~	~~0.50~~
Facility for the visually impaired[b]	
In a chapel (and not used primarily by the staff)	~~0.70~~ 0.58
In a recreation room (and not used primarily by the staff)	~~1.77~~ 1.20
~~Fire Station—sleeping quarters[c]~~	~~0.23~~
Gaming establishments	
High limits game	1.68
Slots	0.54
Sportsbook	0.82
Table games	1.09
Gymnasium/fitness center	
In an exercise area	~~0.90~~ 0.82
In a playing area	~~0.85~~ 0.82
Healthcare facility	
In an exam/treatment room	~~1.40~~ 1.33
In an imaging room	0.94
In a medical supply room	~~0.62~~ 0.56
In a nursery	~~0.92~~ 0.87

COMMON SPACE TYPES	LPD (watts/ft²)
In a nurse's station	~~1.17~~ 1.07
In an operating room	2.26
~~In a patient room[e]~~	~~0.68~~
In a physical therapy room	~~0.91~~ 0.82
In a recovery room	~~1.25~~ 1.18
In a telemedicine room	1.44
Library	
In a reading area	~~0.96~~ 0.86
In the stacks	1.18
Manufacturing facility	
In a detailed manufacturing area	~~0.80~~ 0.75
In an equipment room	~~0.76~~ 0.73
In an extra-high-bay area (greater than 50 feet floor-to-ceiling height)	~~1.42~~ 1.36
In a high-bay area (25–50 feet floor-to-ceiling height)	1.24
In a low-bay area (less than 25 feet floor-to-ceiling height)	0.86
Museum	
In a general exhibition area	0.31
In a restoration room	~~1.10~~ 1.24
Performing arts theater—dressing room	~~0.41~~ 0.39
Post office—sorting area	~~0.76~~ 0.71
Religious buildings	
In a fellowship hall	~~0.54~~ 0.50
In a worship/pulpit/choir area	~~0.85~~ 0.75
Retail facilities	
In a dressing/fitting room	~~0.51~~ 0.45
Hair salon	0.65
Nail salon	0.75
In a mall concourse	~~0.82~~ 0.57
Massage space	0.81
Sports arena—playing area	
For a Class I facility~~[e]~~ [c]	~~2.94~~ 2.86
For a Class II facility~~[f]~~[d]	~~2.01~~ 1.98
For a Class III facility~~[g]~~ [e]	~~1.30~~ 1.29
For a Class IV facility~~[h]~~ [f]	0.86
Sports arena-Pools	
For a Class I facility	2.20
For a Class II facility	1.47
For a Class III facility	0.99
For a Class IV facilty	0.59
Transportation facility	
Airport hanger	1.36
At a terminal ticket counter	~~0.51~~ 0.40
In a baggage/carousel area	~~0.39~~ 0.28
Passenger loading area	0.71
In an airport concourse	~~0.25~~ 0.49
Warehouse—storage area	
For medium to bulky, palletized items	0.33

For smaller, hand-carried items COMMON SPACE TYPES	LPD (watts/ft²) 0.69

For SI: 1 foot = 304.8 mm, 1 watt per square foot = 10.76 w/m^2.

a. In cases where both a common space type and a building area specific space type are listed, the building area specific space type shall apply.

b. A 'Facility for the Visually Impaired' is a facility that is licensed or will be licensed by local or state authorities for senior long-term care, adult daycare, senior support or people with special visual needs.

~~c. Where sleeping units are excluded from lighting power calculations by application of Section R404.1, neither the area of the sleeping units nor the wattage of lighting in the sleeping units is counted.~~

~~d. Where dwelling units are excluded from lighting power calculations by application of Section R404.1, neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.~~

~~e.~~ c. Class I facilities consist of professional facilities; and semiprofessional, collegiate, or club facilities with seating for 5,000 or more spectators.

~~f.~~ d. Class II facilities consist of collegiate and semiprofessional facilities with seating for fewer than 5,000 spectators; club facilities with seating for between 2,000 and 5,000 spectators; and amateur league and high school facilities with seating for more than 2,000 spectators.

~~g.~~ e. Class III facilities consist of club, amateur league and high school facilities with seating for 2,000 or fewer spectators.

~~h.~~ f. Class IV facilities consist of elementary school and recreational facilities; and amateur league and high school facilities without provision for spectators.

C405.3.2.2.1 Additional interior lighting power. Where using the Space-by-Space Method, an increase in the interior lighting power allowance is permitted for specific lighting functions. Additional power shall be permitted only where the specified lighting is installed and controlled in accordance with Section C405.2.5. This additional power shall be used only for the specified luminaires and shall not be used for any other purpose. An increase in the interior lighting power allowance is permitted in the following cases:

1. For lighting equipment to be installed in sales areas specifically to highlight merchandise, the additional lighting power shall be determined in accordance with Equation 4-11.

   Additional interior lighting power allowance = 1000 W + (Retail Area 1 × 0.45 W/ft^2) + (Retail Area 2 × 0.45W/ft^2) + (Retail Area 3 × 1.05 W/ft^2) + (Retail Area 4 × 1.87 W/ft^2)

   For SI units:

   Additional interior lighting power allowance = 1000 W + (Retail Area 1 × 4.8 W/m^2) + (Retail Area 2 × 4.84 W/m^2) + (Retail Area 3 × 11 W/m^2) + (Retail Area 4 × 20 W/m^2)

   Additional lighting power allowance = ~~1000~~ 750 W + (Retail Area 1 x ~~0.45~~ 0.40 W/ft^2) + (Retail Area 2 x ~~0.45~~ 0.40 W/ft^2) + (Retail Area 3 x ~~1.05~~ 0.70 W/ft^2) + (Retail Area 4 x ~~1.87~~ 1.00 W/ft^2)

   For SI units:

   Additional lighting power allowance = ~~1000~~ 750 W + (Retail Area 1 x ~~4.8~~ 4.3 W/m^2) + (Retail Area 2 x ~~4.8~~ 4.3 W/m^2) + (Retail Area 3 x ~~11~~ 7.5 W/m^2) + (Retail Area 4 x ~~20~~ 10.8 W/m^2)

   where: **(Equation 4-11)**

   Retail Area 1 = The floor area for all products not listed in Retail Area 2, 3 or 4.

   Retail Area 2 = The floor area used for the sale of vehicles, sporting goods and small electronics.

   Retail Area 3 = The floor area used for the sale of furniture, clothing, cosmetics and artwork.

   Retail Area 4 = The floor area used for the sale of jewelry, crystal and china.

   Exception: Other merchandise categories are permitted to be included in Retail Areas 2 through 4, provided that justification documenting the need for additional lighting power based on visual inspection, contrast or other critical display is approved by the code official.

2. For spaces in which lighting is specified to be installed in addition to the general lighting for the purpose of decorative appearance or for highlighting art or exhibits, provided that the additional lighting power shall be not more than ~~0.9~~ 0.66 W/ft^2 (~~9.7~~ 7.1 W/m^2) in lobbies and not more than ~~0.75~~ 0.55 W/ft^2 (~~8.1~~ 5.9 W/m^2) in other spaces.

Reason: combined correlated committee proposal based upon recommendations of other LPD proposals

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
correlation of recommended code change proposals

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: This proposal consolidates actions by the SC of the following CEPI-178, 179, 180, 182, 183, and 184 into one consensus proposal by improving indoor lighting efficiency for buildings.

Proposal # 598

CEPI-7-21

Proponents: Kim Cheslak, NBI, representing NBI (kim@newbuildings.org); Bryan Bomer, representing Department of Permitting Services (bryan.bomer@montgomerycountymd.gov); Lauren Urbanek, representing Natural Resources Defense Council (lurbanek@nrdc.org); Ben Rabe, representing Fresh Energy (rabe@fresh-energy.org); Kim Burke, representing Colorado Energy Office (kim.burke@state.co.us); Howard Wiig, representing Hawaii State Energy Office (howard.c.wiig@hawaii.gov); Chris Castro, representing City of Orlando (chris.castro@orlando.gov); Brad Smith, representing City of Fort Collins (brsmith@fcgov.com); Amber Wood, representing ACEEE (awood@aceee.org)

2021 International Energy Conservation Code

Add new definition as follows:

ENERGY STORAGE SYSTEM (ESS). One or more devices, assembled together, capable of storing energy in order to supply electrical energy at a future time.

Revise as follows:

C103.2 Information on construction documents. Construction documents shall be drawn to scale on suitable material. Electronic media documents are permitted to be submitted where *approved* by the *code official*. Construction documents shall be of sufficient clarity to indicate the location, nature and extent of the work proposed, and show in sufficient detail pertinent data and features of the building, systems and equipment as herein governed. Details shall include, but are not limited to, the following as applicable:

1. Energy compliance path.
2. Insulation materials and their *R*-values.
3. Fenestration *U*-factors and solar heat gain coefficients (SHGCs).
4. Area-weighted *U*-factor and solar heat gain coefficient (SHGC) calculations.
5. Mechanical system design criteria.
6. Mechanical and service water-heating systems and equipment types, sizes and efficiencies.
7. Economizer description.
8. Equipment and system controls.
9. Fan motor horsepower (hp) and controls.
10. Duct sealing, duct and pipe insulation and location.
11. Lighting fixture schedule with wattage and control narrative.
12. Location of *daylight* zones on floor plans.
13. Air barrier and air sealing details, including the location of the air barrier.
14. Location reserved for inverters, metering equipment, ESS, and a pathway reserved for routing of raceways or conduit from the renewable energy system to the point of interconnection with the electrical service and the ESS.
15. Location and layout of a designated area for ESS.
16. Rated energy capacity and rated power capacity of the installed or planned ESS.

C105.2.5 Electrical system. Inspections shall verify lighting system controls, components and meters as required by the code, *approved* plans and specifications. Where an electrical energy storage system area is required, inspections shall verify space availability and pathways to electrical service.

Add new text as follows:

C405.15 Electrical energy storage system. Buildings shall comply with the one of C405.15.1 or C405.15.2.

C405.15.1 Electrical energy storage energy capacity.. Each building shall have one or more ESS with a total rated energy capcity and rated power capacity as follows:

1. ESS rated energy capacity (kWh)≥1.0 x Installed PV System Rated Power (kW_{DC})
2. ESS rated power capacity (kW)≥0.25 x Installed PV System Rated Power (kW_{DC})

Where installed, DC coupled battery systems shall meet the requirements for rated energy capacity alone.

C405.15.2 Electrical energy storage system ready. Each building shall have one or more reserved ESS-ready areas to accomododate future electrical storage complying with the following:

1. Energy storage system rated energy capacity (kWH) ≥ Conditioned floor area of the three largest stories (ft^2) x 0.0008 kWh/ft^2

2. Energy storage system rated power capacity (kW) ≥ Conditioned floor area of three largest stories (ft^2) x 0.0002 kWh/ft^2

C405.15.2.1 ESS-ready location. Each ESS-ready area shall be located in accordance with Section 1207 of the *International Fire Code*.

C405.15.2.2 ESS-ready minimum area requirements. Each ESS-ready area shall be sized in accordance with the spacing requirements of Section 1207 of the *International Fire Code* and the UL9540 or UL9540a designated rating of the planned system. Where rated to UL9540a, the shall be in accordance with the manufacturer's instructions.

C405.15.2.3 Electrical distribution equipment. The onsite electrical distribution equipment shall have sufficient capacity, rating, and space to allow installation of overcurrent devices and circuit wiring in accordance with NFPA 70 for future electrical ESS installation complying with the criteria of Section C405.15.2.

Add new standard(s) as follows:

UL

UL LLC
333 Pfingsten Road
Northbrook, IL 60062

9540-2020	Standard for Energy Storage Systems and Equipment
9540A-2019	Standard for Safety Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems

Revise as follows:

CB103.6 Interconnection pathway. Construction documents shall indicate pathways for routing of conduit or piping from the solar-ready zone to the electrical service panel ~~and electrical energy storage system area~~ or service hot water system.

~~**CB103.7 Electrical energy storage system-ready area.** The floor area of the electrical energy storage system-ready area shall be not less than 2 feet (610 mm) in one dimension and 4 feet (1219 mm) in another dimension, and located in accordance with Section 1207 of the *International Fire Code*. The location and layout diagram of the electrical energy storage system-ready area shall be indicated on the construction documents~~.

CB103.~~8~~ 7 Electrical service reserved space. The main electrical service panel shall have a reserved space to allow installation of a dual-pole circuit breaker for future solar electric and ~~a dual-pole circuit breaker for future electrical energy storage system installation. These spaces~~ shall be labeled “For Future Solar Electric ~~and Storage~~.” The reserved space~~s~~ shall be positioned at the end of the panel that is opposite from the panel supply conductor connection.

CB103.~~9~~ 8 Construction documentation certificate. A permanent certificate, indicating the solar-ready zone and other requirements of this section, shall be posted near the electrical distribution panel, water heater or other conspicuous location by the builder or registered design professional.

Reason: Energy storage will soon become critical to achieving President Biden’s goal of a carbon-free power sector by 2035. These systems could also bolster economy, present a cost savings opportunity for homeowners and increase resilience to power outages. In 2020, 21% of the United State’s electricity is sourced from renewable energy, primarily wind, an intermittent source of energy. As the U.S. increases the amount of electricity generated from renewables, buildings must be prepared to aid in this transition by storing energy to match grid demands.
Policies to encourage energy storage will improve the U.S. economy. Energy storage is expected to grow by over 40% each year until 2025 and the U.S., because of its manufacturing background and experience in battery-storage technology for cars is becoming a clear leader in this market.

Energy storage will also present a cost-saving opportunity. Battery prices have and will likely continue to fall in the United States, meaning that behind-the-meter storage will likely become more accessible and affordable in the short-term. More and more utilities are moving beyond voluntary programs and are expanding use of time-of-use rates for electricity as a tool for shaping demand. Ensuring buildings are energy-storage ready now will allow them to cost effectively install storage systems in the future and take advantage of these programs.

Finally, energy storage will improve resilience to power outages. In 2020, DOE found that an average household in the United States goes without power for 8 hours in a year. Because of extreme weather events caused by climate change, those outages are increasing. These outages are estimated to cost the U.S. economy between $25 billion to $70 billion annually. Requiring buildings to be storage-ready will ensure communities are more resilient by allowing buildings to cost effectively install storage which can operate for a short-period of time without relying on the electricity grid.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Analysis completed by NBI using RSMeans showed no incremental costs for this measure.

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Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: This proposal will reduce the future cost of installing ESS by requiring ESS-ready criteria.

Proposal # 302

CEPI-8-21 Part I

Proponents: Mike Nugent, representing Building Code Action Committee (bcac@iccsafe.org); David Collins, representing SEHPCAC (sehpcac@iccsafe.org)

THIS IS A 2 PART PROPOSAL. PART I WILL BE HEARD BY THE IECC-COMMERCIAL COMMITTEE. PART II WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Energy Conservation Code

SECTION C104
FEES

Revise as follows:

C104.1 Payment of Fees. A permit shall not be ~~issued~~ valid until the fees prescribed ~~in Section C104.2~~ by law have been paid ~~, nor~~ . Nor shall an amendment to a permit be released until the additional fee, if any, has been paid.

C104.2 Schedule of permit fees. ~~A~~ Where a permit is required, a fee for each permit shall be paid as required, in accordance with the schedule as established by the applicable governing authority.

Add new text as follows:

C104.3 Permit valuation. The applicant for a permit shall provide an estimated value of the work for which the permit is being issued at the time of application. Such estimated valuations shall include the total value of the work, including materials and labor. Where, in the opinion of the code official, the valuation is underestimated, the permit shall be denied, unless the applicant can show detailed estimates acceptable to the code official. The final valuation shall be *approved* by the code official.

Revise as follows:

~~**C104.3**~~ **C104.4 Work commencing before permit issuance.** Any person who commences any work before obtaining the necessary permits shall be subject to ~~an additional~~ a fee established by the *code official* that shall be in addition to the required permit fees.

~~**C104.4**~~ **C104.5 Related fees.** The payment of the fee for the construction, *alteration*, removal or demolition of work done in connection to or concurrently with the work or activity authorized by a permit shall not relieve the applicant or holder of the permit from the payment of other fees that are prescribed by law.

~~**C104.5**~~ **C104.6 Refunds.** The *code official* is authorized to establish a refund policy.

Reason: The intent is consistency in language for 'Fees' within the codes.

- Payment of fees – consistent title, always two sentences
- Schedule of permit fees – Not all projects require a fee - Commercial and Residential are currently different in this section.
- Permit valuation: This lets the jurisdiction establish fees for permits.
- Work commencing before permit issuance – remove redundant language
- Refunds – no change

The BCAC is working from the philosophy that ICC is a family of codes, so administrative requirements should be consistent across books. Most administrative and enforcement matters are the same for any code. Those matters unique for a specific code remain unchanged. This is one of a series of proposals being submitted relating to technical, editorial and organizational changes proposed for the Administrative chapters (Chapter 1) in all of the I-Codes.

This proposal is submitted by the ICC Building Code Action Committee (BCAC) and the ICC Sustainable and Energy and High Performance Code Action Committee (SEHPCAC).

BCAC was established by the ICC Board of Directors in July 2011 to pursue opportunities to improve and enhance assigned International Codes or portions thereof. In 2020 and 2021 the BCAC has held several virtual meetings open to any interested party. In addition, there were numerous virtual Working Group meetings for the current code development cycle, which included members of the committee as well as interested parties. Related documents and reports are posted on the ICC website at https://www.iccsafe.org/codes-tech-support/codes/codedevelopment-process/building-code-actioncommittee-bcac.

The SEHPCAC was established by the ICC Board of Directors to pursue opportunities to improve and enhance International Codes with regard to sustainability, energy and high performance as it relates to the built environment included, but not limited to, how these criteria relate to the International Green Construction Code (IgCC) and the International Energy Conservation Code (IECC). In 2018-2019, the SEHPCAC has held five two- or three-day open meetings and numerous workgroup calls, to discuss and debate proposed changes and public comments. Attendees at the meetings and calls included members of the SEHPCAC as well as any interested parties. Related documentation and reports are posted on the

SEHPCAC website at http://www.iccsafe.org/cs/SEHPCAC/Pages/default.aspx.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This is an administrative allowance for a building department. This will not change any construction requirements.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: These changes bring consistency to the I codes.

Proposal # 428

CEPI-9-21

Proponents: Nicholas O'Neil, representing NEEA (noneil@energy350.com); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Add new definition as follows:

DEMAND CONTROL KITCHEN VENTILATION (DCKV). A system that provides *automatic*, continuous control over exhaust hood and make-up air fan speed in response to temperature, optical, or infrared (IR) sensors that monitor cooking activity or through direct communication with cooking appliances.

Revise as follows:

C403.7.5 Kitchen exhaust systems. Replacement air introduced directly into the exhaust hood cavity shall not be greater than 10 percent of the hood exhaust airflow rate. Conditioned supply air delivered to any space shall not exceed the greater of the following:

1. The ventilation rate required to meet the space heating or cooling load.
2. The hood exhaust flow minus the available transfer air from adjacent space where available transfer air is considered to be that portion of outdoor *ventilation air* not required to satisfy other exhaust needs, such as restrooms, and not required to maintain pressurization of adjacent spaces.

Kitchen exhaust hood systems serving Type I exhaust hoods shall be provided with *demand control kitchen ventilation (DCKV)* controls w~~W~~here a kitchen or kitchen/dining facility has a total Type I kitchen hood exhaust airflow rate ~~is~~ greater than 5,000 cfm (2360 L/s) . ~~,~~ *DCKV* systems shall be configured to provide a minimum of 50 percent reduction in exhaust and replacement air system airflow rates. Systems shall include controls necessary to modulate exhaust and replacement air system airflows in response to appliance operation and to maintain full capture and containment of smoke, effluent and combustion products during cooking and idle operation. ~~e~~ Each hood shall be a factory-built commercial exhaust hood listed by a nationally recognized testing laboratory ~~in compliance with UL 710. Each hood~~ and shall have a maximum exhaust rate as specified in Table C403.7.5 . ~~and shall comply with one of the following:~~

1. ~~Not less than 50 percent of all replacement air shall be transfer air that would otherwise be exhausted.~~
2. ~~Demand ventilation systems on not less than 75 percent of the exhaust air that are configured to provide not less than a 50-percent reduction in exhaust and replacement air system airflow rates, including controls necessary to modulate airflow in response to appliance operation and to maintain full capture and containment of smoke, effluent and combustion products during cooking and idle.~~
3. ~~Listed energy recovery devices with a sensible heat recovery effectiveness of not less than 40 percent on not less than 50 percent of the total exhaust airflow.~~

Where a single hood, or hood section, is installed over appliances with different duty ratings, the maximum allowable flow rate for the hood or hood section shall be based on the requirements for the highest appliance duty rating under the hood or hood section.

~~Exception~~ Exceptions: ~~Where not less than 75 percent of all the replacement air is transfer air that would otherwise be exhausted.~~

1. UL 710 *listed* exhaust hoods that have a design maximum exhaust flow rate not greater than 250 cfm per linear foot of hood that serve kitchen or kitchen/dining facilities with a total kitchen hood exhaust airflow rate less than 5000 cfm (2360 L/s).
2. Where allowed by the *International Mechanical Code*, an *energy recovery ventilation system* is installed on the kitchen exhaust with a sensible heat recovery effectiveness of not less than 40 percent on not less than 50 percent of the total exhaust hood airflow.

Reason: Demand control kitchen ventilation has been commonplace on make-up air hoods for years and has appeared in the IECC since 2015. This proposal clarifies the section by relocating several nested requirements to the charging language and mandating DCKV on hoods of 5000 cfm or greater unless they have an energy recovery device, or are UL-710 hoods with a maximum 250 cfm/lf flowrate or below the 5,000 cfm threshold. This cleans up the section to make it clearer that DCKV is required on most kitchen exhaust hoods and moves less common compliance paths (such as heat recovery and UL 710 listed hoods) to exceptions rather than in the charging language making this provision easier to understand. It also removes the transfer air requirement which is not common on systems above this size threshold to utilize in real world applications.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Because the threshold for which this applies remains the same for kitchens with a total exhaust airflow of 5,000 cfm there is no expectation that costs will increase. Prior analysis for adding variable speed fans and associated controls have shown an incremental cost of $11,500 regardless of hood size. The 5,000cfm threshold was chosen as the cost-effective breakpoint given the cost and is not changing as part of this proposal.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Subcommittee referenced reason statement in proposal.

Demand control kitchen ventilation has been commonplace on make-up air hoods for years and has appeared in the IECC since 2015. This proposal clarifies the section by relocating several nested requirements to the charging language and mandating DCKV on hoods of 5000 cfm or greater unless they have an energy recovery device, or are UL-710 hoods with a maximum 250 cfm/lf flowrate or below the 5,000 cfm threshold.

This cleans up the section to make it clearer that DCKV is required on most kitchen exhaust hoods and moves less common compliance paths (such as heat recovery and UL 710 listed hoods) to exceptions rather than in the charging language making this provision easier to understand. It also removes the transfer air requirement which is not common on systems above this size threshold to utilize in real world applications.

Proposal # 65

CEPI-12-21 Part I

Proponents: Diana Burk, representing New Buildings Institute (diana@newbuildings.org)
THIS IS A 2 PART PROPOSAL. PART I WILL BE HEARD BY THE IECC-COMMERCIAL COMMITTEE. PART II WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE. SEE THE TENTATIVE HEARING ORDER FOR THESE COMMITTEES.

THIS IS A 2 PART PROPOSAL. PART I WILL BE HEARD BY THE IECC-COMMERCIAL COMMITTEE. PART II WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Energy Conservation Code

Delete without substitution:

~~**BIOMASS.** Nonfossilized and biodegradable organic material originating from plants, animals and/or microorganisms, including products, by-products, residues and waste from agriculture, forestry and related industries as well as the nonfossilized and biodegradable organic fractions of industrial and municipal wastes, including gases and liquids recovered from the decomposition of nonfossilized and biodegradable organic material.~~

Add new definition as follows:

<u>**BIOMASS WASTE.** Organic non-fossil material of biological origin that is a byproduct or a discarded product. Biomass waste includes municipal solid waste from biogenic sources, landfill gas, sludge waste, agricultural crop byproducts, straw, and other biomass solids, liquids, and biogases; but excludes wood and wood-derived fuels (including black liquor), biofuel feedstock, biodiesel, and fuel ethanol.</u>

Revise as follows:

RENEWABLE ENERGY RESOURCES. Energy derived from solar radiation, wind, waves, tides~~, landfill gas, biogas, biomass~~ <u>*biomass waste*</u> or extracted from hot fluid or steam heated within the earth.

Reason: The existing definition for biomass in the IECC dates to the 2012 IECC. It was proposed by the team of New Buildings Institute, US Department of Energy and American Institute of Architects. It was one clause in a comprehensive overhaul of the 2009 IECC. When it was written in 2010, it was the first time that renewable energy had been defined in an I-code, and it reflected a very early understanding of a much less mature industry. It has not been significantly revised since.
This proposal updates the language by further refining biomass energy sources with terms that were not available at the time it was drafted in 2010. The revision also limits the biomass sources that count as renewable energy resources to those that are specified as waste products. There are many flavors of biomass energy, but this proposal ensures that virgin material of unknown origin does not count as a renewable energy resource, which in the provisions of C406 is a trade-off for energy efficiency features of the building. Without an available standard to cite in the IECC for sustainable biomass, it is critical to ensure that biomass used in compliance with the IECC is derived from waste products or byproducts. The definition of *biomass waste* is from the glossary of the Energy Information Administration. A similar amendment has been submitted to amend the residential IECC to ensure the definition of renewable energy resources is consistent between the two codes.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal clarifies the definition of renewable energy and will have no impact on construction costs.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: This proposal ensures that virgin material of unknown origin does not count as a renewable energy resource.

CEPI-14-21

Proponents: Nicholas O'Neil, representing NEEA (noneil@energy350.com); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Add new definition as follows:

DEDICATED OUTDOOR AIR SYSTEM (DOAS). A *ventilation* system that supplies 100 percent outdoor air primarily for the purpose of *ventilation* and that is a separate system from the *zone* space-conditioning system.

DX-DEDICATED OUTDOOR AIR SYSTEM UNITS (DX-DOAS UNITS). A type of air-cooled, water-cooled or water source factory assembled product that dehumidifies 100 percent outdoor air to a low dew point and includes reheat that is capable of controlling the supply dry-bulb temperature of the dehumidified air to the designated supply air temperature. This conditioned outdoor air is then delivered directly or indirectly to the conditioned spaces. It may precondition outdoor air by containing an enthalpy wheel, sensible wheel, desiccant wheel, plate heat exchanger, heat pipes, or other heat or mass transfer apparatus. with an *energy recovery ventilation system.*

Reason: Both DOAS and DX-DOAS terms are used in the IECC (in C403 and C406) but do not have definitions explaining what they are. These definitions are added to provide clarity when talking about DOAS and are coped from common definitions used in ASHRAE 90.1, the WA State Energy Code, and Title 24.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
These are simply definitions to clarify DOAS types and do nothing to impact cost.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Both DOAS and DX-DOAS terms are used in the IECC (in C403 and C406) but do not have definitions explaining what they are. These definitions are added to provide clarity when talking about DOAS and are coped from common definitions used in ASHRAE 90.1, the WA State Energy Code, and Title 24.

Proposal # 526

CEPI-15-21 Part I

Proponents: Amanda Hickman, representing Reflective Insulation Manufacturers Association (RIMA) (amanda@thehickmangroup.com)

THIS IS A 3 PART PROPOSAL. PART I WILL BE HEARD BY THE IECC-COMMERCIAL COMMITTEE. PART II AND PART III WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Energy Conservation Code

Add new definition as follows:

EMITTANCE. The ratio of the radiant heat flux emitted by a specimen to that emitted by a blackbody at the same temperature and under the same conditions.

Reason: This definition is needed because the term emittance is used in various sections of the code and in the definition for radiant barrier and reflective insulation. It is consistent with the definition found in the 2021 IBC, ASHRAE and ASTM standards. The term emittance is used in numerous sections of this code including for: Building Envelope Requirements, Equipment Buildings, Roof Solar Reflectance and Thermal Emittance, Minimum Roof Reflectance and Emittance Options, Specifications for the Standard Reference and Proposed Designs, Roofs, and for Specifications for the Standard Reference and Proposed Designs, Walls above-grade.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Adding a definition of EMITTANCE will neither increase or decrease construction costs. This is only a definition and is identical to the definition found in the 2021 IBC and existing ASHRAE and ASTM standards.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: for consistency with IECC-R admin and consistency with IECC-R consensus committee actions.

Proposal # 102

CEPI-16-21 Part I

Proponents: David Collins, representing SEHPCAC (sehpcac@iccsafe.org)

THIS IS A 2 PART PROPOSAL. PART I WILL BE HEARD BY THE IECC-COMMERCIAL COMMITTEE. PART II WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Energy Conservation Code

FENESTRATION. Products classified as either skylights or vertical fenestration.

Skylights. Glass or other transparent or translucent glazing material installed at a slope of less than 60 degrees (1.05 rad) from horizontal, including unit skylights, tubular daylighting devices and glazing materials in solariums, sunrooms, roofs, greenhouses and sloped walls.

2021 International Energy Conservation Code

Revise as follows:

C402.5.4 Air leakage of fenestration and opaque doors. The air leakage of fenestration and opaque door assemblies shall meet the provisions of Table C402.5.4. Testing shall be in accordance with the applicable reference test standard in Table C402.5.4 by an accredited, independent testing laboratory and *labeled* by the manufacturer.

Exceptions:

1. Field-fabricated fenestration assemblies that are sealed in accordance with Section C402.5.1.
2. Fenestration in buildings that comply with the testing alternative of Section C402.5 are not required to meet the air leakage requirements in Table C402.5.4.

Revise as follows:

Vertical fenestration. Windows that are fixed or operable, ~~opaque doors, glazed~~ doors that are more than half glazed, glazed block and combination opaque and glazed doors composed of glass or other transparent or translucent glazing materials and installed at a slope of not less than 60 degrees (1.05 rad) from horizontal.

Reason: · **Revise the definition of vertical fenestration** in the IECC to resolve a conflict between the IECC and ASHRAE 90.1. By making this change, only doors that are more than one half glazed will be defined as fenestrations in both the IECC and ASHRAE 90.1. thereby clarifying the application of the IECC by more clearly stating that doors that are more than half glazed are included in the definition of vertical glazing. Having technically synonymous definitions will facilitate consistency of requirements going forward and help avoid confusion for designers who work with both the standard and the code.

· **Revise Sec. R402.3** to clarify that opaque doors (by definition *"A door that is not less than 50-percent opaque in surface area*") must meet the fenestration requirements. Since opaque doors are currently included in the definition of fenestration, this represents no technical change.

· **Re-format Sec. R402.**5 for ease of reading and to clearly state that opaque doors must comply with maximum fenestration U-factor limitations when using weighted averages for envelope compliance. Since opaque doors are currently included in the definition of fenestration, this represents no technical change.

· **Re-title the "fenestration" column of Table R402.1.2** to include opaque doors. Since opaque doors are currently included in the definition of fenestration, this represents no technical change.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
None; no technical change to the requirements is proposed.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: To provide consistency between the definitions of fenestration used in the IECC and ASHRAE 90.1. Modification makes sure the air leakage requirement still applies to opaque doors.

CEPI-17-21 Part I

Proponents: Marcin Pazera, Polyisocyanurate Insulation Manufacturers Association, representing Polyisocyanurate Insulation Manufacturers Association (mpazera@pima.org); Justin Koscher, Polyisocyanurate Insulation Manufacturers Association, representing Polyisocyanurate Insulation Manufacturers Association (jkoscher@pima.org)

THIS IS A 2 PART PROPOSAL. PART I WILL BE HEARD BY THE IECC-COMMERCIAL COMMITTEE. PART II WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Energy Conservation Code

Revise as follows:

ROOF REPLACEMENT. ~~The process of removing the existing roof covering, repairing any damaged substrate and installing a new roof covering.~~ <u>An alteration that includes the removal of all existing layers of *roof assembly* materials down to the roof deck and installing replacement materials above the existing roof deck.</u>

Reason: This proposal revises the definition for roof replacement to reflect the intent and the scope of the roof replacement activity that takes place, which includes removal of all existing materials installed above the roof deck, removing those materials down to the roof deck, and installing a new roof assembly above the roof deck. The definition more explicitly states that roof replacement is an alteration as indicated in Section C503 of the IECC. The revised language in the definition more appropriately aligns with the requirements in Chapter 15 (Section 1512) of the IBC. The term “roof assembly” is already defined in the IECC and in the IBC (for use in Chapter 15). Furthermore, PIMA will submit a code change proposal for the Group B development cycle to explicitly reflect that existing roof insulation that is in good repair may be reused as part of a roof replacement (Section 1512.4).

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This code change proposal will have no impact on the cost of construction. The proposal does not impose new requirements.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: clarification was needed that replacement was down to the roof deck and it is also clarifying to bring in the definition of roof assembly. It also uses terminology more consistent with IBC.

Proposal # 357

CEPI-19-21 Part I

Proponents: Darren Meyers, P.E., representing International Energy Conservation Consultants LLC (dmeyers@ieccode.com); Mark Graham, representing National Roofing Contractors Association (mgraham@nrca.net)

THIS IS A 2 PART PROPOSAL. PART I WILL BE HEARD BY THE IECC-COMMERCIAL COMMITTEE. PART II WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Energy Conservation Code

Revise as follows:

C303.1.1 Building thermal envelope insulation. An *R*-value identification mark shall be applied by the manufacturer to each piece of *building thermal envelope* insulation 12 inches (305 mm) or greater in width. Alternatively, the insulation installers shall provide a certification listing the type, manufacturer and *R*-value of insulation installed in each element of the *building thermal envelope.* For blown-in or sprayed fiberglass and cellulose insulation, the initial installed thickness, settled thickness, settled *R*-value, installed density, coverage area and number of bags installed shall be indicated on the certification. For sprayed polyurethane foam (SPF) insulation, the installed thickness of the areas covered and *R*-value of installed thickness shall be indicated on the certification. For insulated siding, the *R*-value shall be labeled on the product's package and shall be indicated on the certification. The insulation installer shall sign, date and post the certification in a conspicuous location on the job site.

> **Exception:** For roof insulation installed above the deck, the *R*-value shall be labeled as required by the material standards specified in Table 1508.2 of the *International Building Code*.

C303.1.2 Insulation mark installation. Insulating materials shall be installed such that the manufacturer's *R*-value mark is readily observable upon inspection. For insulation materials that are installed without an observable manufacturer's *R*-value mark, such as blown or draped products, an insulation certificate complying with Section C303.1.1 shall be left immediately after installation by the installer, in a conspicuous location within the building, to certify the installed *R*-value of the insulation material.

> **Exception:** For roof insulation installed above the deck, the *R-value* shall be labeled as specified by the material standards in Table 1508.2 of the *International Building Code.*

Reason: The National Roofing Contractors Association authored identical exceptions to C303.1.1 and R303.1.1 several cycles ago. Our proposal here, is intent on averting similar confusion relative to field inspection observations. Rigid board insulation intended for above-deck installation is package-labeled. Once the package covering is removed, no permanent marking remains, as these respective sections imply. It is common for inspectors to perform their field inspection duties by collecting or observing unopened or pre-opened packaging materials while on site.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The code change proposal will neither increase nor decrease the cost of construction.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Clarification; the code requires labeling; the standard specifies how the product is to be labeled

Proposal # 339

CEPI-23-21

Proponents: Gayathri Vijayakumar, Steven Winter Associates, Inc., representing Steven Winter Associates, Inc. (gayathri@swinter.com)

2021 International Energy Conservation Code

Revise as follows:

C401.2.1 International Energy Conservation Code. Commercial buildings shall comply with one of the following:

1. **Prescriptive Compliance.** The Prescriptive Compliance option requires compliance with Sections C402 through C406 and Section C408. Dwelling units and sleeping units in Group R-2 buildings ~~without systems serving multiple units~~ shall be deemed to be in compliance with this chapter, provided that they comply with Section R406.
2. **Total Building Performance.** The Total Building Performance option requires compliance with Section C407.

Exception: Additions, alterations, repairs and changes of occupancy to existing buildings complying with Chapter 5.

Reason: In the prior code cycle, there were objections to allowing R406 (ERI) for dwelling / sleeping units in high-rise buildings subject to the Commercial provisions. This was mostly due to a lack of familiarity with the energy rating process and modeling protocols of ANSI/RESNET/ICC 301. As the Chair of the Standards Development Committee that oversees that Standard, it includes calculations that allow shared systems (HVAC and SHW) to be modeled in the energy rating of a dwelling or sleeping unit. A 3 story building with systems that serve multiple units currently is permitted to show compliance using R406 so there is no reason to disallow it for taller buildings.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
There is no specific increase in the cost of construction associated with choosing this compliance path.

For some buildings with systems serving multiple units, R406 may be a less expensive option with respect to the energy modeling costs, but might be more expensive with regard to the specific building systems that would then be needed to meet the current ERI targets. These targets were likely developed with single family homes and low-rise multifamily in mind, without shared systems. The energy rating index uses a baseline where dwelling units and sleeping units have their own HVAC and DHW system. Where the actual design has shared systems, the additional energy associated with distribution is an energy 'penalty' to overcome (which is non-existent in units with their own systems).

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: revises the R-2 definition to include dwelling units with systems that serve multiple units

Proposal # 223

CEPI-24-21 Part I

Proponents: Amy Boyce, representing Institute for Market Transformation

THIS IS A 2 PART PROPOSAL. PART I WILL BE HEARD BY THE IECC-COMMERCIAL COMMITTEE. PART II WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Energy Conservation Code

Revise as follows:

PROPOSED DESIGN. A description of the proposed building used to estimate annual energy use for determining compliance based on ~~total~~ simulated building performance.

STANDARD REFERENCE DESIGN. A version of the *proposed design* that meets the minimum requirements of this code and is used to determine the maximum annual energy use requirement for compliance based on ~~total~~ simulated building performance.

Add new definition as follows:

SIMULATED BUILDING PERFORMANCE. A process in which the proposed building design is compared to a standard reference design for the purposes of estimating relative energy use against a baseline to determine code compliance.

Revise as follows:

C401.2.1 International Energy Conservation Code. Commercial buildings shall comply with one of the following:

1. **Prescriptive Compliance.** The Prescriptive Compliance option requires compliance with Sections C402 through C406 and Section C408. Dwelling units and sleeping units in Group R-2 buildings without systems serving multiple units shall be deemed to be in compliance with this chapter, provided that they comply with Section R406.
2. **~~Total~~ Simulated Building Performance.** The ~~Total~~ Simulated Building Performance option requires compliance with Section C407.

Exception: Additions, alterations, repairs and changes of occupancy to existing buildings complying with Chapter 5.

SECTION C407
~~TOTAL~~ SIMULATED BUILDING PERFORMANCE

C407.1 Scope. This section establishes criteria for compliance using ~~total~~ simulated building performance. The following systems and loads shall be included in determining the ~~total~~ simulated building performance: heating systems, cooling systems, service water heating, fan systems, lighting power, receptacle loads and process loads.

Exception: Energy used to recharge or refuel vehicles that are used for on-road and off-site transportation purposes.

C407.2 Mandatory requirements. Compliance based on ~~total~~ simulated building performance requires that a proposed design meet all of the following:

1. The requirements of the sections indicated within Table C407.2.
2. An annual energy cost that is less than or equal to 80 percent of the annual energy cost of the *standard reference design*. Energy prices shall be taken from a source *approved* by the *code official*, such as the Department of Energy, Energy Information Administration's *State Energy Data System Prices and Expenditures* reports. *Code officials* shall be permitted to require time-of-use pricing in energy cost calculations. The reduction in energy cost of the proposed design associated with *on-site renewable energy* shall be not more than 5 percent of the total energy cost. The amount of renewable energy purchased from off-site sources shall be the same in the *standard reference design* and the *proposed design*.

Exception: Jurisdictions that require site energy (1 kWh = 3413 Btu) rather than energy cost as the metric of comparison.

TABLE C407.2 REQUIREMENTS FOR ~~TOTAL~~ SIMULATED BUILDING PERFORMANCE

SECTION [a]	TITLE
Envelope	
C402.5	Air leakage—thermal envelope
Mechanical	
C403.1.1	Calculation of heating and cooling loads
C403.1.2	Data centers
C403.2	System design
C403.3	Heating and cooling equipment efficiencies
C403.4, except C403.4.3, C403.4.4 and C403.4.5	Heating and cooling system controls
C403.5.5	Economizer fault detection and diagnostics
C403.7, except C403.7.4.1	Ventilation and exhaust systems
C403.8, except C403.8.6	Fan and fan controls
C403.9	Large-diameter ceiling fans
C403.11, except C403.11.3	Refrigeration equipment performance
C403.12	Construction of HVAC system elements
C403.13	Mechanical systems located outside of the building thermal envelope
C404	Service water heating
C405, except C405.3	Electrical power and lighting systems
C408	Maintenance information and system commisioning

a. Reference to a code section includes all the relative subsections except as indicated in the table.

C407.5.3 Exceptional calculation methods. Where the simulation program does not model a design, material or device of the *proposed design*, an exceptional calculation method shall be used where approved by the *code official*. Where there are multiple designs, materials or devices that the simulation program does not model, each shall be calculated separately and exceptional savings determined for each. The total exceptional savings shall not constitute more than half of the difference between the baseline simulated building performance and the proposed simulated building performance. Applications for approval of an exceptional method shall include all of the following:

1. Step-by-step documentation of the exceptional calculation method performed, detailed enough to reproduce the results.
2. Copies of all spreadsheets used to perform the calculations.
3. A sensitivity analysis of energy consumption where each of the input parameters is varied from half to double the value assumed.
4. The calculations shall be performed on a time step basis consistent with the simulation program used.
5. The performance rating calculated with and without the exceptional calculation method.

C502.2 Change in space conditioning. Any nonconditioned or low-energy space that is altered to become *conditioned space* shall be required to comply with Section C502.

Exceptions:

1. Where the component performance alternative in Section C402.1.5 is used to comply with this section, the proposed UA shall be not greater than 110 percent of the target UA.
2. Where the ~~total~~ simulated building performance option in Section C407 is used to comply with this section, the annual energy cost of the proposed design shall be not greater than 110 percent of the annual energy cost otherwise permitted by Section C407.2.

C505.1 General. Spaces undergoing a change in occupancy that would result in an increase in demand for either fossil fuel or electrical energy shall comply with this code. Where the use in a space changes from one use in Table C405.3.2(1) or C405.3.2(2) to another use in Table C405.3.2(1) or C405.3.2(2), the installed lighting wattage shall comply with Section C405.3. Where the space undergoing a change in occupancy or use is in a building with a fenestration area that exceeds the limitations of Section C402.4.1, the space is exempt from Section C402.4.1 provided that there is not an increase in fenestration area.

Exceptions:

1. Where the component performance alternative in Section C402.1.5 is used to comply with this section, the proposed UA shall not be greater than 110 percent of the target UA.
2. Where the ~~total~~ <u>simulated</u> building performance option in Section C407 is used to comply with this section, the annual energy cost of the proposed design shall not be greater than 110 percent of the annual energy cost otherwise permitted by Section C407.3.

ZERO ENERGY PERFORMANCE INDEX (ZEPIPB,EE). The ratio of the proposed <u>simulated</u> building EUI without renewables to the baseline <u>simulated</u> building EUI, expressed as a percentage.

Reason: The “Total Building Performance” path, as prescribed by the IECC, uses simulation software to compare elements of the *proposed building* with that of a *baseline building*. In this simulation, many building elements are simulated using default values, as those elements do not affect the results of the comparison. The path title leads many to the false conclusion that the results of this building simulation will align with the actual building energy use – its performance – once it is built and occupied; however, that is not the intent of the simulation in this case.
While generally confusing in the past, this misconception is more critical now with the adoption of Building Performance Standards (BPS) in many jurisdictions. While BPS govern existing buildings, they will apply to newly constructed buildings once those structures have been occupied for a set number of years. The misunderstanding of the purpose and the results of the code-required proposed building model may lead owners and operators to assume that a building was designed to meet the future BPS requirements and that that design intent is backed up by the model results. Changing the language to clarify that the results of the code-required proposed building model are not necessarily aligned with future building performance will adjust expectations and potentially minimize future legal concerns.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This change affects the language only.

Cost Effectiveness: While the change itself will neither increase nor decrease costs, bringing awareness to the limitations of the current total building performance path will aid owners and designers in the conversation about predicted building performance and potentially reduce costs associated with changes made later on in the process.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Reason: clarifies that the whole building modeling approach is based on simulation and not actual utility bills.

Proposal # 478

CEPI-27-21

Proponents: Jay Crandell, P.E., ABTG/ARES Consulting, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2021 International Energy Conservation Code

SECTION C402
BUILDING ENVELOPE REQUIREMENTS

Revise as follows:

C402.1 General. *Building thermal envelope* assemblies for buildings that are intended to comply with the code on a prescriptive basis in accordance with the compliance path described in Item 1 of Section C401.2.1shall comply with the following:

1. The opaque portions of the *building thermal envelope* shall comply with the specific insulation requirements of Section C402.2 and the thermal requirements of either the *R*-value-based method~~ of~~ Section C402.1.3; the *U*-, *C*- and *F*-factor-based method of Section C402.1.4; or the component performance alternative of Section C402.1.5.
2. Roof solar reflectance and thermal emittance shall comply with Section C402.3.
3. Fenestration in building envelope assemblies shall comply with Section C402.4.
4. Air leakage of building envelope assemblies shall comply with Section C402.5.
5. Walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with Section C403.11.

Alternatively, where buildings have a vertical fenestration area or skylight area exceeding that allowed in Section C402.4, the building and *building thermal envelope* shall comply with Item 2 of Section C401.2.1 or Section C401.2.2.

~~Walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with Section C403.11.~~

C402.1.3 Insulation component R-value-based method. ~~*Building thermal envelope* opaque assemblies shall comply with the requirements of Sections C402.2 and C402.4 based on the *climate zone* specified in Chapter 3.~~ For opaque portions of the *building thermal envelope* intended to comply on an insulation component *R*-value basis, the *R*-values for cavity insulation and continuous insulation shall be not less than that specified in Table C402.1.3. ~~Where cavity insulation is installed in multiple layers, the cavity insulation *R*-values shall be summed to determine compliance with the cavity insulation *R*-value requirements. Where continuous insulation is installed in multiple layers, the continuous insulation *R*-values shall be summed to determine compliance with the continuous insulation *R*-value requirements. Cavity insulation *R*-values shall not be used to determine compliance with the continuous insulation *R*-value requirements in Table C402.1.3.~~ Commercial buildings or portions of commercial buildings enclosing *Group R* occupancies shall use the *R*-values from the "*Group R*" column of Table C402.1.3. Commercial buildings or portions of commercial buildings enclosing occupancies other than *Group R* shall use the *R*-values from the "All other" column of Table C402.1.3.

Add new text as follows:

C402.1.3.1 R-value of multi-layered insulation components.. Where *cavity insulation* is installed in multiple layers, the *cavity insulation R*-values shall be summed to determine compliance with the *cavity insulation R*-value requirements. Where *continuous insulation* is installed in multiple layers, the *continuous insulatio*n *R*-values shall be summed to determine compliance with the *continuous insulation R*-value requirements. *Cavity insulation R*-values shall not be used to determine compliance with the *continuous insulation R*-value requirements in Table C402.1.3.

C402.1.3.2 Area-weighted averaging of R-values. Area-weighted averaging shall not be permitted for *R*-value compliance.

> **Exception:** For tapered above-deck roof insulation, compliance with the *R*-values required in Table C402.1.3 shall be permitted to be demonstrated by multiplying the rated *R*-value per inch of the insulation material by the average thickness of the roof insulation. The average thickness of the roof insulation shall equal the total volume of the roof insulation divided by the area of the roof.

C402.1.3.3 Building materials and air spaces. Building materials that are not insulation components complying with Chapter 3 shall be excluded from demonstrating compliance with the *R*-values of Table C402.1.3. Air spaces used to demonstrate compliance with Table C402.1.3 shall comply with Section C402.2.7.

C402.1.3.4 Assembly construction. Assembly constructions used for compliance with Table C402.1.3 shall be as described in ANSI/ASHRAE/IESNA 90.1 Appendix A.

C402.1.3.5 Concrete masonry units, integral insulation. The *R*-value of integral insulation installed in concrete masonry units shall not be used in determining compliance with Table C402.1.3 except as otherwise noted.

C402.1.3.6 Mass walls and floors. Compliance with required minimum *R*-values for insulation components applied to mass walls and mass floors in accordance with Table C402.1.3 shall be permitted for assemblies complying with the following:

1. Where used as a component of the *building thermal envelope, mass walls* shall comply with one of the following:

   1.1. Weigh not less that 35 pounds per square foot (171 kg/m^2) of wall surface area.

   1.2. Weigh not less than 25 pounds per square foot (122 kg/m^2) of wall surface area where the material weight is not more than 120 pcf (1900 kg/m^3).

   1.3. Have a heat capacity exceeding 7 Btu/ft^2-F (144 kJ/m^2-K).

   1.4. Have a heat capacity exceeding 5 Btu/ft^2-F (103 kJ/m^2-K) where the material weight is not more than 120 pcf (1900 kg/m^3).

2. Where used as a component of the *building thermal envelope* of a building, the minimum weight of mass floors shall comply with provide one of the following:

   2.1. 35 pounds per square foot (171 kg/m^2) of floor surface area.

   2.2. 25 pounds per square foot (122 kg/m^2) of floor surface area where the material weight is not more than 120 pcf (1900 kg/m^3).

Revise as follows:

C402.1.4 Assembly U-factor, C-factor or F-factor-based method. ~~*Building thermal envelope* opaque assemblies shall meet the requirements of Sections C402.2 and C402.4 based on the climate zone specified in Chapter 3.~~ *Building thermal envelope* opaque assemblies intended to comply on an assembly *U*-, *C*- or *F*-factor basis shall have a *U*-, *C*- or *F*-factor not greater than that specified in Table C402.1.4. Commercial buildings or portions of commercial buildings enclosing *Group R* occupancies shall use the *U*-, *C*- or *F*-factor from the "*Group R*" column of Table C402.1.4. Commercial buildings or portions of commercial buildings enclosing occupancies other than *Group R* shall use the *U*-, *C*- or *F*-factor from the "All other" column of Table C402.1.4.

Delete without substitution:

~~**C402.1.4.1 Roof/ceiling assembly.** The maximum roof/ceiling assembly *U*-factor shall not exceed that specified in Table C402.1.4 based on construction materials used in the roof/ceiling assembly.~~

Add new text as follows:

C402.1.4.1 Methods of determining U-, C-, and F-factors. Where assembly U-factors, C-factors and F-factors and calculation procedures are established in ANSI/ASHRAE/IESNA 90.1 Appendix A for opaque assemblies, such opaque assemblies shall be a compliance alternative provided they meet the criteria of Table C402.1.4 and the construction, excluding cladding system on walls, complies with the applicable construction details from ANSI/ASHRAE/ISNEA 90.1 Appendix A. Where U-factors have been established by testing in accordance with ASTM C1363, such opaque assemblies shall be a compliance alternative provided they meet the criteria of Table C402.1.4. The R-value of continuous insulation shall be permitted to be added to or subtracted from the original tested design. Air spaces used for assembly evaluations shall comply with Section C402.2.7.

Revise as follows:

C402.1.4.1.1 Tapered, above-deck insulation based on thickness. For tapered, above-deck roof insulation, the area-weighted U-factor of non-uniform insulation thickness shall be determined by an *approved* method. ~~Where used as a component of a maximum roof/ceiling assembly *U*-factor calculation, the sloped roof insulation *R*-value contribution to that calculation shall use the average thickness in inches (mm) along with the material *R*-value-per-inch (per-mm) solely for *U*-factor compliance as prescribed in Section C402.1.4.~~

> **Exception:** The area-weighted U-factor shall be permitted to be determined by using the inverse of the average R-value determined in accordance with the exception to Section C402.1.3.2.

C402.1.4.1.2 Suspended ceilings. Insulation installed on suspended ceilings having removable ceiling tiles shall not be considered part of the assembly *U*-factor of the roof/ceiling construction.

Delete without substitution:

~~**C402.1.4.1.3 Joints staggered.** Continuous insulation board shall be installed in not less than two layers, and the edge joints between each layer of insulation shall be staggered, except where insulation tapers to the roof deck at a gutter edge, roof drain or scupper.~~

Add new text as follows:

C402.1.4.1.3 Concrete masonry units, integral insulation. Where determining compliance with Table C402.1.4, the *U*-factor of concrete masonry units with integral insulation shall be permitted to be used.

C402.1.4.1.4 Mass walls and floors. Compliance with required maximum *U*-factors for mass walls and mass floors in accordance with Table C402.1.4 shall be permitted for assemblies complying with Section C402.1.3.3.

Revise as follows:

~~**C402.1.4.2**~~ **C402.1.4.1.5 U-factor t~~T~~hermal resistance of cold-formed steel walls.** *U*-factors of walls with cold-formed steel studs shall be permitted to be determined in accordance with Equation 4-1.

$$U = 1/[R_s + (ER)]$$ **(Equation 4-1)**

where:

R_s = The cumulative *R*-value of the wall components along the path of heat transfer, excluding the *cavity insulation* and steel studs.

ER = The effective *R*-value of the *cavity insulation* with steel studs as specified in Table C402.1.4.2.

C402.2 Specific ~~building thermal envelope~~ insulation and installation requirements. Insulation in *building thermal envelope* opaque assemblies shall be installed in accordance ~~comply~~ with Section C303.2 and Sections C402.2.1 through C402.2.7, or an *approved* design ~~and Table C402.1.3~~.

C402.2.1 Roof assembly. ~~The minimum thermal resistance (*R*-value) of the insulating material~~ Roof insulation materials shall be installed ~~either~~ between the roof framing, continuously above the ceiling framing, ~~or~~ continuously on or within the roof assembly, or in any approved combination thereof. Above-deck roof insulation, shall comply with Sections C402.2.1.1 through C402.2.1.3. ~~shall be as specified in Table C402.1.3, based on construction materials used in the roof assembly~~.

Delete without substitution:

~~**C402.2.1.1 Tapered, above-deck insulation based on thickness.** Where used as a component of a roof/ceiling assembly *R*-value calculation, the sloped roof insulation *R*-value contribution to that calculation shall use the average thickness in inches (mm) along with the material *R*-value-per-inch (per-mm) solely for *R*-value compliance as prescribed in Section 402.1.3.~~

Revise as follows:

C402.2.1.1 ~~C402.2.1.2~~ Minimum thickness, lowest point. The ~~minimum~~ thickness of above-deck roof insulation at its lowest point, gutter edge, roof drain or scupper, shall be not less than 1 inch (25 mm).

Delete without substitution:

~~**C402.2.1.3 Suspended ceilings.** Insulation installed on suspended ceilings having removable ceiling tiles shall not be considered part of the minimum thermal resistance (*R*-value) of roof insulation in roof/ceiling construction.~~

Revise as follows:

C402.2.1.2 ~~C402.2.1.4~~ Joints staggered. *Continuous insulation* board located above the roof deck shall be installed in not less than two layers and the edge joints between each layer of insulation shall be staggered, except where insulation tapers to the roof deck at a gutter edge, roof drain, or scupper.

C402.2.1.3 ~~C402.2.1.5~~ Skylight curbs. Skylight curbs shall be insulated to the level of the above-deck roof~~s with~~ insulation ~~entirely above the deck~~ or R-5, whichever is less.

> **Exception:** Unit skylight curbs included as a component of a skylight listed and labeled in accordance with NFRC 100 shall not be required to be insulated.

C402.2.2 Above-grade walls. *Above-grade wall* insulation materials shall be installed between the wall framing, be integral to the wall assembly, be continuous on the wall assembly, or be any combination of these insulation methods. Where *continuous insulation* is layered on the exterior side of a wall assembly, the joints shall be staggered. ~~The minimum thermal resistance (*R*-value) of materials installed in the wall cavity between framing members and continuously on the walls shall be as specified in Table C402.1.3, based on framing type and construction materials used in the wall assembly. The *R*-value of integral insulation installed in concrete masonry units shall not be used in determining compliance with Table C402.1.3 except as otherwise noted in the table. In determining compliance with Table C402.1.4, the use of the *U*-factor of concrete masonry units with integral insulation shall be permitted.~~
~~"Mass walls" where used as a component in the thermal envelope of a building shall comply with one of the following:~~

1. ~~Weigh not less than 35 pounds per square foot (171 kg/m^2) of wall surface area.~~
2. ~~Weigh not less than 25 pounds per square foot (122 kg/m^2) of wall surface area where the material weight is not more than 120 pcf (1900 kg/m^3).~~
3. ~~Have a heat capacity exceeding 7 Btu/ft^2 × °F (144 kJ/m^2 × K).~~
4. ~~Have a heat capacity exceeding 5 Btu/ft^2 × °F (103 kJ/m^2 × K), where the material weight is not more than 120 pcf (1900 kg/m^3).~~

C402.2.3 Floors over outdoor air or unconditioned space. Floor insulation shall be installed between floor framing, be integral to the floor assembly, be continuous on the floor assembly, or be any combination of these insulation methods. Where *continuous insulation* is layered on the exterior side of a floor assembly, the joints shall be staggered. ~~The thermal properties (component *R*-values or assembly *U*-, *C*- or *F*-factors) of~~

~~floor assemblies over outdoor air or unconditioned space shall be as specified in Table C402.1.3 or C402.1.4 based on the construction materials used in the floor assembly.~~ Floor framing *cavity insulation* or structural slab insulation shall be installed to maintain permanent contact with the underside of the subfloor decking or structural slabs.
~~"Mass floors" where used as a component of the thermal envelope of a building shall provide one of the following weights:~~

1. ~~35 pounds per square foot (171 kg/m^2) of floor surface area.~~
2. ~~25 pounds per square foot (122 kg/m^2) of floor surface area where the material weight is not more than 120 pounds per cubic foot (1923 kg/m^3).~~

Exceptions:

1. The floor framing *cavity insulation* or structural slab insulation shall be permitted to be installed in contact with the top side of sheathing or *continuous insulation* installed on the bottom side of floor assemblies. Floor framing or structural slab members at the perimeter of the floor assembly shall be insulated vertically for their full depth ~~where combined~~ with insulation equivalent to that required for the above-grade wall construction. ~~meets or exceeds the minimum *R*-value in Table C402.1.3 for "Metal framed" or "Wood framed and other" values for "Walls, above grade" and extends from the bottom to the top of all perimeter floor framing or floor assembly members.~~
2. Insulation applied to the underside of concrete floor slabs shall be permitted an airspace of not more than 1 inch (25 mm) where it turns up and is in contact with the underside of the floor under walls associated with the *building thermal envelope*.

Delete without substitution:

~~**C402.2.4 Slabs-on-grade.** The minimum thermal resistance (*R*-value) of the insulation for unheated or heated slab-on-grade floors designed in accordance with the *R*-value method of Section C402.1.3 shall be as specified in Table C402.1.3.~~

Revise as follows:

~~**C402.2.4.1**~~ **C402.2.4** ~~**Insulation installation**~~ **Slabs-on-grade.** Where installed, the perimeter insulation for slab-on-grade shall be placed on the outside of the foundation or on the inside of the foundation wall. For installations complying with Table C402.1.3, the ~~The~~ perimeter insulation shall extend downward from the top of the slab for the minimum distance shown in the table or to the top of the footing, whichever is less, or downward to not less than the bottom of the slab and then horizontally to the interior or exterior for the total distance shown in the table. ~~Insulation extending away from the building shall be protected by pavement or by not less than 10 inches (254 mm) of soil.~~ Where installed, full slab insulation shall be continuous under the entire area of the slab-on-grade floor, except at structural column locations and service penetrations. Insulation required at the heated slab perimeter shall not be required to extend below the bottom of the heated slab and shall be continuous with the full slab insulation.

Exception: Where the slab-on-grade floor is greater than 24 inches (61 mm) below the finished exterior grade, perimeter insulation is not required.

C402.2.5 Below-grade walls. *Below-grade wall* insulation shall be installed between framing members, be integral to the wall assembly, be continuous on the wall assembly, or be any combination of these insulation methods. ~~The *C*-factor for the below-grade exterior walls shall be in accordance with Table C402.1.4. The *R*-value of the insulating material installed continuously within or on the below-grade exterior walls of the building envelope shall be in accordance with Table C402.1.3. The*C*-factor or *R*-value required~~ For installations complying with Section C401.2.1, insulation shall extend to a depth of not less than 10 feet (3048 mm) below the outside finished ground level, or to the level of the lowest floor of the conditioned space enclosed by the below-grade wall, whichever is less.

C402.2.6 Insulation of radiant heating systems. *Radiant heating system* panels, and their associated components that are installed in interior or exterior assemblies, shall be insulated to an *R*-value of not less than R-3.5 on all surfaces not facing the space being heated. *Radiant heating system* panels that are installed in the *building thermal envelope* shall be separated from the exterior of the building or unconditioned or exempt spaces by not less than the *R*-value of insulation installed in the opaque assembly in which they are installed or the assembly shall comply with Section C402.1.4.

Exception: Heated slabs on grade insulated in accordance with Section C402.2.4 and Section C402.1.

Reason: Sections C402.1, C402.1.3, C402.1.4, and C402.2 are in need of improvement and better coordination to address redundancies and misplaced requirements related to R-value or U-factor compliance versus basic installation or application requirements. This proposal does not change any requirements, but places requirements in their proper location for clarity and ease of use. In addition, redundant language or restatement of requirements already established are removed.
For example, alternative means for fenestration and skylight compliance mentioned in Section C402.1 are deleted because those requirements are already established in Section C401.2 and are not relevant when choosing to comply with Section C402.1. Requirements in Section C402.2 that are related to complying with R-values (Section C402.1.3) or U/C/F-factors (Section C402.1.4) are moved into those sections respectively. Table footnotes that provide important information for compliance are moved into text of those sections and clarified (such as reference to data and requirements in ASHRAE Appendix A). In some cases, editorial errors are identified and corrected. Finally, Section C402.2 is streamlined to focus on installation and application related matters pertaining to insulation installation and, consequently, R-value and U/C/F-factor compliance requirements are moved into Sections C402.1.3 or C402.1.4.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal is a formatting/clarification change and does not change requirements and should have no cost impacts. However, it could help improve efficiency and consistency of compliance and enforcement.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Proposal reorganizes the section for better clarity.

Proposal # 511

CEPI-28-21

Proponents: Jay Crandell, P.E., ABTG/ARES Consulting, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2021 International Energy Conservation Code

SECTION C402
BUILDING ENVELOPE REQUIREMENTS

Revise as follows:

C402.1 General. *Building thermal envelope* assemblies for buildings that are intended to comply with the code on a prescriptive basis in accordance with the compliance path described in Item 1 of Section C401.2.1shall comply with the following:

1. The opaque portions of the *building thermal envelope* shall comply with the specific insulation requirements of Section C402.2 and the thermal requirements of either ~~the *R*-value-based method of~~ U-, C- and F-factor based method of Section C402.1.3; ~~the *U*-, *C*- and *F*-factor-based method of~~ R-value based method of Section C402.1.4; or the component performance alternative of Section C402.1.5.
2. Roof solar reflectance and thermal emittance shall comply with Section C402.3.
3. Fenestration in building envelope assemblies shall comply with Section C402.4.
4. Air leakage of building envelope assemblies shall comply with Section C402.5.

Alternatively, where buildings have a vertical fenestration area or skylight area exceeding that allowed in Section C402.4, the building and *building thermal envelope* shall comply with Item 2 of Section C401.2.1 or Section C401.2.2.

Walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with Section C403.11.

C402.1.4 ~~C402.1.3~~ Insulation component R-value alternatives ~~-based method~~. *Building thermal envelope* opaque assemblies shall comply with the requirements of Sections C402.2 and C402.4 based on the *climate zone* specified in Chapter 3. For opaque portions of the *building thermal envelope* ~~intended to comply on an insulation component *R*-value basis~~, the *R*-values for cavity insulation and continuous insulation shall be not less than that specified in Table C402.1.4 ~~C402.1.3~~. Where cavity insulation is installed in multiple layers, the cavity insulation *R*-values shall be summed to determine compliance with the cavity insulation *R*-value requirements. Where continuous insulation is installed in multiple layers, the continuous insulation *R*-values shall be summed to determine compliance with the continuous insulation *R*-value requirements. Cavity insulation *R*-values shall not be used to determine compliance with the continuous insulation *R*-value requirements in Table C402.1.4 ~~C402.1.3~~. Commercial buildings or portions of commercial buildings enclosing *Group R* occupancies shall use the *R*-values from the "*Group R*" column of Table C402.1.3. Commercial buildings or portions of commercial buildings enclosing occupancies other than *Group R* shall use the *R*-values from the "All other" column of Table C402.1.4 ~~C402.1.3~~.

C402.1.3 ~~C402.1.4~~ Assembly U-factor, C-factor or F-factor-based method. *Building thermal envelope* opaque assemblies shall meet the requirements of Sections C402.2 and C402.4 based on the climate zone specified in Chapter 3. *Building thermal envelope* opaque assemblies ~~intended to comply on an assembly *U*-, *C*- or *F*-factor basis~~ shall have a *U*-, *C*- or *F*-factor not greater than that specified in Table C402.1.3 ~~C402.1.4~~. Commercial buildings or portions of commercial buildings enclosing *Group R* occupancies shall use the *U*-, *C*- or *F*-factor from the "*Group R*" column of Table C402.1.3 ~~C402.1.4~~. Commercial buildings or portions of commercial buildings enclosing occupancies other than *Group R* shall use the *U*-, *C*- or *F*-factor from the "All other" column of Table C402.1.3 ~~C402.1.4~~.

TABLE C402.1.4 ~~C402.1.3~~ OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, R-VALUE ALTERNATIVES ~~METHOD~~[a]

Portions of table not shown remain unchanged.

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m^2, 1 pound per cubic foot = 16 kg/m^3.

ci = Continuous Insulation, NR = No Requirement, LS = Liner System.

a. Assembly descriptions can be found in ANSI/ASHRAE/IESNA 90.1 Appendix A.

b. Where using *R*-value compliance method, a thermal spacer block shall be provided, otherwise use the *U*-factor compliance method in Table C402.1.3 ~~C402.1.4~~.

c. R-5.7ci is allowed to be substituted with concrete block walls complying with ASTM C90, ungrouted or partially grouted at 32 inches or less on center vertically and 48 inches or less on center horizontally, with ungrouted cores filled with materials having a maximum thermal conductivity of 0.44 Btu-in/h-f^2 °F.

d. Where heated slabs are below grade, below-grade walls shall comply with the exterior insulation requirements for heated slabs.

e. “Mass floors” shall be in accordance with Section C402.2.3.

f. “Mass walls” shall be in accordance with Section C402.2.2.

g. The first value is for perimeter insulation and the second value is for full, under-slab insulation. Perimeter insulation is not required to extend below the bottom of the slab.

TABLE <u>C402.1.3</u> ~~C402.1.4~~ OPAQUE THERMAL ENVELOPE ASSEMBLY MAXIMUM REQUIREMENTS, U-FACTOR METHOD[a, b]
Portions of table not shown remain unchanged.

Reason: This proposal places assembly U-factor approach as the primary approach for compliance since it is the basis for prescriptive R-value solutions. The R-value path is retained as an alternative to the U-factor approach and retains the same R-value requirements as before (consistent with the assembly U-factors). This proposal makes no criteria change but clarifies that R-values are to be derived from and be equivalent to the U-factors, C-factors, or F-factors. This proposal also makes the IECC consistent with similar action taken for the 2021 IRC.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal does not change current criteria.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: To align with IBC with IRC and assign U-factors as the primary basis; modifications were added for increased clarity

Proposal # 337

CEPI-29-21

Proponents: Duncan Brown, New York City Department of Buildings, representing New York City Department of Buildings

2021 International Energy Conservation Code

Revise as follows:

C402.1 General. *Building thermal envelope* assemblies for buildings that are intended to comply with the code on a prescriptive basis in accordance with the compliance path described in Item 1 of Section C401.2.1shall comply with the following:

1. The opaque portions of the *building thermal envelope* shall comply with the specific insulation requirements of Section C402.2 and the thermal requirements of either the *R*-value-based method of Section C402.1.3; the *U*-, *C*- and *F*-factor-based method of Section C402.1.4; or the component performance alternative of Section C402.1.5. Where the total area of the through-wall penetrations of mechanical equipment is greater than 1 percent of the opaque above-grade wall area, the building thermal envelope shall comply with C402.1.4.3.
2. Roof solar reflectance and thermal emittance shall comply with Section C402.3.
3. Fenestration in building envelope assemblies shall comply with Section C402.4.
4. Air leakage of building envelope assemblies shall comply with Section C402.5.

Alternatively, where buildings have a vertical fenestration area or skylight area exceeding that allowed in Section C402.4, the building and *building thermal envelope* shall comply with Item 2 of Section C401.2.1 or Section C401.2.2.

Walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with Section C403.11.

Add new text as follows:

C402.1.4.3 Thermal Resistance of mechanical equipment penetrations. Where the total area of through-wall penetrations of mechanical equipment is greater than 1 percent of the opaque above-grade wall area, such area shall be calculated as a separate wall assembly with a published and *approved* U-factor for that equipment or a default U-factor of 0.5.

Reason: A tremendous amount of energy is lost with through-wall mechanical equipment penetrations in building envelopes. This proposal, which has been in effect in New York City since 2016, amends the code to require that these areas of lower thermal value are accounted for when demonstrating compliance.

Cost Impact: The code change proposal will increase the cost of construction.
While there is increased construction cost compensating for the areas of lower insulation value, even with dated numbers, there is a simple payback period followed by improved overall performance.

Bibliography: Design of Experiment to Evaluate Thermal Resistance of a PTAC Unit - Leylegian, Naraghi et al., Proceedings of the 2011 International Mechanical Engineering Congress and Exposition, IMEC2011-65030

Attached Files

- **DESIGN OF EXPERIMENT TO EVALUATE THERMAL RESISTANCE OF A PTAC UNIT .pdf**
  https://energy.cdpaccess.com/proposal/171/1145/files/download/94/
- **160106_PTAC Unit R-Value Memo_lk .pdf**
  https://energy.cdpaccess.com/proposal/171/1145/files/download/34/
- **PTAC Envelope Study - SWA - 2016-06-06.pdf**
  https://energy.cdpaccess.com/proposal/171/1145/files/download/33/

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: This proposal, which has been in effect in New York City since 2016, amends the code to require that these areas of lower thermal value are accounted for when demonstrating compliance.

CEPI-31-21

Proponents: Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Revise as follows:

C402.1 General. *Building thermal envelope* assemblies for buildings that are intended to comply with the code on a prescriptive basis in accordance with the compliance path described in Item 1 of Section C401.2.1shall comply with the following:

1. The opaque portions of the *building thermal envelope* shall comply with the specific insulation requirements of Section C402.2 and the thermal requirements of either the *R*-value-based method of Section C402.1.3; the *U*-, *C*- and *F*-factor-based method of Section C402.1.4; or the component performance alternative of Section C402.1.5.
2. Wall solar reflectance and thermal emittance shall comply with Section C402.3.
3. ~~2.~~ 3. Roof solar reflectance and thermal emittance shall comply with Section ~~C402.3~~ C402.4.
4. ~~3.~~ 4. Fenestration in building envelope assemblies shall comply with Section ~~C402.4~~ C402.5.
5. ~~4.~~ 5. Air leakage of building envelope assemblies shall comply with Section ~~C402.5~~ C402.6.

Alternatively, where buildings have a vertical fenestration area or skylight area exceeding that allowed in Section C402.4, the building and *building thermal envelope* shall comply with Item 2 of Section C401.2.1 or Section C401.2.2.

Walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with Section C403.11.

Add new text as follows:

C402.3 Above Grade Wall Solar Reflectance. For Climate Zone 0, above-grade east-oriented, south-oriented, and west-oriented walls shall comply with either of the following:

1. Not less than 75% of the above grade wall area shall have an area-weighted initial solar reflectance of not less than 0.30 where tested in accordance with ASTM C1549 with AM1.5GV, output or ASTM E903 with AM1.5GV output, or determined in accordance with an approved source. This above grade wall area shall have an emittance or emissivity of not less than 0.75 where tested in accordance with ASTM C835, C1371, E408, or determined in accordance with an *approved source.* For the portion of the above grade wall that is glass spandrel area, a solar reflectance of not less than 0.29, as determined in accordance with NFRC 300 or ISO 9050, shall be permitted. Area-weighted averaging is permitted only using south-, east-, and west-oriented walls enclosing the same occupancy classification.
2. Not less than 30% of the above-grade wall area shall be shaded by manmade structures, existing buildings, hillsides, permanent building projections, on-site renewable energy systems, or a combination of these. Shade coverage shall be calculated by projecting the shading surface downward on the above grade wall at an angle of 45 degrees.

Exception: Above grade walls of low energy buildings complying with C402.1.1, greenhouses complying with C402.1.1.1, and equipment buildings complying with C402.1.2.

Reason: The proposal adds requirements for south-, east-, and west-facing walls to have a minimum solar reflectance of 0.30 in Climate Zone 0. Thermal emittance values do not vary much for opaque, nonmetallic surfaces. A minimum value of 0.75 is sufficient and can be demonstrated by published values or testing. The main reason to have 0.75 backstop is to avoid shiny bare metal, which can become hot.
For solar reflectance, three options have been provided for measurement: (1) ASTM C1549 with air mass 1.5 global vertical (AM1.5GV) output (labeled “1.590” for air mass 1.5, 90 degree tilt in an upgrade to the Devices and Services Solar Spectrum Reflectometer v6, available from its manufacturer); (2) ASTM E903, using the AM1.5GV solar spectral irradiance to weight near normal-hemispherical solar spectral reflectance; or (3) the “G197GT90” output of the Surface Optics 410-Solar-i Hemispherical Reflectometer, operated following Appendix 9 of the CRRC-1 Program Manual (https://coolroofs.org/documents/CRRC-1_Program_Manual.pdf). All three options are based on the global solar spectral irradiance for a 90 degree sun-facing tilted surface specified in ASTM G197.

For emittance, ASTM C1371 is the simplest and least expensive measurement method but other options have been provided.

Initial reflectance is specified because there isn’t a fully developed measurement technique for measuring aged wall reflectance. Preliminary testing shows that walls become much less dirty than roofs because they are vertical surfaces.

Cost Impact: The code change proposal will increase the cost of construction.
For climate zone 0 the cost of construction may increase in the short term as these requirements are new and the availability of products may be limited. For all other climate zones this proposal will have no impact. However, long term the cost impact will most likely be reduced as more manufacturers produce products to meet demand, and as testing and reporting opportunities become available, such as the Cool Roof Rating Council’s new program for Cool Wall Rating Program, which is currently under construction.

However, it should be noted that there are many products on the market that currently meet these thresholds.

Bibliography: ANSI/ASHRAE/IES Standard 90.1-2019 Energy Standard for Buildings Except Low-Rise Residential Buildings, Addendum s. https://www.ashrae.org/technical-resources/standards-and-guidelines/standards-addenda/addenda-to-standard-90-1-2019

Levinson, R., et. al., “Solar Reflective “Cool” Walls: Benefits, Technologies, and Implementation,” State of California, California Energy Commission, Sacramento, CA, Report CEC-500-2019-040, April 2019.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Agree with the proponent’s reason statement. Further, the modifications made by the IECC Commercial Envelope Subcommittee were designed to be consistent with the ICC manual of style and clarifies the text.

Proposal # 209

CEPI-32-21

Proponents: Theresa A Weston, The Holt Weston Consultancy, representing The Air Barrier Association of America (ABAA) (holtweston88@gmail.com)

2021 International Energy Conservation Code

Add new definition as follows:

AIR LEAKAGE. The uncontrolled air flow through the building thermal envelope caused by pressure differences across the building thermal envelope. Air leakage can be inward (infiltration) or outward (exfiltration) through the building thermal envelope.

Revise as follows:

C402.1 General. *Building thermal envelope* assemblies for buildings that are intended to comply with the code on a prescriptive basis in accordance with the compliance path described in Item 1 of Section C401.2.1shall comply with the following:

1. The opaque portions of the *building thermal envelope* shall comply with the specific insulation requirements of Section C402.2 and the thermal requirements of either the *R*-value-based method of Section C402.1.3; the *U*-, *C*- and *F*-factor-based method of Section C402.1.4; or the component performance alternative of Section C402.1.5.
2. Roof solar reflectance and thermal emittance shall comply with Section C402.3.
3. Fenestration in building envelope assemblies shall comply with Section C402.4.
4. Air leakage of the *building thermal envelope* ~~building envelope assemblies~~ shall comply with Section C402.5.

Alternatively, where buildings have a vertical fenestration area or skylight area exceeding that allowed in Section C402.4, the building and *building thermal envelope* shall comply with Item 2 of Section C401.2.1 or Section C401.2.2.

Walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with Section C403.11.

C402.5 Air leakage—thermal envelope. The *building thermal envelope* shall comply with Sections C402.5.1 through Section C402.5.11.1, or the ~~building~~ *building* *thermal envelope* shall be tested in accordance with Section C402.5.2 or C402.5.3. Where compliance is based on such testing, the building shall also comply with Sections C402.5.7, C402.5.8 and C402.5.9.

C402.5.1 Air barriers. A continuous ~~air barrier~~ *air barrier* shall be provided throughout the *building thermal envelope*. The continuous ~~air barriers~~ *air barrier* shall be located on the inside or outside of the ~~building thermal envelope~~ *building thermal envelope*, located within the assemblies composing the ~~building thermal envelope~~ *building thermal envelope*, or any combination thereof. The ~~air barrier~~ *air barrier* shall comply with Sections C402.5.1.1, and C402.5.1.2.

Exception: ~~Air barriers~~ *Air barriers* are not required in buildings located in *Climate Zone* 2B.

C402.5.1.1 Air barrier construction. The *continuous air barrier* shall be constructed to comply with the following:

1. The ~~air barrier~~ *air barrier* shall be continuous for all assemblies that ~~are~~ comprise the ~~thermal envelope of the building~~ *building thermal envelope* and across the joints and assemblies.
2. Air barrier joints and seams shall be sealed, including sealing transitions in places and changes in materials. The joints and seals shall be securely installed in or on the joint for its entire length so as not to dislodge, loosen or otherwise impair its ability to resist positive and negative pressure from wind, stack effect and mechanical ventilation.
3. Penetrations of the ~~air barrier~~ *air barrier* shall be caulked, gasketed or otherwise sealed in a manner compatible with the construction materials and location. Sealing shall allow for expansion, contraction and mechanical vibration. Joints and seams associated with penetrations shall be sealed in the same manner or taped. Sealing materials shall be securely installed around the penetration so as not to dislodge, loosen or otherwise impair the penetrations' ability to resist positive and negative pressure from wind, stack effect and mechanical ventilation. Sealing of concealed fire sprinklers, where required, shall be in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.
4. Recessed lighting fixtures shall comply with Section C402.5.10. Where similar objects are installed that penetrate the ~~air barrier~~ *air barrier*, provisions shall be made to maintain the integrity of the ~~air barrier~~ *air barrier*.

C402.5.1.2 . A continuous ~~air barrier~~ *air barrier* for the ~~opaque building envelope~~ *building thermal envelope* shall comply with the following:

1. Buildings or portions of buildings, including Group R and I occupancies, shall meet the provisions of Section C402.5.2.

   Exception: Buildings in Climate Zones 2B, 3C and 5C.

2. Buildings or portions of buildings other than Group R and I occupancies shall meet the provisions of Section C402.5.3.

   Exceptions:

   1. Buildings in Climate Zones 2B, 3B, 3C and 5C.
   2. Buildings larger than 5,000 square feet (464.5 m^2) floor area in Climate Zones 0B, 1, 2A, 4B and 4C.
   3. Buildings between 5,000 square feet (464.5 m^2) and 50,000 square feet (4645 m^2) floor area in Climate Zones 0A, 3A and 5B.

3. Buildings or portions of buildings that do not complete air barrier testing shall meet the provisions of Section C402.5.1.3 or C402.5.1.4 in addition to Section C402.5.1.5.

C402.5.1.5 Building envelope performance verification. The installation of the continuous ~~air barrier~~ *air barrier* shall be verified by the *code official*, a *registered design professional* or *approved* agency in accordance with the following:

1. A review of the construction documents and other supporting data shall be conducted to assess compliance with the requirements in Section C402.5.1.
2. Inspection of continuous ~~air barrier~~ *air barrier* components and assemblies shall be conducted during construction while the ~~air barrier~~ *air barrier* is still accessible for inspection and repair to verify compliance with the requirements of Sections C402.5.1.3 and C402.5.1.4.
3. A final commissioning report shall be provided for inspections completed by the *registered design professional* or *approved* agency. The commissioning report shall be provided to the building owner or owner's authorized agent and the *code official*. The report shall identify deficiencies found during the review of the construction documents and inspection and details of corrective measures taken.

C402.5.3 Building thermal envelope testing. The *building thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E3158 or ASTM E1827 or an equivalent method approved by the code official. The measured ~~air leakage~~ *air leakage* shall not exceed 0.40 cfm/ft^2 (2.0 L/s × m^2) of the *building thermal envelope* area at a pressure differential of 0.3 inch water gauge (75 Pa). Alternatively, portions of the building shall be tested and the measured ~~air leakages~~ *air leakage* shall be area weighted by the surface areas of the ~~building envelope~~ *building thermal envelope* in each portion. The weighted average test results shall not exceed the whole building *air leakage* ~~leakage~~ limit. In the alternative approach, the following portions of the building shall be tested:

1. The entire ~~envelope~~ *building thermal envelope* area of all stories that have any spaces directly under a roof.
2. The entire ~~envelope~~ *building thermal envelope* area of all stories that have a building entrance, exposed floor, or loading dock, or are below grade.
3. Representative above-grade sections of the ~~building~~ *building thermal envelope* totaling at least 25 percent of the wall area enclosing the remaining conditioned space.

Exception: Where the measured ~~air leakage~~ *air leakage* rate exceeds 0.40 cfm/ft^2 (2.0 L/s × m^2) but does not exceed 0.60 cfm/ft^2 (3.0 L/s × m^2), a diagnostic evaluation using smoke tracer or infrared imaging shall be conducted while the building is pressurized along with a visual inspection of the ~~air barrier~~ *air barrier.* Any leaks noted shall be sealed where such sealing can be made without destruction of existing building components. An additional report identifying the corrective actions taken to seal leaks shall be submitted to the code official and the building owner, and shall be deemed to comply with the requirements of this section.

C402.5.2 Dwelling and sleeping unit enclosure testing. The *building thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E1827 or an equivalent method approved by the *code official*. The measured ~~air leakage~~ *air leakage* shall not exceed 0.30 cfm/ft^2 (1.5 L/s m^2) of the testing unit enclosure area at a pressure differential of 0.2 inch water gauge (50 Pa). Where multiple dwelling units or sleeping units or other occupiable conditioned spaces are contained within one *building thermal envelope*, each unit shall be considered an individual testing unit, and the building ~~air leakage~~ *air leakage* shall be the weighted average of all testing unit results, weighted by each testing unit's enclosure area. Units shall be tested separately with an unguarded blower door test as follows:

1. Where buildings have fewer than eight testing units, each testing unit shall be tested.
2. For buildings with eight or more testing units, the greater of seven units or 20 percent of the testing units in the building shall be tested, including a top floor unit, a ground floor unit and a unit with the largest testing unit enclosure area. For each tested unit that exceeds the maximum air leakage rate, an additional two units shall be tested, including a mixture of testing unit types and locations.

C402.5.8 Loading dock weather seals. Cargo door openings and loading door openings shall be equipped with weather seals that restrict ~~infiltration~~ *air leakage* and provide direct contact along the top and sides of vehicles that are parked in the doorway.

C402.5.11 Operable openings interlocking. Where occupancies utilize operable openings to the outdoors that are larger than 40 square feet (3.7 m^2) in area, such openings shall be interlocked with the heating and cooling system so as to raise the cooling setpoint to 90°F (32°C) and lower the heating setpoint to 55°F (13°C) whenever the operable opening is open. The change in heating and cooling setpoints shall occur within 10 minutes of opening the operable opening.

Exceptions:

1. Separately zoned areas associated with the preparation of food that contain appliances that contribute to the HVAC loads of a restaurant or similar type of occupancy.
2. Warehouses that utilize overhead doors for the function of the occupancy, where approved by the code official.
3. The first entrance doors where located in the exterior wall and are part of a vestibule system.

Revise as follows:

C406.1 Additional energy efficiency credit requirements. New buildings shall achieve a total of 10 credits from Tables C406.1(1) through C406.1(5) where the table is selected based on the use group of the building and from credit calculations as specified in relevant subsections of Section C406. Where a building contains multiple-use groups, credits from each use group shall be weighted by floor area of each group to determine the weighted average building credit. Credits from the tables or calculation shall be achieved where a building complies with one or more of the following:

1. More efficient HVAC performance in accordance with Section C406.2.
2. Reduced lighting power in accordance with Section C406.3.
3. Enhanced lighting controls in accordance with Section C406.4.
4. On-site supply of renewable energy in accordance with Section C406.5.
5. Provision of a dedicated outdoor air system for certain HVAC equipment in accordance with Section C406.6.
6. High-efficiency service water heating in accordance with Section C406.7.
7. Enhanced envelope performance in accordance with Section C406.8.
8. Reduced ~~air infiltration~~ *air leakage* in accordance with Section C406.9
9. Where not required by Section C405.12, include an energy monitoring system in accordance with Section C406.10.
10. Where not required by Section C403.2.3, include a fault detection and diagnostics (FDD) system in accordance with Section C406.11.
11. Efficient kitchen equipment in accordance with Section C406.12.

TABLE C406.1(1) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP B OCCUPANCIES

Portions of table not shown remain unchanged.

SECTION	CLIMATE ZONE																
	0A & 1A	**0B & 1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	1	1	NA	1
C406.2.2: 5% cooling efficiency improvement	6	6	5	5	4	4	3	3	3	2	2	2	1	2	2	2	1
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2	1	1	2	2	NA	1
C406.2.4: 10% cooling efficiency improvement	11	12	10	9	7	7	6	5	6	4	4	5	3	4	3	3	3
C406.3: Reduced lighting power	9	8	9	9	9	9	10	8	9	9	7	8	8	6	7	7	6
C406.4: Enhanced digital lighting controls	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1	1
C406.5: On-site renewable energy	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
C406.6: Dedicated outdoor air	4	4	4	4	4	3	2	5	3	2	5	3	2	7	4	5	3
C406.7.2: Recovered or renewable water heating	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.3: Efficient fossil fuel water heater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.4: Heat pumpwater heater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.8: Enhanced envelope performance	1	4	2	4	4	3	NA	7	4	5	10	7	6	11	10	14	16
C406.9: Reduced ~~air infiltration~~ *air leakage*	2	1	1	2	4	1	NA	8	2	3	11	4	1	15	8	11	6
C406.10: Energy monitoring	4	4	4	4	3	3	3	3	3	3	2	3	2	2	2	2	2
C406.11: Fault detection and diagnostics system	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1

NA = Not Applicable.

TABLE C406.1(2) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP R AND I OCCUPANCIES

Portions of table not shown remain unchanged.

SECTION	CLIMATE ZONE																
	0A & 1A	**0B & 1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	1	NA	NA	1	NA	1	1	1	1	2	1	2	2
C406.2.2: 5% cooling efficiency improvement	3	3	2	2	1	1	1	1	1	NA	1	1	NA	1	1	1	NA
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	NA	1	NA	NA	1	1	1	2	2	1	3	2	3	4
C406.2.4: 10% cooling efficiency improvement	5	5	4	3	2	3	1	2	2	1	1	1	1	1	1	1	1
C406.3: Reduced lighting power	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
C406.4: Enhanced digital lighting controls	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.5: On-site renewable energy	8	8	8	8	7	8	8	7	7	7	7	7	7	7	7	7	7
C406.6: Dedicated outdoor air system	3	4	3	3	4	2	NA	6	3	4	8	5	5	10	7	11	12
C406.7.2: Recovered or renewable water heating	10	9	11	10	13	12	15	14	14	15	14	14	16	14	15	15	15
C406.7.3: Efficient fossil fuel water heater	5	5	6	6	8	7	8	8	8	9	9	9	10	10	9	10	11
C406.7.4: Heat pump water heater	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
C406.8: Enhanced envelope performance	3	6	3	5	4	4	1	4	3	3	4	5	3	5	4	6	6
C406.9: Reduced ~~air infiltration~~ *air leakage*	6	5	3	11	6	4	NA	7	3	3	9	5	1	13	6	8	3
C406.10: Energy monitoring	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
C406.11: Fault detection and diagnostics system	1	1	1	1	1	1	NA	1	1	NA	1	1	NA	1	1	1	1

NA = Not Applicable.

TABLE C406.1(3) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP E OCCUPANCIES

SECTION	CLIMATE ZONE																
	0A & 1A	0B & 1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	1	1	1	1	1	2	1	2	1	2	2	3	4
C406.2.2: 5% cooling efficiency improvement	4	4	3	3	2	2	2	2	1	1	1	1	NA	1	1	1	NA
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	1	1	1	1	2	3	4	3	4	3	4	3	5	7
C406.2.4: 10% cooling efficiency improvement	7	8	7	6	5	4	3	4	3	1	2	2	1	2	2	2	1
C406.3: Reduced lighting power	8	8	8	9	8	9	9	8	9	9	8	9	8	7	8	7	7
C406.4: Enhanced digital lighting controls	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1
C406.5: On-site renewable energy	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	5	5
C406.6: Dedicatedoutdoor air system	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.2: Recoveredor renewable water heating[a]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
C406.7.3: Efficient fossil fuel water heater[a]	NA	1	1	1	1	1	1	2	2	3	2	3	2	3	3	3	5
C406.7.4: Heat pump water heater[a]	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	1	1	NA	1	1	1	1
C406.8: Enhanced envelope performance	3	7	3	4	2	4	1	1	3	1	2	3	NA	4	3	6	9
C406.9: Reduced ~~air infiltration~~ *air leakage*	1	1	1	2	NA	NA	NA	NA	NA	NA	1	NA	NA	4	1	4	3
C406.10: Energy monitoring	3	3	3	3	3	3	3	3	3	2	2	3	2	2	2	2	2
C406.11: Fault detection and diagnostics system	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2

NA = Not Applicable.

a. For schools with showers or full-service kitchens.

TABLE C406.1(4) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP M OCCUPANCIES

SECTION	CLIMATE ZONE																
	0A & 1A	**0B & 1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	1	1	NA	1	1	2	2	2	2	3	2	3	4
C406.2.2: 5% cooling efficiency improvement	5	6	4	4	3	3	1	2	2	1	1	2	NA	1	1	1	NA
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	1	1	1	1	2	2	4	3	4	5	5	3	6	8
C406.2.4: 10% cooling efficiency improvement	9	12	9	8	6	6	3	4	4	1	2	3	NA	2	2	2	1
C406.3: Reduced lighting power	13	13	15	14	16	14	17	15	15	14	12	14	14	16	16	14	12
C406.4: Enhanced digital lighting controls	3	3	4	3	4	3	4	4	4	3	3	3	3	4	4	3	3
C406.5: On-site renewable energy	8	8	8	8	8	8	8	8	8	7	7	7	7	7	7	7	6
C406.6: Dedicated outdoor air system	3	4	3	3	3	3	1	3	2	2	2	3	2	4	3	4	4
C406.7.2: Recovered or renewable water heating	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.3: Efficient fossil fuel water heater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.4: Heat pump water heater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.8: Enhanced envelope performance	4	6	3	4	3	3	1	6	4	4	4	5	4	6	5	8	9
C406.9: Reduced ~~air infiltration~~ *air leakage*	1	1	1	2	1	1	NA	3	1	1	3	2	1	7	3	6	3
C406.10: Energy monitoring	4	5	5	5	5	4	4	4	4	3	3	4	3	4	4	4	3
C406.11: Fault detection and diagnostics system	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	2	2

NA = Not Applicable.

TABLE C406.1(5) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR OTHER[a] OCCUPANCIES

SECTION	CLIMATE ZONE																
	0A & 1A	0B & 1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	1	1	1	1	1	2	1	2	1	2	2	3	3
C406.2.2: 5% cooling efficiency improvement	5	5	4	4	3	3	2	2	2	1	1	2	1	1	1	1	1
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	1	1	1	1	2	2	3	3	3	3	4	3	5	5
C406.2.4: 10% cooling efficiency improvement	8	9	8	7	5	5	3	4	4	2	2	3	2	2	2	2	2
C406.3: Reduced lighting power	8	8	9	9	9	9	10	8	9	9	7	8	8	8	8	8	7
C406.4: Enhanced digital lighting controls	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	1
C406.5: On-site renewable energy	8	8	8	8	8	8	8	8	8	7	7	7	7	7	7	7	7
C406.6: Dedicated outdoor air system	3	4	3	3	4	3	2	5	3	3	5	4	3	7	5	7	6
C406.7.2: Recovered or renewable water heating [b]	10	9	11	10	13	12	15	14	14	15	14	14	16	14	15	15	15
C406.7.3: Efficient fossil fuel water heater [b]	5	5	6	6	8	7	8	8	8	9	9	9	10	10	9	10	11
C406.7.4: Heat pump water heater [b]	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
C406.8: Enhanced envelope performance	3	6	3	4	3	4	1	5	4	3	5	5	4	7	6	9	10
C406.9: Reduced ~~air infiltration~~ *air leakage*	3	2	2	4	4	2	NA	6	2	2	6	4	1	10	5	7	4
C406.10: Energy monitoring	3	3	3	3	3	3	3	3	3	3	2	3	2	2	2	3	2
C406.11: Fault detection and diagnostics system	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1

NA = Not Applicable.

a. Other occupancy groups include all groups except Groups B, E, I, M and R.

b. For occupancy groups listed in Section C406.7.1.

C406.9 Reduced ~~air infiltration~~ air leakage. ~~Air infiltration~~ *Air leakage* shall be verified by whole-building pressurization testing conducted in accordance with ASTM E779 or ASTM E1827 by an independent third party. The measured ~~air leakage rate~~ *air leakage* of the ~~building envelope~~ *building thermal envelope* shall not exceed 0.25 cfm/ft^2 (2.0 L/s × m^2) under a pressure differential of 0.3 inches water column (75 Pa), with the calculated surface area being the sum of the above- and below-grade building envelope. A report that includes the tested surface area, floor area, air by volume, stories above grade, and leakage rates shall be submitted to the code official and the building owner.

Exception: For buildings having over 250,000 square feet (25 000 m^2) of *conditioned floor area*, ~~air leakage~~ *air leakage* testing need not be conducted on the whole building where testing is conducted on representative above-grade sections of the building. Tested areas shall total not less than 25 percent of the conditioned floor area and shall be tested in accordance with this section.

Reason: The purpose of this proposal is to introduce correct terminology and to standardize it throughout the code:

- The current term, *air infiltration*, is replaced with *air leakage*. As noted in the proposed definition air leakage can occur either as infiltration or exfiltration and both directions have energy efficiency implications. Furthermore, the new term, *air leakage* and its definition are consistent with the ASHRAE 90.1 Addendum t and expected to be included in ASHRAE 90.1.Therefore, this terminology change will provide consistency across the key industry documents and will enable clarity of the code.
- Additionally, the code is updated to make sure the already defined terms *building thermal envelope* and *air barrier* are used consistently throughout the document.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The proposed changes are to improve clarity of the code by making the terminology consistent throughout the document and consistent with other industry documents.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: adds definition and clarifies usage of the term “air leakage” throughout the code. Modification removes unnecessary extra language from definition.

CEPI-34-21

Proponents: Leonard Sciarra, representing Sciarra Architecture & Planning (leonard.sciarra@gmail.com)

2021 International Energy Conservation Code

Revise as follows:

C402.1.1 Low-energy buildings and greenhouses. The following low-energy buildings, or portions thereof separated from the remainder of the building by *building thermal envelope* assemblies complying with this section, shall be exempt from the *building thermal envelope* provisions of Section C402.

1. ~~Those with a peak design rate of energy usage less than 3.4 Btu/h × ft^2 (10.7 W/m^2) or 1.0 watt per square foot (10.7 W/m^2) of floor area for space conditioning purposes.~~
2. ~~Those that do not contain *conditioned space*.~~

Add new text as follows:

C402.1.1.1 Low-energy buildings. Buildings that comply with either of the following:

1. Those with a peak design rate of energy usage less than 3.4 Btu/h × ft^2 (10.7 W/m^2) or 1.0 watt per square foot (10.7 W/m^2) of floor area for space conditioning purposes.
2. Those that do not contain *conditioned space*.

Revise as follows:

~~**C402.1.1.1**~~ **C402.1.1.2 Greenhouses.** Greenhouse structures or areas that are mechanically heated or cooled and that comply with all of the following shall be exempt from the building envelope requirements of this code:

1. Exterior opaque envelope assemblies comply with Sections C402.2 and C402.4.5.

   Exception: Low energy greenhouses that comply with Section C402.1.1.

2. Interior partition *building thermal envelope* assemblies that separate the greenhouse from *conditioned space* comply with Sections C402.2, C402.4.3 and C402.4.5.
3. Fenestration assemblies that comply with the thermal envelope requirements in Table C402.1.1.1. The *U*-factor for a roof shall be for the roof assembly or a roof that includes the assembly and an *internal curtain system*.

   Exception: Unconditioned greenhouses.

TABLE ~~C402.1.1.1~~ C402.1.1.2 FENESTRATION THERMAL ENVELOPE MAXIMUM REQUIREMENTS

COMPONENT	*U*-FACTOR (BTU/h × ft^2 × °F)
Skylight	0.5
Vertical fenestration	0.7

~~**C402.1.2**~~ **C402.1.1.3 Equipment buildings.** Buildings that comply with the following shall be exempt from the *building thermal envelope* provisions of this code:

1. Are separate buildings with floor area not more than 1,200 square feet (110 m^2).
2. Are intended to house electric equipment with installed equipment power totaling not less than 7 watts per square foot (75 W/m^2) and not intended for human occupancy.
3. Have a heating system capacity not greater than (17,000 Btu/hr) (5 kW) and a heating thermostat setpoint that is restricted to not more than 50°F (10°C).
4. Have an average wall and roof *U*-factor less than 0.200 in *Climate Zones* 1 through 5 and less than 0.120 in *Climate Zones* 6 through 8.
5. Comply with the roof solar reflectance and thermal emittance provisions for *Climate Zone* 1.

Reason: This proposal cleans up the list of buildings that have unique envelope requirements so they all have their unique sections.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
this proposal does not change requirements

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Clarifies organization of low energy building requirements. The proposal is cleaner and easier to read than the existing language. Prefers that low energy buildings, green houses, and equipment building exemptions are presented separately.

Proposal # 373

CEPI-35-21

Proponents: Jay Crandell, P.E., ABTG/ARES Consulting, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2021 International Energy Conservation Code

Revise as follows:

TABLE C402.1.3 OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, R-VALUE METHOD[a]
Portions of table not shown remain unchanged.

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m^2, 1 pound per cubic foot = 16 kg/m^3.

ci = Continuous Insulation, NR = No Requirement, LS = Liner System.

a. Assembly descriptions can be found in ANSI/ASHRAE/IESNA 90.1 Appendix A.
b. Where using *R*-value compliance method, a thermal spacer block shall be provided, otherwise use the *U*-factor compliance method in Table C402.1.4.
c. R-5.7ci is allowed to be substituted with concrete block walls complying with ASTM C90, ungrouted or partially grouted not less than ~~at~~ 32 inches ~~or less~~ on center vertically and not less than 48 inches ~~or less~~ on center horizontally, with ungrouted cores filled with materials having a maximum thermal conductivity of 0.44 Btu-in/h-f^2 °F.
d. Where heated slabs are below grade, below-grade walls shall comply with the exterior insulation requirements for heated slabs.
e. “Mass floors” shall be in accordance with Section C402.2.3.
f. “Mass walls” shall be in accordance with Section C402.2.2.
g. The first value is for perimeter insulation and the second value is for full, under-slab insulation. Perimeter insulation is not required to extend below the bottom of the slab.

Reason: The spacing of grouted masonry cores should be 32"oc or 48"oc or MORE, not LESS. If less it would allow fully grouted concrete masonry with no cores available for integral insulation as addressed by footnote 'c'. This may be an editorial or inadvertent error from some time ago, but it should be corrected.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This is a correction of an obvious editorial error with technical implications. However, in my understanding folks are tending to read or apply the intent of footnote 'c' correctly even though it is written incorrectly.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: clarified text.

Proposal # 529

CEPI-36-21

Proponents: Jay Crandell, P.E., ABTG/ARES Consulting, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2021 International Energy Conservation Code

Revise as follows:

TABLE C402.1.3 OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, R-VALUE METHOD[a]
Portions of table not shown remain unchanged.

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m^2, 1 pound per cubic foot = 16 kg/m^3.

ci = Continuous Insulation, NR = No Requirement, LS = Liner System.

a. Assembly descriptions can be found in ANSI/ASHRAE/IESNA 90.1 Appendix A.
b. Where using *R*-value compliance method, a thermal spacer block shall be provided, otherwise use the *U*-factor compliance method in Table C402.1.4.
c. R-5.7ci is allowed to be substituted with concrete block walls complying with ASTM C90, ungrouted or partially grouted at 32 inches or less on center vertically and 48 inches or less on center horizontally, with ungrouted cores filled with materials having a maximum thermal conductivity of 0.44 Btu-in/h-f^2 °F.
d. Where heated slabs are below grade, below-grade walls shall comply with the R-value ~~exterior insulation~~ requirements for above-grade mass walls ~~heated slabs~~.
e. “Mass floors” shall be in accordance with Section C402.2.3.
f. “Mass walls” shall be in accordance with Section C402.2.2.
g. The first value is for perimeter insulation and the second value is for full, under-slab insulation. Perimeter insulation is not required to extend below the bottom of the slab.

Reason: Footnote ‘d’ in Table C402.1.3 is incorrect and also inconsistent with the same topic addressed in footnote ‘c’ of Table C402.1.4 which reads as follows: "c. Where heated slabs are below grade, below-grade walls shall comply with the *U*-factor requirements for above-grade mass walls." Therefore, this proposal revises footnote ‘d’ of Table C402.1.4 to align with footnote ‘c’ of Table C402.1.4. The intent is that the below-grade walls be insulated in accordance with the insulation requirements for above-grade mass walls when the below-grade floor is a heated slab.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal makes the two footnotes in the R-value and U-factor tables consistent and in net effect may actually reduce cost for the case of a below-grade heated slab and walls complying with R-value requirements.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: Making correlation to R-value table.

Proposal # 166

CEPI-37-21

Proponents: Jay Crandell, P.E., ABTG/ARES Consulting, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2021 International Energy Conservation Code

Revise as follows:

TABLE C402.1.3 OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, R-VALUE METHOD[a]
Portions of table not shown remain unchanged.

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m^2, 1 pound per cubic foot = 16 kg/m^3.

ci = Continuous Insulation, NR = No Requirement, LS = Liner System.

a. Assembly descriptions can be found in ANSI/ASHRAE/IESNA 90.1 Appendix A.
b. Where using *R*-value compliance method, a thermal spacer block shall be provided, otherwise use the *U*-factor compliance method in Table C402.1.4.
c. R-5.7ci is allowed to be substituted with concrete block walls complying with ASTM C90, ungrouted or partially grouted at 32 inches or less on center vertically and 48 inches or less on center horizontally, with ungrouted cores filled with materials having a maximum thermal conductivity of 0.44 Btu-in/h-f^2 °F.
d. Where heated slabs are below grade, below-grade walls shall comply with the exterior insulation requirements for heated slabs.
e. “Mass floors” shall be in accordance with Section C402.2.3.
f. “Mass walls” shall be in accordance with Section C402.2.2.
g. The first value is for perimeter insulation and the second value is for full, under-slab insulation. Perimeter insulation <u>and full-slab insulation components shall be installed in accordance with Section C402.2.4.1</u> ~~is not required to extend below the bottom of the slab~~.

Reason: Footnote g includes installation guidance for insulating heated slabs that is incomplete and potentially conflicts with the newly added Section C402.2.4.1. The current footnote misses important information in Section C402.2.4.1 such as the requirement that the under-slab and perimeter slab insulation be continuous. Referencing Section C402.2.4.1 in footnote ‘g’ resolves this disconnect in updating the code last cycle.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This revision is a clarification to coordinate with slab insulation installation provisions revised last code cycle. It does not change requirements.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: Per the proponents reasoning statement.

Proposal # 165

CEPI-38-21

Proponents: Jay Crandell, P.E., ABTG/ARES Consulting, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2021 International Energy Conservation Code

Revise as follows:

TABLE C402.1.3 OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, R-VALUE METHOD[a]
Portions of table not shown remain unchanged.

CLIMATE ZONE	0 AND 1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R
Walls, above grade																
Metal framed[h]	R-0 + R-10ci or R-13 + R-5ci or R-20 + R-3.8ci	R-0 + R-10ci or R-13 + R-5ci or R-20 + R-3.8ci	R-0 + R-10ci or R-13 + R-5ci or R-20 + R-3.8ci	R-0 + R-12.6ci or R-13 + R-7.5ci or R-20 + R-6.3ci	R-0 + R-12.6ci or R-13 + R-7.5ci or R-20 + R-6.3ci	R-0 + R-12.6ci or R-13 + R-7.5ci or R-20 + R-6.3ci	R-0 + R-12.6ci or R-13 + R-7.5ci or R-20 + R-6.3ci	R-0 + R-12.6ci or R-13 + R-7.5ci or R-20 + R-6.3ci	R-0 + R-15.2ci or R-13 + R-10ci or R-20 + R-9ci	R-0 + R-15.2ci or R-13 + R-10ci or R-20 + R-9ci	R-0 + R-17.3ci or R-13 + R-12.5ci or R-20 + R-11ci	R-0 + R-17.3ci or R-13 + R-12.5ci or R-20 + R-11ci	R-0 + R-17.3ci or R-13 + R-12.5ci or R-20 + R-11ci	R-0 + R-21ci or R-13 + R-15.6ci or R-20 + R-14.3ci	R-0 + R-24ci or R-13 + R-18.8ci or R-20 + R-17.5ci	R-0 + R-24ci or R-13 + R-18.8ci or R-20 + R-17.5ci
Wood framed and other[h]	R-0 + R-12ci or R-13 + R-3.8ci or R-20	R-0 + R-12ci or R-13 + R-3.8ci or R-20	R-0 + R-12ci or R-13 + R-3.8ci or R-20	R-0 + R-12ci or R-13 + R-3.8ci or R-20	R-0 + R-12ci or R-13 + R-3.8ci or R-20	R-0 + R-12ci or R-13 + R-3.8ci or R-20	R-0 +R-12ci or R-13 + R-3.8ci or R-20	R-0 + R-12ci or R-13 + R-3.8ci or R-20	R-0 +R-16ci or R-13 + R-7.5ci or R20 + R3.8ci or R-27	R-0 +R-16ci or R-13 + R-7.5ci or R20 + R3.8ci or R-27	R-0 +R-16ci or R-13 + R-7.5ci or R20 + R3.8ci or R-27	R-0 +R-16ci or R-13 + R-7.5ci or R20 + R3.8ci or R-27	R-0 +R-16ci or R-13 + R-7.5ci or R20 + R3.8ci or R-27	R-0 +R-16ci or R-13 + R-7.5ci or R20 + R3.8ci or R-27	R-0 + R-27.5ci or R-13 + R-18.8ci or R-20 + R-14ci	R-0 + R-27.5ci or R-13 + R-18.8ci or R-20 + R-14ci

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m^2, 1 pound per cubic foot = 16 kg/m^3.

ci = Continuous Insulation, NR = No Requirement, LS = Liner System.

a. Assembly descriptions can be found in ANSI/ASHRAE/IESNA 90.1 Appendix A.

b. Where using *R*-value compliance method, a thermal spacer block shall be provided, otherwise use the *U*-factor compliance method in Table C402.1.4.

c. R-5.7ci is allowed to be substituted with concrete block walls complying with ASTM C90, ungrouted or partially grouted at 32 inches or less on center vertically and 48 inches or less on center horizontally, with ungrouted cores filled with materials having a maximum thermal conductivity of 0.44 Btu-in/h-f^2 °F.

d. Where heated slabs are below grade, below-grade walls shall comply with the exterior insulation requirements for heated slabs.

e. "Mass floors" shall be in accordance with Section C402.2.3.

f. "Mass walls" shall be in accordance with Section C402.2.2.

g. The first value is for perimeter insulation and the second value is for full, under-slab insulation. Perimeter insulation is not required to extend below the bottom of the slab.

h. The first value is *cavity insulation*; the second value is *continuous insulation*. Therefore, "R-0+R-12ci" means R-12 *continuous insulation* and no *cavity insulation*; "R-13+R-3.8ci" means R-13 *cavity insulation* and R-3.8 *continuous insulation*; "R-20" means R-20 *cavity insulation* and no *continuous insulation*. R-13, R-20, and R-27 *cavity insulation* as used in this table apply to a nominal 4-inch, 6-inch, and 8-inch deep wood or cold-formed steel stud cavities, respectively.

Reason: This proposal does not change the stringency of the insulation requirements for walls. It provides additional equivalent prescriptive R-value options for all climate zones that address the three primary insulation strategies or locations on framed assemblies (cavity insulation only, cavity + continuous insulation, and continuous insulation only). For these common strategies for insulation, the user should not be required to do calculations or reference U-factor tables in a separate document, Appendix A of ASHRAE 90.1. Similar action was taken and is now included in 2021 IECC-R for wall R-values. The calculations and assumptions are exactly the same as used for existing values in the table and are available to the committee upon request.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal merely adds options for user without requiring calculations (which may reduce costs).

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: per the proponent's reason statement.

Proposal # 366

CEPI-41-21

Proponents: Marcin Pazera, representing Polyisocyanurate Insulation Manufacturers Association (mpazera@pima.org); Justin Koscher, Polyisocyanurate Insulation Manufacturers Association, representing Polyisocyanurate Insulation Manufacturers Association (jkoscher@pima.org)

2021 International Energy Conservation Code

Revise as follows:

C402.1.4.1 Roof/ceiling assembly. The maximum roof/ceiling assembly *U*-factor shall not exceed that specified in Table C402.1.4. <u>Insulation shall be installed in accordance with C402.2.1.2 through C402.2.1.5.</u>

C402.1.4.1.1 Tapered, above-deck insulation based on thickness. Where used as a component of a maximum roof/ceiling assembly *U*-factor calculation, the sloped roof insulation *R*-value contribution to that calculation shall use the average thickness in inches (mm) along with the material *R*-value-per-inch (per-mm) solely for *U*-factor compliance as prescribed in Section C402.1.4.

Delete without substitution:

~~**C402.1.4.1.2 Suspended ceilings.** Insulation installed on suspended ceilings having removable ceiling tiles shall not be considered part of the assembly *U*-factor of the roof/ceiling construction.~~

~~**C402.1.4.1.3 Joints staggered.** Continuous insulation board shall be installed in not less than two layers, and the edge joints between each layer of insulation shall be staggered, except where insulation tapers to the roof deck at a gutter edge, roof drain or scupper.~~

Reason: The IECC contains installation requirements applicable to roof insulation in various sections of the code. However, the intent of the code is for the installation requirements to be consistent regardless of the selected compliance method (i.e., R-value, U-factor). In previous code development cycles, inconsistencies were inadvertently created in Section C402 between the installation requirements applicable to the R-value method and the U-factor method. This proposal is intended to eliminate these inconsistencies by referencing a single set of installation requirements applicable to roof insulation. The general installation requirements in Section C402.1.4.1 (U-factor) are stricken and replaced with a pointer reference to the general installation requirements that currently appear in Section C402.2.1 (R-value). Including one set of general installation requirements in the IECC for roof insulation eliminates redundancy in code language and will make maintaining the requirements easier going forward while reducing the chance for inconsistencies. Note that the tapered insulation provisions are specific to either the U-factor or R-value compliance method and are not amended by this proposal.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This code change proposal will have no impact on the cost of construction. The proposal does not impose new requirements.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Reformatting of section removes redundancy. Change does not modify any requirements but improves clarity.

Proposal # 358

CEPI-42-21

Proponents: Darren Meyers, P.E., representing International Energy Conservation Consultants LLC (dmeyers@ieccode.com); Mark Graham, representing National Roofing Contractors Association (mgraham@nrca.net)

2021 International Energy Conservation Code

Revise as follows:

C402.1.4.1.3 Joints staggered. Continuous insulation board located above deck shall be installed in not less than two layers, and the edge joints between each layer of insulation shall be staggered, except where insulation tapers to the roof deck at a gutter edge, roof drain or scupper.

C402.2.1.4 Joints staggered. Continuous, above-deck insulation board shall be installed in not less than two layers and the edge joints between each layer of insulation shall be staggered, except where insulation tapers to the roof deck at a gutter edge, roof drain or scupper.

Reason: Clarify the intent of these provisions using language already in Table C402.1.3 and Table C402.1.4.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The code change proposal will neither increase nor decrease the cost of construction.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: The proposed language cleans up the language and clarifies the intent.

Proposal # 342

CEPI-43-21

Proponents: Jonathan Humble, representing American Iron and Steel Institute (Jhumble@steel.org)

2021 International Energy Conservation Code

Revise as follows:

C402.1.4.2 Thermal resistance of cold-formed steel ~~walls~~ assemblies. *U*-factors for building envelopes containing ~~of walls with~~ cold-formed steel framed ceilings and walls ~~studs~~ shall be permitted to be determined in accordance ~~with Equation 4-1~~ with AISI S250 as modified herein.

1. Where the steel-framed wall contains no cavity insulation, and uses continuous insulation to satisfy the U-factor maximum, thesteel-framed wall member spacing is permitted to be installed at any on-center spacing.
2. Where the steel-framed wall contains framing at 24 inches (610 mm) on center with a 23% framing factor or framing at 16 inches (400 mm) on-center with a 25% framing factor, the next lower framing member spacing input values shall be used when calculating using AISI S250.
3. Wher the steel-framed wall contains less than 23% framing factors the AISI S250 shall be used without any modifications.
4. Where the steel-framed wall contains other than standard C-shape framing members the AISI S250 calculation option for other than standard C-shape framing is permitted to be used.

~~**U = 1/[Rs + (ER)] (Equation 4-1)**~~

~~where:~~

~~R_s = The cumulative *R*-value of the wall components along the path of heat transfer, excluding the *cavity insulation* and steel studs.~~

~~*ER* = The effective *R*-value of the *cavity insulation* with steel studs as specified in Table C402.1.4.2.~~

~~TABLE C402.1.4.2 EFFECTIVE R-VALUES FOR STEEL STUD WALL ASSEMBLIES~~

~~NOMINAL STUD DEPTH (inches)~~	~~SPACING OF FRAMING (inches)~~	~~CAVITY *R*-VALUE (insulation)~~	~~CORRECTION FACTOR (F_c)~~	~~EFFECTIVE *R*-VALUE (ER) (Cavity *R*-Value × F_c)~~
~~3½~~	~~16~~	~~13~~	~~0.46~~	~~5.98~~
		~~15~~	~~0.43~~	~~6.45~~
~~3½~~	~~24~~	~~13~~	~~0.55~~	~~7.15~~
		~~15~~	~~0.52~~	~~7.80~~
~~6~~	~~16~~	~~19~~	~~0.37~~	~~7.03~~
		~~21~~	~~0.35~~	~~7.35~~
~~6~~	~~24~~	~~19~~	~~0.45~~	~~8.55~~
		~~21~~	~~0.43~~	~~9.03~~
~~8~~	~~16~~	~~25~~	~~0.31~~	~~7.75~~
	~~24~~	~~25~~	~~0.38~~	~~9.50~~

~~For SI: 1 inch = 25.4 mm.~~

Add new standard(s) as follows:

AISI

American Iron and Steel Institute
25 Massachusetts Avenue, NW, Suite 800
Washington, DC 20001

AISI . AISI S250 - 21North American Standard for Thermal Transmittance of Building Envelopes with Cold-Formed Steel Framing

Reason: The purpose of this proposal is to address the issue of having to submit to the code official a request to use the alternative means and methods provisions for cold-formed steel framing designs that are not shown in the IECC. For example, Section C402.1.4.2 addresses only wall framing spacing for 16 and 24 inch on center spacing and is limited to cavity plus continuous insulation options only, whereas, in the market there are many more framing spacing and insulation options used.
This proposal recommends that the Section be modified to recognize the ANSI/AISI/COFS S250 standard. This standard covers cold-formed steel wall framing spacings from 6 inches to 24 inches on center, covers member sizes from 3.5 inches to 12 inches wide, and covers member thicknesses from 0.033 inches thick to 0.064 inches thick. This standard will provide greater latitude for the user of the IECC by mitigating the necessity of having to submit for approval under alternate means and methods provisions. Further, this standard also includes provisions for evaluation of wall assemblies where all the insulation is located outside the wall cavity, which is an option the IECC does not cover.

This standard also contains provisions for calculating ceiling assemblies constructed of cold-formed steel framing with either conventional c-shape framing members, or truss construction with insulation in the attic and with additional continuous insulation below the truss framing. Previous to this proposal we found users applying the 2003 IECC provisions, which contained the calculation procedures, as part of the alternative means and methods submission process to demonstrate compliance. This proposal is intended to mitigate that additional step.

The ANSI/AISI/COFS S250 was approved and published in September 2021.

As part of AISI's effort to make this document user friendly, an excel spread sheet containing all the necessary equations and back-ground data was generated so that users would merely input the basic assembly materials data (e.g. R-values of insulations, sheathings, etc.) and allow the spread sheet to calculate within seconds the result. This excel spread sheet is available at no cost to any potential user (e.g. code official, design professional, building owner, etc.)

The proponent wishes to schedule time to present to the IECC Commercial Committee this proposal, discuss, and to take questions from the Committee.

Cost Impact: The code change proposal will decrease the cost of construction.
This proposed change we expect will decease the cost of construction by eliminating the need to prepare an application to the alternative means and methods process. This is because of the standards wider range of envelope assembly options that the user is permitted to calculate in order to demonstrate compliance.

Bibliography: AISI, "Development of a U-Factor Calculation Procedure for Cold-Formed Steel C-Shaped Clear Wall Assemblies," American Iron and Steel Institute, Washington, DC. Research Report RP20-2, April 2020.
AISI, "North American Standard for Thermal Transmittance of Building Envelopes with Cold-Formed Steel Framing," American Iron and Steel Institute, Washington, DC, AISI S250-21.

Attached Files

- **AISI S250-21&S250-21-C_s.pdf**
  https://energy.cdpaccess.com/proposal/104/1146/files/download/21/
- **AISI_CFSD-Report-RP20-2-Final.pdf**
  https://energy.cdpaccess.com/proposal/104/1146/files/download/17/

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Agree with proponent's reason statement that this proposal will be beneficial in standardizing the procedures for calculating building envelopes containing cold-formed steel framing. Also, agree that the amended portions do enhance, and are within the scope of, this proposal that are designed to provide greater clarity through instructions for the four different wall design configurations that could occur in building construction.

CEPI-44-21

Proponents: Duncan Brown, New York City Department of Buildings, representing New York City Department of Buildings

2021 International Energy Conservation Code

Add new text as follows:

C402.1.4.3 Thermal Resistance of Spandrel Panels. U-factors of opaque assemblies within fenestration framing systems shall be determined in accordance with the default values in Table C402.1.4.3, ASTM C1363, or ANSI/NFRC 100.

TABLE C402.1.4.3 EFFECTIVE *U*-FACTORS FOR SPANDREL PANELS[a]

Rated R-value of Insulation between Framing Members		R-4	R-7	R-10	R-15	R-20	R-25	R-30
Frame Type	Spandrel Panel	Default U-factor						
Aluminum without Thermal Break[b]	Single glass pane, stone, or metal panel	0.285	0.259	0.247	0.236	0.230	0.226	0.224
	Double glazing with no low-e coatings	0.273	0.254	0.244	0.234	0.229	0.226	0.223
	Triple glazing or double glazing with low-e glass	0.263	0.249	0.241	0.233	0.228	0.225	0.223
Aluminum with Thermal Break[c]	Single glass pane, stone, or metal panel	0.243	0.212	0.197	0.184	0.176	0.172	0.169
	Double glazing with no low-e coatings	0.228	0.205	0.193	0.182	0.175	0.171	0.168
	Triple glazing or double glazing with low-e glass	0.217	0.199	0.189	0.180	0.174	0.170	0.167
Structural Glazing[d]	Single glass pane, stone, or metal panel	0.217	0.180	0.161	0.145	0.136	0.130	0.126
	Double glazing with no low-e coatings	0.199	0.172	0.157	0.143	0.135	0.129	0.126
	Triple glazing or double glazing with low-e glass	0.186	0.165	0.152	0.140	0.133	0.128	0.125
No framing or Insulation is Continuous[e]	Single glass pane, stone, or metal panel	0.160	0.108	0.082	0.058	0.045	0.037	0.031
	Double glazing with no low-e coatings	0.147	0.102	0.078	0.056	0.044	0.036	0.030
	Triple glazing or double glazing with low-e glass	0.139	0.098	0.076	0.055	0.043	0.035	0.030

a. Extrapolation outside of the table shall not be permitted. Assemblies with distance between framing less than 30 inches (762 mm), or not included in the default table, shall have a *U-factor* determined by testing in compliance with ASTM C1363 or modeling in compliance with ANSI/NFRC 100. Spandrel panel assemblies in the table do not include metal backpans. For designs with metal backpans, multiply the U-factor by 1.20.

b. This frame type shall be used for systems that do not contain a non-metallic element that separates the metal exposed to the exterior from the metal that is exposed to the interior condition.

c. This frame type chall be used for systems where a urethan or other non-metallic element separates the metal exposed to the exterior from the metal that is exposed to the interior condition.

d. This frame type shall be used for systems that have no exposed mullion on the exterior.

e. This frame types shall be used for systems where there is no framing or the insulation is continuous and uninterrupted between framing.

Reason: Considerable review time is spent in debating the appropriate classification and thermal properties of spandrel wall types. Not to mention energy lost through the misrepresentation of U-factors. The new table, derived from Title 24 Appendix Table 4.3.8 and, a variant in effect in NYCECC since 2020, provides clear direction as to how the differently insulated types for a proposed design should be entered.

Table 4.3.8 – U-factors for Spandrel Panels and Curtain Walls

			Rated R-value of Insulation between Framing Members							
			None	R-4	R-7	R-10	R-15	R-20	R-25	R-30
Frame Type	**Spandrel Panel**		A	B	C	D	E	F	G	H
Aluminum without Thermal Break	Single glass pane, stone, or metal panel	1	0.4[illegible]5	0.285	0.259	0.247	0.236	0.230	0.226	0.224
	Double glass with no low-e coatings	2	0.3[illegible]6	0.273	0.254	0.244	0.234	0.229	0.226	0.223
	Triple or low-e glass	3	0.3[illegible]3	0.263	0.249	0.241	0.233	0.228	0.225	0.223
Aluminum with Thermal Break	Single glass pane, stone, or metal panel	4	0.4[illegible]9	0.243	0.212	0.197	0.184	0.176	0.172	0.169
	Double glass with no low-e coatings		0.3[illegible]8	0.228	0.205	0.193	0.182	0.175	0.171	0.168
	Triple or low-e glass		0.2[illegible]7	0.217	0.199	0.189	0.180	0.174	0.170	0.167
Structural Glazing	Single glass pane, stone, or metal panel	7	0.4[illegible]8	0.217	0.180	0.161	0.145	0.136	0.130	0.126
	Double glass with no low-e coatings		0.3[illegible]6	0.199	0.172	0.157	0.143	0.135	0.129	0.126
	Triple or low-e glass	9	0.2[illegible]7	0.186	0.165	0.152	0.140	0.133	0.128	0.125
No framing or Insulation is Continuous	Single glass pane, stone, or metal panel	10	0.4[illegible]5	0.160	0.108	0.082	0.058	0.045	0.037	0.031
	Double glass with no low-e coatings	11	0.3[illegible]6	0.147	0.102	0.078	0.056	0.044	0.036	0.030
	Triple or low-e glass	12	0.3[illegible]3	0.139	0.098	0.076	0.055	0.043	0.035	0.030
Frame Type	**Curtain Wall**									
Aluminum without Thermal Break	Single glass pane, stone, or metal panel	13	1.224	0.929	0.427	0.372	0.347	0.326	0.315	0.308
	Double glass with no low-e coatings	14	0.727	0.611	0.400	0.361	0.341	0.323	0.313	0.307
	Triple or low-e glass	15	0.567	0.494	0.380	0.351	0.335	0.320	0.311	0.306
Aluminum with Thermal Break	Single glass pane, stone, or metal panel	16	1.110	0.862	0.339	0.282	0.256	0.234	0.222	0.215
	Double glass with no low-e coatings	17	0.617	0.531	0.311	0.270	0.249	0.230	0.220	0.214
	Triple or low-e glass	18	0.458	0.409	0.290	0.260	0.243	0.227	0.218	0.212
Structural Glazing	Single glass pane, stone, or metal panel	19	1.106	0.859	0.290	0.228	0.199	0.175	0.162	0.154
	Double glass with no low-e coatings	20	0.577	0.502	0.260	0.215	0.192	0.171	0.160	0.152
	Triple or low-e glass	21	0.407	0.368	0.237	0.204	0.185	0.168	0.158	0.151
No framing or Insulation is Continuous	Single glass pane, stone, or metal panel	22	1.224	0.929	0.197	0.124	0.090	0.062	0.047	0.038
	Double glass with no low-e coatings	23	0.727	0.611	0.177	0.116	0.086	0.060	0.046	0.038
	Triple or low-e glass	24	0.567	0.494	0.166	0.111	0.083	0.059	0.045	0.037

This table has U-factors for the spandrel section of glass and other curtain wall systems. Design factors that affect performance are the type of framing, the type of spandrel panel and the R-value of insulation.

Four framing conditions are considered in the table. The first is the common case where standard aluminum mullions are used. Standard mullions provide a thermal bridge through the insulation, reducing its effectiveness. The second case is for metal framing members that have a thermal break. A thermal break frame uses a urethane or other non-metallic element to separate the metal exposed to outside conditions from the metal that is exposed to interior conditions. The third case is for structural glazing or systems where there is no exposed mullion on the interior. The fourth case is for the condition where there is no framing or the insulation is continuous and uninterrupted by framing. The columns in the table can be used for any specified level of insulation between framing members installed in framed curtain walls or spandrel panels.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The intent of the proposal is to aid in compliance review and does not affect the cost of construction.

Attached Files

- **Table 4.3.8.pdf**
  https://energy.cdpaccess.com/proposal/282/1162/files/download/59/

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: It provides reasonable guidance on how to assess the thermal performance of spandrel assemblies that is not previously available and can cause problems with consistency.

CEPI-46-21

Proponents: Helen Sanders, Facade Tectonics Institute/Technoform North America, representing The Facade Tectonics Institute

2021 International Energy Conservation Code

Revise as follows:

C402.1.5 Component performance alternative. Building envelope values and fenestration areas determined in accordance with ~~Equation 4-2~~ the following procedure shall be an alternative to compliance with the *U*-, *F*- and *C*-factors in Tables C402.1.4 and C402.4 and the maximum allowable fenestration areas in Section C402.4.1. *Fenestration* shall meet the applicable SHGC requirements of Section C402.4.3.

$$A + B + C + D + E \leq Zero$$

(Equation 4-2)

$$A_p + B_p + C_p \leq A_T + B_T + C_T - V_F - V_S$$

where:

A_p = Sum of the (area x *U*-factor) for each proposed building thermal envelope assembly, other than slab-on-grade or below-grade wall assemblies.

B_p = Sum of the (length x *F*-factor) for each proposed slab-on-grade edge condition

C_p = Sum of the (area x *C*-factor) for each proposed below-grade wall assembly

A_T = Sum of the (area x *U*-factor permitted by Tables C402.1.4 and C402.4) for each proposed building thermal envelope assembly, other than slab-on grade or below-grade wall assemblies

B_T = Sum of the (length x *F*-factor permitted by Table C402.1.4 for each proposed slab-on-grade edge condition)

C_T = Sum of the (area x *C*-factor permitted by Table C402.1.4) for each proposed below-grade wall assembly

P_F = Maximum vertical fenestration area allowable by Section C402.4.1, C402.4.1.1, or C402.4.1.2

Q_F = Proposed vertical fenestration area

$R_F = Q_F - P_F$, but not less than zero (excess vertical fenestration area)

S_F = Area-weighted average *U*-factor permitted by Table C402.4 of all vertical fenestration assemblies

T_F = Area-weighted average *U*-factor permitted by Table C402.1.4 of all exterior opaque wall assemblies

$U_F = S_F - T_F$ (excess *U*-factor for excess vertical fenestration area)

$V_F = R_F \times U_F$ (excess U x A due to excess vertical fenestration area)

P_S = Maximum skylight area allowable by Section C402.1.4

Q_S = Actual skylight area

$R_S = Q_S - P_S$, but not less than zero (excess skylight area)

S_S = Area-weighted average *U*-factor permitted by Table C402.4 of all skylights

T_S = Area-weighted average *U*-factor permitted by Table C402.4.1 of all opaque roof assemblies

$U_S = S_S - T_S$ (excess *U*-factor for excess skylight area)

$V_S = R_S \times U_S$ (excess U x A due to excess skylight area)

~~A = Sum of the (UA Dif) values for each distinct assembly type of the *building thermal envelope*, other than slabs on grade and below-grade walls.~~

~~UA Dif = UA Proposed – UA Table.~~

~~UA Proposed = Proposed *U*-value × Area.~~

~~UA Table = (*U*-factor from Table C402.1.3, C402.1.4 or C402.4) × Area.~~

~~B = Sum of the (FL Dif) values for each distinct slab-on-grade perimeter condition of the *building thermal envelope*.~~

~~FL Dif = FL Proposed – FL Table.~~

~~FL Proposed = Proposed *F*-value × Perimeter length.~~

~~FL Table = (*F*-factor specified in Table C402.1.4) × Perimeter length.~~

~~C = Sum of the (CA Dif) values for each distinct *below-grade wall* assembly type of the *building thermal envelope*.~~

~~CA Dif = CA Proposed – CA Table.~~

~~CA Proposed = Proposed *C*-value × Area.~~

~~CA Table = (Maximum allowable *C*-factor specified in Table C402.1.4) × Area.~~

~~Where the proposed vertical glazing area is less than or equal to the maximum vertical glazing area allowed by Section C402.4.1, the value of D (Excess Vertical Glazing Value) shall be zero. Otherwise:~~

~~D = (DA × UV) – (DA × U Wall), but not less than zero.~~

~~DA = (Proposed Vertical Glazing Area) – (Vertical Glazing Area allowed by Section C402.4.1).~~

~~UA Wall = Sum of the (UA Proposed) values for each opaque assembly of the exterior wall.~~

~~U Wall = Area-weighted average *U*-value of all above-grade wall assemblies.~~

~~UAV = Sum of the (UA Proposed) values for each vertical glazing assembly.~~

~~UV = UAV/total vertical glazing area.~~

~~Where the proposed skylight area is less than or equal to the skylight area allowed by Section C402.4.1, the value of E (Excess Skylight Value) shall be zero. Otherwise:~~

~~E = (EA × US) – (EA × U Roof), but not less than zero.~~

~~EA = (Proposed Skylight Area) – (Allowable Skylight Area as specified in Section C402.4.1).~~

~~U Roof = Area-weighted average *U*-value of all roof assemblies.~~

~~UAS = Sum of the (UA Proposed) values for each skylight assembly.~~

~~US = UAS/total skylight area.~~

Reason: A traditional UA calculation compares the UA of the entire proposed building to the UA of the entire prescriptive code baseline building matches the intent of the code. The above grade window-to-wall ratio for the prescriptive baseline building would be apportioned and fixed at the maximum allowable percentage to allow for trade-off of exterior wall systems against each other in the proposed building. The same applies to skylights and roofs. No trade off of façade systems against better performing building services systems is permitted anymore; the façade shall be code compliant within itself.
Equation 4-2 leads to erroneous results that allowed for excessive fenestration, which is counter to the intent of the compliance approach. This proposal "fixes" the problem created by the existing equation and delivers on the original intent of the section. The proposed procedure accounts for the envisioned penalty for excess fenestration above and beyond the permissible window-to-wall ratio.

We recognize that this may not have exactly the right code language or formatting, but we hope that the committee will review the section and support addressing the problem with equation 4-2.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The proposed code update fixes an error with an equation and will not increase the cost of construction, as it limits excessive use of lower performance fenestration, which means that the building will be more aligned with a prescriptive building.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: this proposal clarifies the equation for component trade off eliminating some confusion that existed.

Proposal # 549

CEPI-47-21

Proponents: Darren Meyers, P.E., representing International Energy Conservation Consultants LLC (dmeyers@ieccode.com); Mark Graham, representing National Roofing Contractors Association (mgraham@nrca.net)

2021 International Energy Conservation Code

Revise as follows:

C402.2.1.1 Tapered, above-deck insulation based on thickness. Where used as a component of a roof/ceiling assembly *R*-value calculation, the sloped roof insulation *R*-value contribution to that calculation shall use the average thickness in inches (mm) along with the material *R*-value-per-inch (per-mm) solely for *R*-value compliance as prescribed in Section 402.1.3. The thickness of tapered, above-deck roof insulation at its lowest point, gutter edge, roof drain or scupper, shall be not less than 1 inch (25 mm).

Delete without substitution:

~~**C402.2.1.2 Minimum thickness, lowest point.** The minimum thickness of above-deck roof insulation at its lowest point, gutter edge, roof drain or scupper, shall be not less than 1 inch (25 mm).~~

Reason: Provisions for "Minimum thickness, lowest point," apply to tapered, above-deck installations of insulation, as intended.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The code change proposal will neither increase nor decrease the cost of construction.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: This change improves the clarity of the requirement by indicating that it applies only to tapered insulation.

Proposal # 344

CEPI-48-21

Proponents: Amanda Hickman, representing Reflective Insulation Manufacturers Association (RIMA) (amanda@thehickmangroup.com)

2021 International Energy Conservation Code

Revise as follows:

C402.2.7 Airspaces. Where the *R*-value of an airspace is used for compliance in accordance with Section C402.1, the airspace shall be enclosed in an unventilated cavity bounded on all sides by building components and constructed to minimize airflow into and out of the enclosed airspace. Airflow shall be deemed minimized where one of the following conditions occur: ~~the enclosed airspace is located on the interior side of the continuous air barrier and is bounded on all sides by building components.~~

1. The enclosed airspace is unventilated.
2. The enclosed airspace is bounded on at least one side by an anchored masonry veneer, constructed in accordance with Chapter 14 of the *International Building Code*, and vented by veneer weep holes located only at the bottom of the airspace and space not less than 15 inches (381 mm) on center with top of the cavity airspace closed.

Exception: ~~The thermal resistance~~ For ventilated cavities, the effect of the ventilation of airspaces located on the exterior side of the continuous air barrier and adjacent to and behind the exterior wall-covering material shall be determined in accordance with ASTM C1363 modified with an airflow entering the bottom and exiting the top of the airspace at an air movement rate of not less than 70 mm/second.

Reason: With the current focus by the energy building code bodies to increase energy efficiency every code cycle, it is imperative that code language be technically accurate. Unfortunately in its current state, this section of the code is not.
The current language does not evaluate the realistic stipulations as they relate to air spaces.

1. The first issue is the location of an “enclosed unventilated cavity”.
2. The second, is the specification for a test method for thermal performance of an air space on the exterior of the air barrier.

A masonry wall assembly that is built to the 2021 IBC will typically include an “enclosed airspace that is bounded on all sides by building components". This provides an “unventialled” condition as the “weep holes” provided for drainage do not promote a level of air exchange that would affect the thermal performance of the system.

An air space that is enclosed, unventilated and bounded by building components on all sides performs thermally the same regardless of location. It is not necessary to differentiate a location if the assembly meets these requirements. If an assembly has ventilation, a mechanism or design for free air exchange, then the requirements are not met, and the air space cannot be utilized as a contributor to the thermal performance of the assembly.

Free air exchange in a wall system requires “air in” and an avenue for “air out”. In order to achieve this with a masonry wall, it would require “venting” in the upper and lower half of the wall. A series of weep holes across the lower extreme of the wall do not qualify as venting which is necessary for a system to be ventilated.

The requirements related to ASTM C1363 are completely inappropriate and impossible to actually execute.

“ASTM C1363 Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus” specifies in Paragraph 1.14 “The test method does not permit intentional mass transfer of air or moisture through the specimen during measurements”.

In regard to the specified “air movement rate” of 70 mm/second, this value is arbitrary. Data to substantiate this as a “real world” rate has never been available or offered. This really is a moot point since the introduction of air movement into the apparatus is prohibited, but further exemplifies the faults with this section/exception.

Cost Impact: The code change proposal will decrease the cost of construction.
This code change simplifies the code and eliminates unnecessary requirements, which will decrease the cost of construction.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Clarifies what systems can use standard R-values.

CEPI-58-21

Proponents: Mark Lyles, representing New Buildings Institute (markl@newbuildings.org); Gayathri Vijayakumar, representing Steven Winter Associates, Inc. (gvijayakumar@swinter.com); Diana Burk, representing New Buildings Institute (diana@newbuildings.org)

2021 International Energy Conservation Code

Revise as follows:

C402.5 Air leakage—thermal envelope. The *building thermal envelope* shall comply with Sections C402.5.1 through Section C402.5.11.1~~, or the building *thermal envelope* shall be tested in accordance with Section C402.5.2 or C402.5.3. Where compliance is based on such testing, the building shall also comply with Sections C402.5.7, C402.5.8 and C402.5.9~~.

C402.5.1.2 Air barrier compliance. A continuous air barrier for the opaque building envelope shall comply with the following:

1. Buildings or portions of buildings, including Group R-2 and I -1 occupancies, shall meet the provisions of Section C402.5.2.

   Exception: Buildings in Climate Zones 2B, 3C and 5C.

2. Buildings or portions of buildings other than Group R-2 and I -1 occupancies shall meet the provisions of Section C402.5.3.

   Exceptions:

   1. Buildings in Climate Zones 2B, 3B, 3C and 5C.
   2. Buildings larger than 5,000 square feet (464.5 m^2) floor area in Climate Zones 0B, 1, 2A, 4B and 4C.
   3. Buildings between 5,000 square feet (464.5 m^2) and 50,000 square feet (4645 m^2) floor area in Climate Zones 0A, 3A and 5B.

3. Buildings or portions of buildings that do not complete air barrier testing shall meet the provisions of Section C402.5.1.3 or C402.5.1.4 in addition to Section C402.5.1.5.

C402.5.2 Dwelling and sleeping unit enclosure testing. The *building thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E1827 or an equivalent method approved by the *code official*. The measured air leakage shall not exceed 0.30 cfm/ft^2 (1.5 L/s m^2) of the testing unit enclosure area at a pressure differential of 0.2 inch water gauge (50 Pa). Where multiple dwelling units or sleeping units or other *enclosed* ~~occupiable conditioned~~ *spaces* are contained within one *building thermal envelope*, each ~~unit~~ shall be considered an individual testing unit, and the building air leakage shall be the weighted average of all test ed~~ing~~ unit results, weighted by the ~~each testing unit's~~ enclosure area of each tested unit. Units shall be tested without simultaneously testing adjacent units and shall be separately ~~with an unguarded blower door test~~ tested as follows:

1. Where buildings have fewer than eight total dwelling or sleeping ~~testing~~ units, each ~~testing~~ unit shall be tested.
2. For buildings with eight or more dwelling or sleeping ~~testing~~ units, the greater of seven units or 20 percent of the ~~testing~~ units in the building shall be tested, including a top floor unit, a ground floor unit and a unit with the largest *testing~~-~~unit enclosure area*. For each tested unit that exceeds the maximum air leakage rate, an additional two units shall be tested, including a mixture of ~~testing~~ unit types and locations.
3. *Enclosed spaces* with not less than one *exterior wall* in the *building thermal envelope* shall be tested in accordance with C402.5.3.

   Exception: Corridors, stairwells, and *enclosed spaces* having a *conditioned floor area* not greater than 1,500 ft^2 (139 m^2)shall be permitted to comply with Section C402.5.1.5 and either Section C402.5.1.3 or C402.5.1.4.

C402.5.3 Building thermal envelope testing. The *building thermal envelope* shall be tested in accordance with ASTM E779, ~~ANSI/RESNET/ICC 380~~, ASTM E3158 or ASTM E1827 or an equivalent method approved by the code official. The measured air leakage shall not exceed ~~0.40 cfm/ft^2 (2.0 L/s × m^2)~~ 0.25 cfm/ft^2 (1.25 L/s m^2) of the *building thermal envelope* area at a pressure differential of 0.3 inch water gauge (75 Pa). ~~Alternatively, portions of the building shall be tested and the measured air leakages shall be area weighted by the surface areas of the building envelope in each portion. The weighted average test results shall not exceed the whole building leakage limit. In the alternative approach, the following portions of the building shall be tested:~~

Exceptions:

1. ~~The entire envelope area of all stories that have any spaces directly under a roof.~~ For buildings larger than 50,000 ft^2 (4,645 m^2), portions of the building shall be tested and the measured air leakages shall be area weighted by the surface areas of the building envelope in each portion. The weighted average test results shall not exceed the whole building leakage limit. The following portions of the building shall be tested.
   1.1. The entire envelope area of all stories that have any spaces directly under a roof.

   1.2. The entire envelope area of all stories that have a building entrance, exposed floor, or loading dock, or are below grade.

   1.3. Representative above-grade sections of the building totaling at least 25 percent of the wall area enclosing the remaining conditioned space.

   1.4. Portions of buildings containing Group R or Group I occupancies that are not tested shall meet the provisions of Section C402.5.1.3 or C402.5.1.4 in addition to Section C402.5.1.5.

2. ~~The entire envelope area of all stories that have a building entrance, exposed floor, or loading dock, or are below grade.~~ For buildings larger than 250,000 ft^2 (25,000 m^2), that do not include Group R or Group I occupancies, where an approved agency verifies the design and installation of the continuous air barrier in accordance with Section C402.5.1.5.

3. ~~Representative above-grade sections of the building totaling at least 25 percent of the wall area enclosing the remaining conditioned space.~~

~~**Exception:** Where the measured air leakage rate exceeds 0.40 cfm/ft^2 (2.0 L/s × m^2) but does not exceed 0.60 cfm/ft^2 (3.0 L/s × m^2), a diagnostic evaluation using smoke tracer or infrared imaging shall be conducted while the building is pressurized along with a visual inspection of the air barrier. Any leaks noted shall be sealed where such sealing can be made without destruction of existing building components. An additional report identifying the corrective actions taken to seal leaks shall be submitted to the code official and the building owner, and shall be deemed to comply with the requirements of this section.~~

C406.9 Reduced air infiltration. Air infiltration shall be verified by whole-building pressurization testing conducted in accordance with ASTM E779 or ASTM E1827 by an independent third party. The measured air-leakage rate of the building envelope shall not exceed ~~0.25 cfm/ft^2 (2.0 L/s × m^2)~~ 0.17 cfm/ft^2 (0.85 L/s x m^2) under a pressure differential of 0.3 inches water column (75 Pa), with the calculated surface area being the sum of the above- and below-grade building envelope. A report that includes the tested surface area, floor area, air by volume, stories above grade, and leakage rates shall be submitted to the code official and the building owner.

Exception:~~For buildings having over 250,000 square feet (25 000 m^2) of *conditioned floor area*, air leakage testing need not be conducted on the whole building where testing is shall be conducted on representative above-grade sections of the building. Tested areas shall total not less than 25 percent of the conditioned floor area and shall be tested in accordance with this section.~~ Buildings tested in accordance with C402.5.2 where the weighted average of all tested unit results is not greater than 0.20 cfm/ft^2 (1.0 L/s x m^2) at a pressure differential of 0.2 inch water gauge (50 Pa).

TESTING UNIT ENCLOSURE AREA. The area sum of all the boundary surfaces that define the *dwelling unit*, *sleeping unit* or ~~occupiable~~ *conditioned* *enclosed* *space* including top/ceiling, bottom/floor and all side walls. This does not include interior partition walls within the *dwelling unit*, *sleeping unit*, or ~~occupiable~~ *conditioned* *enclosed* *space*. Wall height shall be measured from the finished floor of the *conditioned space* to the finished floor or roof/ceiling air barrier above.

Reason: Air leakage can be a significant source of energy waste in buildings, contributing to higher heating and cooling costs for building owners and occupants, and increasing risk related to comfort and durability. Air tightness testing can result in more attention to envelope assembly air barrier sealing and significantly reduced building leakage. Adequate control over air leakage can provide many benefits, including reduced HVAC equipment sizing, better building pressurization, and energy savings due to reduced heating and cooling of infiltrated outside air. In moist climates, ensuring lower air leakage through whole-building testing can also result in better humidity control and reduced risk of durability issues. While it is important that the materials and assemblies have limited leakage, that alone does not guarantee a low leakage building. Recent research shows that 40% of buildings constructed without an envelope consultant have air leakage exceeding the currently optional test standard requirements, while buildings with envelope consultants all had leakage below 0.25 cfm/ft (Wiss J. 2014).

Testing is the most reliable means of ensuring that the intent of this code section—limiting unintended energy waste in buildings due to air infiltration—will be achieved. Durston and Heron's review (2012) of the 0.25cfm/ft^2 requirement by the U.S. Department of Defense (DOD) shows that without testing, the range of building leakage can exceed the requirement by more than double (0.9 cfm/ft). However, with testing included as part of the construction process, the average leakage of buildings was determined to be below the 0.25 cfm/ft limit and in many cases lower leakage levels in the range of 0.15 cfm/ft^2 can be achieved (Durston and Heron 2012). Therefore, a test limit of 0.25 cfm/ft is considered to be both a realistic and achievable goal.

This amendment proposes exempting whole building leakage testing for buildings larger than 250,000 ft^2 because of the technical and practical issues with testing these large buildings. This amendment also proposes different test thresholds for multifamily structures (Group R and I occupancies) that align with current industry practice in blower door testing for the multifamily market. The original air leakage testing threshold for residential buildings of 0.30 cfm/square foot tested at 50 Pascals was lowered to 0.20 cfm/square foot to align with the requirements in ASHRAE 62.2.

Additioanlly, as a result of these previous changes, the air leakage rate in Section C406.9 was reduced from 0.25 cfm/ft2 to 0.17 cfm/ft2 at 75 Pa and the specific requirements for Group R and Group I buildings were added as an exception.

Cost Impact: The code change proposal will increase the cost of construction.
This measure will increase the cost of construction of new commercial buildings as whole building air leakage testing will be required except for primarily residential buildings (Group R and I building occupancies). Based on a survey of professional commercial building air barrier testing companies, it was determined that the cost of air leakage testing fell into three ranges:

- $350 or $0.12 to $0.07 per square foot for buildings up to 5000 square feet
- $0.50 to $0.15 per square foot for buildings between 5000 and 50,000 square feet
- $0.15 to $0.09 per square foot for buildings between 50,000 and 100,000 square feet, with decreasing costs for larger buildings.

As demand for air leakage testing in commercial buildings increases, more companies will enter the market to provide these services. Therefore, a gradual decrease in cost is expected as more companies are available to do the testing.

Bibliography: Wiss J. 2014. *ASHRAE 1478-RP Measuring Airtightness of Mid- and High-Rise Non-Residential Buildings*. Elstner Associates, Inc. for ASHRAE. https://www.ashrae.org/resources--publications/periodicals/enewsletters/esociety/2014-12-10-articles/completed-research-december-2014.
Durston JL and M Heron. 2012. *Summary and Analysis of Large Building Air Leakage Testing for the U.S. Department of Defense*. Atlanta, GA. https://cdn.ymaws.com/www.nibs.org/resource/resmgr/BEST/best3_durston.2.9.pdf.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: CEPI-58 was modified by the proponents to remove overlapping changes with other proposals that also addressed re-structuring, test exemptions, and test stringency.

Proposal # 322

CEPI-60-21

Proponents: Megan Hayes, representing NEMA (Megan.Hayes@nema.org); Harold Jepsen, representing NEMA (harold.jepsen@legrand.us)

2021 International Energy Conservation Code

Revise as follows:

C402.5.1.1 Air barrier construction. The *continuous air barrier* shall be constructed to comply with the following:

1. The air barrier shall be continuous for all assemblies that are the thermal envelope of the building and across the joints and assemblies.
2. Air barrier joints and seams shall be sealed, including sealing transitions in places and changes in materials. The joints and seals shall be securely installed in or on the joint for its entire length so as not to dislodge, loosen or otherwise impair its ability to resist positive and negative pressure from wind, stack effect and mechanical ventilation.
3. Penetrations of the air barrier shall be caulked, gasketed or otherwise sealed in a manner compatible with the construction materials and location. Sealing shall allow for expansion, contraction and mechanical vibration. Joints and seams associated with penetrations shall be sealed in the same manner or taped. Sealing materials shall be securely installed around the penetration so as not to dislodge, loosen or otherwise impair the penetrations' ability to resist positive and negative pressure from wind, stack effect and mechanical ventilation. Sealing of concealed fire sprinklers, where required, shall be in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.
4. Recessed lighting fixtures shall comply with Section C402.5.10. Where similar objects are installed that penetrate the air barrier, provisions shall be made to maintain the integrity of the air barrier.
5. Electrical and communication boxes shall comply with C405.5.12. Where similar objects are installed that penetrate the air barrier, provisions shall be made to maintain the integrity of the air barrier.

Add new text as follows:

C402.5.12 Electrical and communication boxes. Electrical and communication boxes installed in the *building thermal envelope* shall meet one of the following:

1. Boxes that penetrates the *building thermal envelope* shall be air sealed to the subfloor, wall covering, or ceiling penetrated by the box. Spaces behind boxes penetrating the thermal envelope shall have insulation cut or blown to fit or that readily conforms to the space around the box.
2. Boxes that penetrate the *building thermal envelope* shall be the air-sealed type. Air-sealed boxes shall be tested in accordance with NEMA OS 4, Requirements for
Air-Sealed Boxes for Electrical and Communication Applications, and shall have an air leakage rate of not greater than 2.0 cfm (0.944 L/s) at a pressure differential of 1.57 psf (75 Pa). Air-sealed boxes shall be marked "NEMA OS 4" or "OS4" in accordance with NEMA OS 4. Air-Sealed boxes shall be installed per the manufacturer's instructions and with any supplied components required to achieve compliance with NEMA OS 4.

Reason: It is clear that C402.5 currently requires all building and system components that penetrate the thermal envelope to be sealed to create an air barrier and prevent air leakage. However, additional guidance is needed on how what options are available to achieve the objectives outlined in C402.5 when it comes to electrical and communication outlet boxes. This proposal corrects this gap in the code by offering a prescriptive option for conventional outlet boxes and a performance option utilizing tested air-sealed boxes. Approval of this proposal aligns the IECC-C with the IECC-R that already includes similar provisions for outlet boxes in Table R402.1.1 and R402.4.6.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
There is no increase or decrease cost in construction as this proposal simply adds language specific to electrical and communication outlet boxes that penetrate the thermal envelope and already intended to be sealed against air leakage in C402.5 by mirroring the requirement in C402.5.1.1.4 and C402.5.10 for recessed lighting.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: clarifies requirements for the sealing of electrical boxes that penetrate the air barrier.

CEPI-61-21

Proponents: Helen Sanders, Facade Tectonics Institute/Technoform North America, representing Facade Tectonics Institute

2021 International Energy Conservation Code

Revise as follows:

C402.5.1.2 . A continuous air barrier for the opaque building envelope shall comply with the following:

1. Buildings or portions of buildings, including Group R and I occupancies, shall meet the provisions of Section C402.5.2.

   ~~**Exception:** Buildings in Climate Zones 2B, 3C and 5C.~~

2. Buildings or portions of buildings other than Group R and I occupancies shall meet the provisions of Section C402.5.3.

   Exceptions:

   1. Buildings in Climate Zones 2B~~, 3B, 3C and 5C.~~
   ~~2. Buildings larger than 5,000 square feet (464.5 m^2) floor area in Climate Zones 0B, 1, 2A, 4B and 4C.~~
   ~~3.~~ 2. Buildings~~ between 5,000~~ larger than 25,000 square feet ~~(464.5~~ 2323 m^2~~) and 50,000 square feet (4645 m^2)~~ floor area in Climate Zones 0 through 4 ~~0A, 3A and 5B.~~

3. Buildings or portions of buildings that do not complete air barrier testing shall meet the provisions of Section C402.5.1.3 or C402.5.1.4 in addition to Section C402.5.1.5.

Reason: The members of the Façade Tectonics Institute (FTI) believe that the IECC has been moving in the right direction in terms of mandating whole building air leakage testing to improve building energy efficiency. The current 2021 version restricts the requirements to a select few climate zones though – mostly those that are heating dominated. Actual air leakage testing assures the quality of construction of the building envelope in this critical performance area. And air leakage is an energy efficiency degrader in all climate zones, whether heating dominated, mixed or cooling dominated (see references in bibliography).
In cooling dominated climate zones, air-leakage through the building envelope impacts the load on the air conditioning system (cooling of hot air infiltration), and even more so in humid climate zones where water also needs to be removed. This puts additional load on the electrical grid. As we move towards net zero buildings, and 100% electrification for decarbonization, it is becoming even more critical not just to reduce energy usage, but to free up electrical grid capacity, and manage peak demand (timing and amount) because of the increased use of renewables. This further supports the need to focus on more southern climate zones for verifying airtightness performance to reduce grid loads.

In order to achieve net zero energy and carbon emissions in buildings by 2030, the design and construction practitioners of the Façade Tectonics Institute believe we need to eliminate the exceptions to air leakage requirements so that they cover the majority of buildings as soon as possible. Previous studies have shown energy cost savings from air barriers of 2% to 36% (Emmerich et al. 2005) across all climate zones. If air-barriers are required for energy efficiency, they should be verified by testing to ensure the appropriate energy savings are captured. Verification and commissioning of building envelope systems are key tools in closing the performance gap between as-designed and as-built in building assemblies and systems.

Washington State's energy code (see reference for link) is a successful demonstration of the implementation of mandatory air-leakage testing in climate zone 4 (Maritime). Note that based on IECC 2021, only buildings less than 5,000 sq.ft. are required to do air leakage testing in this climate zone. As a result of the introduction of air leakage testing requirement, the state's construction industry has built up testing infrastructure to support meeting the requirements. The cost of fabricating an air-tight barrier is no more expensive than making a poorer one – it just requires high quality installation and quality control. Meeting the standard doesn't cost anything more, the additional cost is in the testing of the barrier's performance. Since testing is considered cost-effective in climate zone 4 (Maritime), it should be cost-effective elsewhere.

Washington's example illustrates that if air barrier testing is required, the industry will set up to do it. The fact that IECC 2021 already requires air-barrier testing in some climate zones supports the further development of testing infrastructure, as the standard is adopted by states. Expanding the climate zones in which air barrier testing is required in IECC 2024, will build on the momentum of what is already required by the 2021 version, and there should be plenty of testing capacity developed to leverage.

FTI strongly recommends removing all exceptions to air leakage testing as soon as possible, since the building envelopes constructed in the near term will be with us for the next fifty years, contributing to carbon emissions. However, an intermediate step could be to require testing for climate zones 3 and higher in the 2024 version, moving to no exceptions in 2027.

Cost Impact: The code change proposal will increase the cost of construction.
As mentioned in the reason statement, Washington State has been successful at introducing air leakage testing and an ecosystem of suppliers has

been developed and is considered cost-effective in climate zone 4 Maritime. IECC 2021 also requires air leakage testing in some climate zones already and so has been considered cost-effective. Adoption of this 2021 revision should also support further development of testing infrastructure. It should not cost more to install an air barrier well, and to meet the already established standard than to install it poorly – no change in materials or process are needed. The only additional cost is the testing.

Whole building air leakage testing can run the gamut from $10k to $60k+ depending on the size and complexity of the building. The larger the building the more fans are required. The more separate zones within a building, the more individual tests are required. The more compartmentalized the interior the more extensive the required prep-work. As a result, large multi-residential projects tend to be the more expensive buildings to test. That said, even in this range of $10K to $60K, the cost of the test is a very small portion of a typical building project budget, so the fractional incremental cost is low. Blower door testing of single family residential is typically less than $1,000 (typically less than 1% of the cost of construction).

Bibliography: Steven J Emmerich et al., Investigation of the Impact of Commercial Building Envelope Airtightness on HVAC Energy Use, NIST, 2005 https://www.govinfo.gov/content/pkg/GOVPUB-C13-db70d72cbf88472707ae51276ee7e599/pdf/GOVPUB-C13-db70d72cbf88472707ae51276ee7e599.pdf
S. Emmerich and A. Persily, The air tightness of commercial buildings in the U.S. https://www.nist.gov/publications/airtightness-commercial-buildings-united-states

Washington State Energy Code 2018, https://sbcc.wa.gov/sites/default/files/2020-04/2018%20WSEC_C%202nd%20print.pdf

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Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: To provide for more consistency with prior actions regarding inspection versus testing options in acknowledgement of the costs of testing on smaller buildings

CEPI-65-21

Proponents: Lisa Rosenow, representing Self (lrosenow@evergreen-tech.net); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Delete without substitution:

~~**C402.5.11 Operable openings interlocking.** Where occupancies utilize operable openings to the outdoors that are larger than 40 square feet (3.7 m^2) in area, such openings shall be interlocked with the heating and cooling system so as to raise the cooling setpoint to 90°F (32°C) and lower the heating setpoint to 55°F (13°C) whenever the operable opening is open. The change in heating and cooling setpoints shall occur within 10 minutes of opening the operable opening.~~

~~**Exceptions:**~~

1. ~~Separately zoned areas associated with the preparation of food that contain appliances that contribute to the HVAC loads of a restaurant or similar type of occupancy.~~
2. ~~Warehouses that utilize overhead doors for the function of the occupancy, where approved by the code official.~~
3. ~~The first entrance doors where located in the exterior wall and are part of a vestibule system.~~

~~**C402.5.11.1 Operable controls.** Controls shall comply with Section C403.14.~~

~~**C403.14 Operable opening interlocking controls.** The heating and cooling systems shall have controls that will interlock these mechanical systems to the set temperatures of 90ºF (32ºC) for cooling and 55ºF (12.7ºC) for heating when the conditions of Section C402.5.8 exist. The controls shall configure to shut off the systems entirely when the outdoor temperatures are below 90ºF (32ºC) or above 55ºF (12.7ºC).~~

Add new text as follows:

C403.4.6 HVAC system controls for operable openings to the outdoors. All doors from a *conditioned space* to the outdoors and all other operable openings from a *conditioned space* to the outdoors that are larger than 40 square feet (3.7 m^2) when fully open, shall have *automatic* controls interlocked with the heating and cooling system. The controls shall be configured to do the following within 5 minutes of opening:

1. Disable mechanical heating to the *zone* or reset the space heating temperature setpoint to 55°F (12.7°C) or less.
2. Disable mechanical cooling to the *zone* or reset the space cooling temperature setpoint to 90°F (32°C) or more. Mechanical cooling can remain enabled if the outdoor air temperature is below the space temperature.

Exceptions:

1. *Building entrances* with *automatic* closing devices.
2. Emergency exits with an *automatic* alarm that sounds when open.
3. Operable openings and doors serving *enclosed spaces* without a *thermostat* or HVAC temperature sensor.
4. Separately zoned areas associated with the preparation of food that contain appliances that contribute to the HVAC loads of a restaurant or similar type of occupancy.
5. Warehouses that utilize operable openings for the function of the occupancy where *approved* by the *code official.*
6. The first entrance doors where located in the exterior wall and are part of a vestibule system.
7. Operable openings into spaces served by radiant heating and cooling systems.
8. *Alterations* where walls would have to be opened solely for the purpose of meeting this requirement and where *approved.*
9. Doors served by *air curtains* meeting the requirements of Section C402.5.9.

Revise as follows:

TABLE C407.2 REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE

SECTION [a]	TITLE
Envelope	
C402.5	Air leakage—thermal envelope
Mechanical	
C403.1.1	Calculation of heating and cooling loads
C403.1.2	Data centers
C403.2	System design
C403.3	Heating and cooling equipment efficiencies
C403.4.1~~, except C403.4.3, C403.4.4 and C403.4.5~~	~~Heating and cooling system~~ Thermostatic controls
C403.4.2	Off-hour controls
C403.4.6	HVAC system controls for operable openings to the outdoors
C403.5.5	Economizer fault detection and diagnostics
C403.7, except C403.7.4.1	Ventilation and exhaust systems
C403.8, except C403.8.6	Fan and fan controls
C403.9	Large-diameter ceiling fans
C403.11, except C403.11.3	Refrigeration equipment performance
C403.12	Construction of HVAC system elements
C403.13	Mechanical systems located outside of the building thermal envelope
C404	Service water heating
C405, except C405.3	Electrical power and lighting systems
C408	Maintenance information and system commissioning

a. Reference to a code section includes all the relative subsections except as indicated in the table.

Reason: Remove duplication, improve description of code intent and relocate mechanical controls provision to the appropriate location within the code.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The intent of this proposal is to improve code language clarity only.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: proposal supports increased energy efficiency around the building envelope though operable openings.

CEPI-68-21

Proponents: Aaron Gary, representing Seft (aaron.gary@texenergy.org)

2021 International Energy Conservation Code

Revise as follows:

C402.5.2 Dwelling and sleeping unit enclosure testing. The *building thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E1827 or an equivalent method approved by the *code official*. The measured air leakage shall not exceed 0.30 cfm/ft^2 (1.5 L/s m^2) of the testing unit enclosure area at a pressure differential of 0.2 inch water gauge (50 Pa). Where multiple dwelling units or sleeping units or other occupiable conditioned spaces are contained within one *building thermal envelope*, each unit shall be considered an individual testing unit, and the building air leakage shall be the weighted average of all testing unit results, weighted by each testing unit's enclosure area. Units shall be tested separately with an unguarded blower door test as follows:

1. Where buildings have fewer than eight testing units, each testing unit shall be tested.
2. For buildings with eight or more testing units, the greater of seven units or 20 percent of the testing units in the building shall be tested, including a top floor unit, <u>a middle floor unit,</u> a ground floor unit and a unit with the largest testing unit enclosure area. For each tested unit that exceeds the maximum air leakage rate, an additional ~~two~~ <u>three</u> units shall be tested, including a mixture of testing unit types and locations.

Reason: This amendment brings this section into closer alignment with the updated RESNET sampling guidelines for the testing of multifamily buildings.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This change will only result in a change to the cost of verification if testing failures occur.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: Brings the selection of dwelling units for air leakage testing more in alignment with industry standards for sampling in multifamily buildings.

Proposal # 520

CEPI-69-21

Proponents: Theresa A Weston, The Holt Weston Consultancy, representing The Air Barrier Association of America (ABAA) (holtweston88@gmail.com)

2021 International Energy Conservation Code

Revise as follows:

C402.5.2 Dwelling and sleeping unit enclosure testing. The *building thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E1827 or an equivalent method approved by the *code official*. The measured air leakage shall not exceed 0.30 cfm/ft^2 (1.5 L/s m^2) of the testing unit enclosure area at a pressure differential of 0.2 inch water gauge (50 Pa). Testing shall be conducted by an *approved* third party. Where multiple dwelling units or sleeping units or other occupiable conditioned spaces are contained within one *building thermal envelope*, each unit shall be considered an individual testing unit, and the building air leakage shall be the weighted average of all testing unit results, weighted by each testing unit's enclosure area. Units shall be tested separately with an unguarded blower door test as follows:

1. Where buildings have fewer than eight testing units, each testing unit shall be tested.
2. For buildings with eight or more testing units, the greater of seven units or 20 percent of the testing units in the building shall be tested, including a top floor unit, a ground floor unit and a unit with the largest testing unit enclosure area. For each tested unit that exceeds the maximum air leakage rate, an additional two units shall be tested, including a mixture of testing unit types and locations.

C402.5.3 Building thermal envelope testing. The *building thermal envelope* shall be tested by an *approved* third party in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E3158 or ASTM E1827 or an equivalent method approved by the code official. The measured air leakage shall not exceed 0.40 cfm/ft^2 (2.0 L/s × m^2) of the *building thermal envelope* area at a pressure differential of 0.3 inch water gauge (75 Pa). Alternatively, portions of the building shall be tested and the measured air leakages shall be area weighted by the surface areas of the building envelope in each portion. The weighted average test results shall not exceed the whole building leakage limit. In the alternative approach, the following portions of the building shall be tested:

1. The entire envelope area of all stories that have any spaces directly under a roof.
2. The entire envelope area of all stories that have a building entrance, exposed floor, or loading dock, or are below grade.
3. Representative above-grade sections of the building totaling at least 25 percent of the wall area enclosing the remaining conditioned space.

Exception: Where the measured air leakage rate exceeds 0.40 cfm/ft^2 (2.0 L/s × m^2) but does not exceed 0.60 cfm/ft^2 (3.0 L/s × m^2), an *approved* third party shall perform a diagnostic evaluation using smoke tracer or infrared imaging shall be conducted while the building is pressurized along with a visual inspection of the air barrier in accordance with ASTM E1186. Any leaks noted shall be sealed where such sealing can be made without destruction of existing building components. An additional report identifying the corrective actions taken to seal leaks shall be submitted to the code official and the building owner, and shall be deemed to comply with the requirements of this section.

Add new standard(s) as follows:

ASTM

ASTM International
100 Barr Harbor Drive, P.O. Box C700
West Conshohocken, PA 19428-2959

E1186 - 17	Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems

Reason: This proposal seeks to ensure that whole building air leakage and diagnostic test is conducted by an independent & qualified entity that is acceptable to the code official. Additionally, the proposal adds a new reference standard which provides consensus procedures for conducting the diagnostic testing specified in the code. The new reference, ASTM E1186, has the following scope:

"1. Scope

1.1 These practices cover standardized techniques for locating air leakage sites in building envelopes and air barrier systems.

1.2 These practices offer a choice of means for determining the location of air leakage sites with each offering certain advantages for specific applications.

1.3 Some of the practices require a knowledge of infrared scanning, building and test chamber pressurization and depressurization, smoke and fog generation techniques, sound generation and detection, and tracer gas concentration measurement techniques.

1.4 The practices described are of a qualitative nature in determining the air leakage sites rather than determining quantitative leakage rates.

1.5 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this* *standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use. For specific hazard statements, see Section 6.*

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee."*

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal does not change the technical requirements for building thermal envelope. But rather it seeks to ensure that the current code requirements are verified by qualified practitioners and in accordance with industry standard methods.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: clarify that an approved third party shall provide air leakage testing and that they can also provide diagnostic evaluation when required

Proposal # 150

CEPI-71-21

Proponents: Theresa A Weston, The Holt Weston Consultancy, representing The Air Barrier Association of America (ABAA) (holtweston88@gmail.com)

2021 International Energy Conservation Code

Revise as follows:

C402.5.2 Dwelling and sleeping unit enclosure testing. The *building thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E1827 or an equivalent method approved by the *code official*. The measured air leakage shall not exceed ~~0.30~~ 0.27 cfm/ft^2 (~~1.5~~ 1.4 L/s m^2) of the testing unit enclosure area at a pressure differential of 0.2 inch water gauge (50 Pa). Where multiple dwelling units or sleeping units or other occupiable conditioned spaces are contained within one *building thermal envelope*, each unit shall be considered an individual testing unit, and the building air leakage shall be the weighted average of all testing unit results, weighted by each testing unit's enclosure area. Units shall be tested separately with an unguarded blower door test as follows:

1. Where buildings have fewer than eight testing units, each testing unit shall be tested.
2. For buildings with eight or more testing units, the greater of seven units or 20 percent of the testing units in the building shall be tested, including a top floor unit, a ground floor unit and a unit with the largest testing unit enclosure area. For each tested unit that exceeds the maximum air leakage rate, an additional two units shall be tested, including a mixture of testing unit types and locations.

C402.5.3 Building thermal envelope testing. The *building thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E3158 or ASTM E1827 or an equivalent method approved by the code official. The measured air leakage shall not exceed ~~0.40~~ 0.35 cfm/ft^2 (~~2.0~~ 1.8 L/s × m^2) of the *building thermal envelope* area at a pressure differential of 0.3 inch water gauge (75 Pa). Alternatively, portions of the building shall be tested and the measured air leakages shall be area weighted by the surface areas of the building envelope in each portion. The weighted average test results shall not exceed the whole building leakage limit. In the alternative approach, the following portions of the building shall be tested:

1. The entire envelope area of all stories that have any spaces directly under a roof.
2. The entire envelope area of all stories that have a building entrance, exposed floor, or loading dock, or are below grade.
3. Representative above-grade sections of the building totaling at least 25 percent of the wall area enclosing the remaining conditioned space.

Exception: Where the measured air leakage rate exceeds ~~0.40~~ 0.35 cfm/ft^2 (~~2.0~~ 1.8 L/s × m^2) but does not exceed ~~0.60~~ 0.45 cfm/ft^2 (~~3.0~~ 2.3 L/s × m^2), a diagnostic evaluation using smoke tracer or infrared imaging shall be conducted while the building is pressurized along with a visual inspection of the air barrier. Any leaks noted shall be sealed where such sealing can be made without destruction of existing building components. An additional report identifying the corrective actions taken to seal leaks shall be submitted to the code official and the building owner, and shall be deemed to comply with the requirements of this section.

C406.9 Reduced air infiltration. Air infiltration shall be verified by whole-building pressurization testing conducted in accordance with ASTM E779 or ASTM E1827 by an independent third party. The measured air-leakage rate of the building envelope shall not exceed ~~0.25~~ 0.22 cfm/ft^2 (~~2.0~~ 1.1 L/s × m^2) under a pressure differential of 0.3 inches water column (75 Pa), with the calculated surface area being the sum of the above- and below-grade building envelope. A report that includes the tested surface area, floor area, air by volume, stories above grade, and leakage rates shall be submitted to the code official and the building owner.

Exception: For buildings having over 250,000 square feet (25 000 m^2) of *conditioned floor area*, air leakage testing need not be conducted on the whole building where testing is conducted on representative above-grade sections of the building. Tested areas shall total not less than 25 percent of the conditioned floor area and shall be tested in accordance with this section.

Reason: Reducing the measured air leakage from 0.40 to 0.30 cfm/ft^2 at a pressure differential of 0.3 inch water gauge (75 Pa) recognizes the advances the industry has made in air leakage control technology and methods since whole building air leakage tested was introduced in the IECC-C in 2012 (about a decade ago). The advancement of air leakage control technology (including both materials and installation practices) during the last decade has led to increased building performance. Experiences with the air leakage testing and building performance have been recorded industry literature, some of which are listed in the bibliography.[1,2,3]
This change in the maximum air leakage requirement is consistent with industry practices and specifications which have been instituted in the industry, including:

- Seattle Energy Code 2015: .30 cfm/ft^2
- US Army Corps of Engineers (2012): .25 cfm/ft^2 (Demonstrated achievable [5])
- IgCC/ASHRAE 189.1: .25 cfm/ft^2
- Seattle Energy Code 2018: .25 cfm/ft^2
- PHIUS+ 2015: .08 cfm/ft^2 (included in incentive and tax credit programs in multiple states)

It has long been understood, deficient airtightness has negative consequences, the most important of which are:

- increased energy use
- reduced thermal comfort
- reduced air quality
- moisture damages.[6,7]

Only one of these consequences, energy use, is considered directly in the development of the IECC, but all are experienced by the building occupants.

Cost Impact: The code change proposal will increase the cost of construction.
The level of air leakage control is the same as that balloted under ASHRAE 90.1 Addendum t First Public Review Draft (March 2021). In that draft it is stated "improved performance related to airtightness requirements was reviewed and found to be cost effective". The 90.1 process uses an approximately 40 year life to perform a life cycle cost assessment.

Bibliography:

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2. D. Jonlin, "Rookie Mistakes: Lessons from a Decade of Mandatory Air Barrier Testing," in Whole Building Air Leakage: Testing and Building Performance Impacts, ed. T. Weston, K. Nelson, and K. Wissink (West Conshohocken, PA: ASTM International, 2019), 20-37. https://doi.org/10.1520/STP161520180025
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4. Diana Hun, Mahabir Bhandari, Melissa Lapsa, Som Shrestha, and Simon PallinAirtightness of Commercial Building Envelopes: Where are we and where could we go? , Oak Ridge National Laboratory Caroline Hazard, CSRA https://www.osti.gov/servlets/purl/1559734
5. J.L. Durston ab\nd M. Heron, "Summary and Analysis of Large Building Air Leakage Testing for the U. S. Departmeny of Defense", https://web.archive.org/web/20190829185002/https://cdn.ymaws.com/www.nibs.org/resource/resmgr/BEST/best3_durston.2.9.pdf
6. Per Invar Sandberg, PhD, Claes Bankvall, PhD, Eva Sikander, Paula Wahlgren, PhD and Bengt Larsson, PhD. "The Effects and Cost Impact of Poor Airtightness -- Information for Developers and Clients", Buildings X Conference, ASHRAE, 2007.
7. J. S. Der Ananian, T. S. Fu, and B. A. Gabby, "Detrimental Effects of Air Leakage on Building Enclosure Performance: Energy Consumption, Occupant Comfort, and Moisture Accumulation," in Whole Building Air Leakage: Testing and Building Performance Impacts, ed. T. Weston, K. Nelson, and K. Wissink (West Conshohocken, PA: ASTM International, 2019), 38-60. https://doi.org/10.1520/STP161520180024

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Increases stringency, reflects supported 0.35 value per subcommittee straw poll, and is consistent with ASHRAE value

Proposal # 73

CEPI-72-21

Proponents: Amanda Hickman, representing Air Movement and Control Association (AMCA) (amanda@thehickmangroup.com); Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Revise as follows:

AIR CURTAIN UNIT. A device, installed at the *building entrance* , that generates and discharges a laminar air stream intended to prevent the infiltration of external, unconditioned air into the conditioned spaces, or the loss of interior, conditioned air to the outside.

C402.5.9 Vestibules. Building entrances shall be protected with an enclosed vestibule, with all doors opening into and out of the vestibule equipped with self-closing devices. Vestibules shall be designed so that in passing through the vestibule it is not necessary for the interior and exterior doors to open at the same time. The installation of one or more revolving doors in the *building entrance* shall not eliminate the requirement that a vestibule be provided on any doors adjacent to revolving doors.

Exceptions: Vestibules are not required for the following:

1. Buildings in *Climate Zones* 0 through 2.
2. Doors not intended to be used by the public, such as doors to mechanical or electrical equipment rooms, or intended solely for employee use.
3. Doors opening directly from a *sleeping unit* or dwelling unit.
4. Doors that open directly from a space less than 3,000 square feet (298 m^2) in area.
5. Revolving doors.
6. Doors used primarily to facilitate vehicular movement or material handling and adjacent personnel doors.
7. Doors that have an air curtain unit with a velocity of not less than 6.56 feet per second (2 m/s) at 6.0 inches (15 cm) above the floor that ~~have~~ has been tested in accordance with ANSI/AMCA 220 or ISO 27327-1 and installed in accordance with the manufacturer's instructions. Manual or automatic controls shall be provided that will operate the air curtain unit with the opening and closing of the door and comply with Section C403.4.1.4. Air curtain~~s~~ units and their controls shall comply with Section C408.2.3.

C403.4.1.4 Heated or cooled vestibules or air curtain units with integral heating. The heating systems for heated vestibules and air curtain~~s~~ units with integral heating shall be provided with controls configured to shut off the source of heating when the outdoor air temperature is greater than 45°F (7°C). Vestibule heating and cooling systems shall be controlled by a thermostat located in the vestibule configured to limit heating to a temperature not greater than 60°F (16°C) and cooling to a temperature not less than 85°F (29°C).

Exception: Control of heating or cooling provided by site-recovered energy or transfer air that would otherwise be exhausted.

AMCA

Air Movement and Control Association International
30 West University Drive
Arlington Heights, IL 60004-1806

220—~~05~~ 21 Laboratory Methods of Testing Air Curtain Units for Aerodynamic Performance Rating

Add new standard(s) as follows:

ISO

International Organization for Standardization
Chemin de Blandonnet 8, CP 401, 1214 Vernier
Geneva, Switzerland

ISO 27327-1(2009) Air Curtain Units – Laboratory Methods of Testing for Aerodynamic Performance Rating

Reason:
The primary reason for this proposal is to make clarifications regarding air curtain unit requirements, consistent with provisions for air curtain units in a parallel proposal for ASHRAE 90.1-2022 that has undergone public review without comments (ASHRAE 90.1-2019 addendum ao).

There are a few places in this proposal that add the word "unit" where appropriate to "air curtain" (including the definition), which help to clarify the difference between the air curtain (the stream of air) and the air curtain unit (the product creating the air curtain).

Under Exception 7 to Section C402.5.9, there are a few clarifications related to the use of air curtain units. Adding ISO 27327-1 as an optional test standard adds flexibility as to which standard the product can be tested to. The pointer for compliance of controls with Section C403.4.1.4 is intended to help instruct the code user with the requirements for air curtain units that have integral heating. The change to the title of Section

C403.4.1.4 is intended to have the same effect.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal adds clarity to the sections on air curtain units, consistent with the parallel ASHRAE 90.1-2022 proposal mentioned in the reason statement. This proposal does not add any new requirements. Therefore, it will not increase the cost of construction.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: The primary reason for this proposal is to make clarifications regarding air curtain unit requirements, consistent with provisions for air curtain units in a parallel proposal for ASHRAE 90.1-2022 that has undergone public review without comments (ASHRAE 90.1-2019 addendum ao).
There are a few places in this proposal that add the word "unit" where appropriate to "air curtain" (including the definition), which help to clarify the difference between the air curtain (the stream of air) and the air curtain unit (the product creating the air curtain).
Under Exception 7 to Section C402.5.9, there are a few clarifications related to the use of air curtain units. Adding ISO 27327-1 as an optional test standard adds flexibility as to which standard the product can be tested to. The pointer for compliance of controls with Section C403.4.1.4 is intended to help instruct the code user with the requirements for air curtain units that have integral heating. The change to the title of Section C403.4.1.4 is intended to have the same effect.

Proposal # 196

CEPI-75-21

Proponents: Nicholas O'Neil, representing NEEA (noneil@energy350.com); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Revise as follows:

C403.1.2 Data centers. *Data center systems* shall comply with Sections 6 and 8 of ASHRAE 90.4. ~~with the following changes:~~

1. ~~Replace design mechanical load component (MLC) values specified in Table 6.2.1.1 of the ASHRAE 90.4 with the values in Table C403.1.2(1) as applicable in each climate zone.~~
2. ~~Replace annualized MLC values specified in Table 6.2.1.2 of the ASHRAE 90.4 with the values in Table C403.1.2(2) as applicable in each climate zone.~~

Delete without substitution:

~~TABLE C403.1.2(1) MAXIMUM DESIGN MECHANICAL LOAD COMPONENT (DESIGN MLC)~~

~~CLIMATE ZONE~~	~~DESIGN MLC AT 100% AND AT 50% ITE LOAD~~
~~0A~~	~~0.24~~
~~OB~~	~~0.26~~
~~1A~~	~~0.23~~
~~2A~~	~~0.24~~
~~3A~~	~~0.23~~
~~4A~~	~~0.23~~
~~5A~~	~~0.22~~
~~6A~~	~~0.22~~
~~1B~~	~~0.28~~
~~2B~~	~~0.27~~
~~3B~~	~~0.26~~
~~4B~~	~~0.23~~
~~5B~~	~~0.23~~
~~6B~~	~~0.21~~
~~3C~~	~~0.19~~
~~4C~~	~~0.21~~
~~5C~~	~~0.19~~
~~7~~	~~0.20~~
~~8~~	~~0.19~~

~~TABLE C403.1.2(2) MAXIMUM ANNUALIZED MECHANICAL LOAD COMPONENT (ANNUALIZED MLC)~~

~~CLIMATE ZONE~~	~~HVAC MAXIMUM ANNUALIZED MLC AT 100% AND AT 50% ITE LOAD~~
~~0A~~	~~0.19~~
~~0B~~	~~0.20~~
~~1A~~	~~0.18~~
~~2A~~	~~0.19~~
~~3A~~	~~0.18~~
~~4A~~	~~0.17~~
~~5A~~	~~0.17~~
~~6A~~	~~0.17~~
~~1B~~	~~0.16~~
~~2B~~	~~0.18~~
~~3B~~	~~0.18~~
~~4B~~	~~0.18~~
~~5B~~	~~0.16~~
~~6B~~	~~0.17~~
~~3C~~	~~0.16~~
~~4C~~	~~0.16~~
~~5C~~	~~0.16~~
~~7~~	~~0.16~~
~~8~~	~~0.16~~

Revise as follows:

ASHRAE

ASHRAE
180 Technology Parkway NW
Peachtree Corners, GA 30092

90.4~~—2016~~ 2019 Energy Standard for Data Centers - (with Addenda a, b, d, e, f)

Reason: Including references to ASHRAE 90.4-2016 and more stringent MLC values in the 2021 IECC ensured that data center systems were held to equivalent efficiency standards as other building mechanical systems. While the MLC values in ASHRAE 90.4-2016 were egregiously lenient and required individual climate zone modifications, the more recent version of 90.4-2019 corrects this issue and therefore the MLC table modifications in the IECC are no longer required.
Additionally, 90.4-2019 removed the requirement to meet a design MLC value and instead splits annualized MLC values by data centers above and below 300kW. This distinction requires more stringent MLC thresholds for larger data centers and provides more lenient MLC thresholds for smaller data centers. This aligns more closely with the built environment, where smaller data centers are limited in their ability to increase efficiency compared to larger data centers, whereas larger data centers have a variety of methods to meet MLC thresholds.

The changes to the reference section also include adopted ASHRAE Addenda that provide necessary clarifications on how to calculate the MLC value with shared data center systems and how to incorporate heat recovery into the calculations. The transition from 90.4-2016 to 90.4-2019 has made the standard more robust and is important to capture in the IECC updates.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The levels specified in ASHRAE 90.1-2019 for >300kW data centers are similar to the adjusted levels published in the IECC using 90.4-2016, especially in climate zones where data centers are commonly located. For less dense data centers (<300kW) ASHRAE determined the updated MLC levels based on achievable technology from real-world projects and the MLC thresholds are more lenient in this size to better track with market practices and available efficiency improvements. Therefore costs to meet 90.4-2019 MLC levels for both data center size classes are not expected to increase on average.

Bibliography: ANSI/ASHRAE Standard 90.4-2019 - Energy Standard for Data Centers

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Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: Supports greater efficiency in data centers by following the latest updates in a national standard (90.4).

Proposal # 64

CEPI-76-21

Proponents: Jeremy Williams, representing U.S. Department of Energy (jeremy.williams@ee.doe.gov)

2021 International Energy Conservation Code

Add new definition as follows:

BLOCK. A generic concept used in energy simulation. It can include one or more thermal zones. It represents a whole building or portion of a building with the same use type served by the same HVAC system type.

HVAC TOTAL SYSTEM PERFORMANCE RATIO (HVAC TSPR). The ratio of the sum of a building's annual heating and cooling load in thousands of Btus to the sum of annual site energy consumption of the building HVAC systems in BTU.

STANDARD REFERENCE DESIGN. A version of the proposed design that meets the minimum requirements of this code and is used to determine the maximum annual energy use requirement for compliance based on total building performance and *HVAC total system performance ratio*.

PROPOSED DESIGN. A description of the proposed building used to estimate annual energy use for determining compliance based on total building performance and *HVAC total system performance ratio*.

Revise as follows:

C403.1 General. Mechanical systems and equipment serving the building heating, cooling, ventilating or refrigerating needs shall comply with ~~this section~~ one of the following:

1. Sections C403.1.1 and C403.2 through C403.14
2. Data Centers shall comply with C403.1.1, C403.1.2 and C403.6 through C403.14
3. Section C403.1.3 and sections within Section C403 that are listed in Table C407.2

~~**Exception:** Data center systems are exempt from the requirements of Sections C403.4 and C403.5.~~

Add new text as follows:

C403.1.3 HVAC total system performance ratio (*HVAC TSPR*).. HVAC systems serving buildings or portions of buildings listed in C403.1.3.1 that are not served by systems listed in C403.1.3.2 shall have an *HVAC total system performance ratio* (*HVAC TSPR*) of the *proposed design* HVAC systems that is greater than or equal to the *HVAC TSPR* of the *standard reference design* divided by the applicable mechanical performance factor (MPF) from Table C409.3.1. *HVAC TSPR* shall be calculated in accordance with Section C409, Calculation of HVAC Total System Performance Ratio. Systems using the HVAC TSPR method shall also meet requirements in C403.1.3.3.

C403.1.3.1 Included Building Types. Only HVAC systems that serve the following building use types are allowed to use the TSPR Method:

1. Office (including medical office) (occupancy group B)
2. Retail (occupancy group M),
3. Library (occupancy group A-3),
4. Education (occupancy group E),
5. Hotel/motel occupancies (occupancy group R-1),
6. the *dwelling units* and common areas within occupancy group R-2 multifamily buildings.

C403.1.3.2 Excluded Systems. The following *HVAC systems* are excluded from using the TSPR Method:

1. HVAC Systems using
   - 1.1 District heating water, chilled water or steam
   - 1.2. Small duct high velocity air cooled, space constrained air cooled, single package vertical air conditioner, single package vertical heat pump, or double-duct air conditioner or double-duct heat pump as defined in subpart F to 10CFR part 431
   - 1.3 Packaged terminal air conditioners and packaged terminal heat pumps that have cooling capacity greater than 12,000 Btu/hr 5.(3500 kW)
   - 1.4. A common heating source serving both HVAC and service water heating equipment, or
2. HVAC systems that provide recovered heat for service water heating

3. HVAC systems not included in Table C409.5.2.10.1
4. HVAC systems included in table C409.5.2.10.1 with parameters in Table C409.5.2.10.2, not identified as applicable to that HVAC system type.
5. HVAC systems with chilled water supplied by absorption chillers, heat recovery chillers, water to water heat pumps, air to water heat pumps, or a combination of air- and water-cooled chillers on the same chilled water loop.
6. HVAC systems served by heating water plants that include air to water or water to water heat pumps.
7. Underfloor air distribution and displacement ventilation HVAC systems.
8. Space conditioning systems that do not include mechanical cooling.
9. HVAC systems serving laundry rooms, elevator rooms, mechanical rooms, electrical rooms, data centers, and computer rooms.
10. Buildings or areas of medical office buildings that comply fully with ASHRAE Standard 170, including but not limited to surgical centers, or that are required by other applicable codes or standards to provide 24/7 air handling unit operation
11. HVAC systems serving laboratories with fume hoods
12. Locker rooms with more than 2 showers
13. Natatoriums and rooms with saunas
14. Restaurants and commercial kitchens with total cooking capacity greater than 100,000 Btu/h
15. Areas of buildings with commercial refrigeration equipment exceeding 100 kW of power input.
16. Cafeterias and dining rooms

C403.1.3.3 TSPR Method Partial Prescriptive Requirements. HVAC systems using the HVAC Performance Rating Method shall meet relevant prescriptive requirements in Section C403 as follows:

1. Air economizers shall meet the requirements of Section C403.5.3.4 “relief of excess outdoor air” and Section C403.5.5 “Economizer fault detection and diagnostics.”
2. Variable-air-volume system systems shall meet requirements of Sections C403.6.5, C403.6.6, and C403.6.9.
3. Hydronic systems shall meet the requirements of C403.4.4.
4. Plants with multiple chillers or boilers shall meet the requirements of Section C403.4.5.
5. Hydronic (Water Loop) Heat Pumps and Water-Cooled Unitary Air Conditioners shall meet the requirements of Section C403.4.3.3.
6. Cooling tower turndown shall meet requirements of Section C403.10.4.
7. Heating of unenclosed spaces shall meet the requirements of Section C403.13.1.
8. Hot-gas bypass shall meet the requirements of Section C403.3.3.
9. Systems shall meet the operable openings interlock requirements of Section C402.5.11.10. Refrigeration systems shall meet the requirements of Section C403.11.

C406.13 HVAC Performance (TSPR). For systems allowed to use Section C403.1.3, the *HVAC TSPR* shall exceed the minimum requirement by 5 percent. If improvement is greater, credits in Tables C406.1(1) through C406.1(5) are permitted to be prorated up to a 20 percent improvement using Equation 4-16. Energy credits for C406.13 may not be combined with energy credits from any of the HVAC measures described in Section C406.2.

HVAC TSPR energy credit = base energy credit from Table 406.1 x (TSPR % / 5%) **(Equation 4-14)**
where:
TSPR% = Percentage by which TSPR of proposed design exceeds minimum TSPR requirement. The value of TSPR% cannot exceed 20% for purposes of calculating H01 energy credits.

Revise as follows:

TABLE C406.1(1) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP B OCCUPANCIES

Portions of table not shown remain unchanged.

SECTION	CLIMATE ZONE																
	0A & 1A	**0B & 1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
C406.13: *HVAC TSPR*	8	8	7	7	6	6	4	6	6	4	6	6	4	6	6	6	6

TABLE C406.1(2) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP R AND I OCCUPANCIES

Portions of table not shown remain unchanged.

SECTION	CLIMATE ZONE															
	0A & 1A	0B & 1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.13: *HVAC TSPR*	8	8	8	7	6	6	5	6	6	4	6	5	4	6	6	6	7

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TABLE C406.1(3) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP E OCCUPANCIES

Portions of table not shown remain unchanged.

SECTION	**CLIMATE ZONE**																
	0A & 1A	**0B & 1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
C406.13: *HVAC TSPR*	11	11	10	9	8	8	6	8	7	6	7	7	6	8	7	8	8

NA = Not Applicable.

a. For schools with showers or full-service kitchens.

TABLE C406.1(4) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP M OCCUPANCIES

Portions of table not shown remain unchanged.

SECTION	CLIMATE ZONE																
	0A & 1A	**0B & 1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
C406.13 *HVAC TSPR*	11	11	10	9	8	8	6	8	8	7	8	8	6	9	8	9	10

NA = Not Applicable.

TABLE C406.1(5) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR OTHER[a] OCCUPANCIES

Portions of table not shown remain unchanged.

SECTION	CLIMATE ZONE															
	0A & 1A	**0B & 1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
C406.13: HVAC TSPR	7	8	7	6	6	5	3	6	5	4	7	6	4	8	7	8	8

Add new text as follows:

SECTION C409
CALCULATION OF HVAC TOTAL SYSTEM PERFORMANCE RATIO

C409.1 Purpose. Section 409 establishes criteria for demonstrating compliance with the requirements of C403.1.1, *HVAC total system performance ratio (HVAC TSPR)*

C409.2 Scope. Section C409 applies to new HVAC systems that serve buildings in Section C403.1.3.1 and are not excluded from using *HVAC TSPR* by Section C403.1.3. All applicable HVAC systems shall comply with Section C409.

C409.3 Core & Shell / Initial Build-Out, and Future System Construction Analysis. Where the building permit applies to only a portion of the HVAC system in a building and the remaining components will be designed under a future building permit or were previously installed, the future or previously installed components shall be modeled as follows:

1. Where the HVAC zones that do not include HVAC systems in the current permit will be or are served by independent systems, then the block including those zones shall not be included in the model.
2. Where the HVAC zones that do not include complete HVAC systems in the permit are intended to receive HVAC services from systems in the permit, their proposed zonal systems shall be modeled with equipment that meets, but does not exceed, the requirements of C403.
3. Where the zone equipment in the permit receives HVAC services from previously installed systems that are not in the permit, the previously installed systems shall be modeled with equipment matching the certified value of what is installed or equipment that meets the requirements of C403.
4. Where the central plant heating and cooling equipment is completely replaced and HVAC zones with existing systems receive HVAC services from systems in the permit, their proposed zonal systems shall be modeled with equipment that meets, but does not exceed, the requirements of Section C403.

C409.4 HVAC TSPR Compliance. Systems allowed to use *HVAC TSPR* in accordance with C403.1.3 shall comply with all of the following:

1. Systems shall meet the applicable provisions of Section C403.1.3.3 and Sections within Section C403 that are listed in Table C407.2
2. The *HVAC TSPR* of the *proposed design* shall be greater than or equal to the *HVAC TSPR* of the *standard reference design* divided by the mechanical performance factor (MPF)using Equation 4-16.

$TSPRp > TSPRr / MPF$ **(Equation 4-16)**

where:

TSPRp = *HVAC TSPR* of the *proposed design* calculated in accordance with Sections C409.4, C409.5 and C409.6.

TSPRr = *HVAC TSPR* of the *reference building design* calculated in accordance with Sections C409.4, C409.5 and C409.6.

MPF = Mechanical Performance Factor from Table C409.4 based on climate zone and building use type

Where a *building* has multiple *building* use types, MPF shall be area weighted using Equation 4-17

$MPF = (A_1 * MPF_1 + A_2 * MPF_2 + ... + A_n * MPF_n)/(A_1 + A_2 + ... + A_n)$ **(Equation 4-17)**

where:

MPF_1, MPF_2 through MPF_n = Mechanical Performance Factors from Table C409.4 based on climate zone and *building* use types 1,2, through n

A_1, A_2 through A_n = Conditioned *floor* areas for *building* use types 1, 2, through n

Table C409.4 Mechanical Performance Factors

Climate Zone: *Building* type	Ocp. Group	0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
Office (small and medium)[a]	B	0.72	0.715	0.7	0.705	0.685	0.65	0.71	0.68	0.645	0.805	0.70	0.78	0.845	0.765	0.805	0.865	0.835	0.875	0.895
Office (Large)[a]	B	0.83	0.83	0.84	0.84	0.79	0.82	0.72	0.81	0.77	0.67	0.76	0.63	0.71	0.72	0.63	0.73	0.71	0.71	0.71
Retail	M	0.6	0.57	0.5	0.55	0.46	0.46	0.43	0.51	0.4	0.45	0.57	0.68	0.46	0.68	0.67	0.5	0.45	0.44	0.38
Hotel/Motel	R-1	0.62	0.62	0.63	0.63	0.62	0.68	0.61	0.71	0.73	0.45	0.59	0.52	0.38	0.47	0.51	0.35	0.38	0.31	0.26
Multi-Family/ Dormitory	R-2	0.64	0.63	0.67	0.63	0.65	0.64	0.59	0.72	0.55	0.53	0.5	0.44	0.54	0.47	0.38	0.55	0.5	0.51	0.47
School/ Education and Libraries	E (A-3)	0.82	0.81	0.8	0.79	0.75	0.72	0.71	0.72	0.67	0.73	0.72	0.68	0.82	0.73	0.61	0.89	0.8	0.83	0.77

a. Large office gross conditioned floor area >150,000 ft^2 (14,000 m^2) or > 5 floors; all other offices are small or medium

C409.4.1 HVAC TSPR. *HVAC TSPR* is calculated according to Equation 4-18 .

HVAC TSPR = Heating and cooling load / Building HVAC system energy **(Equation 4-18)**
where:

Building HVAC system energy = Sum of the annual site energy consumption for heating, cooling, fans, energy recovery, pumps, and heat rejection in thousands of Btus

Heating and cooling load = Sum of the annual heating and cooling loads met by the building HVAC system in thousands of Btus

C409.5 General. Projects shall comply with the requirements of this Section when calculating compliance using *HVAC Total System Performance Ratio.*

C409.5.1 Simulation Program. Simulation tools used to calculate HVAC TSPR of the *Standard Reference Design* shall comply with the following:

1. The simulation program shall calculate the *HVAC TSPR* based only on the input for the *proposed design* and the requirements of Section 409. The calculation procedure shall not allow the user to directly modify the building component characteristics of the *standard reference design*.
2. Performance analysis tools meeting the applicable subsections of Section 409 and tested according to ASHRAE Standard 140, except for Sections 7 and 8 of Standard 140, shall be permitted to be *approved*. The required tests shall include *building thermal envelope* and fabric load test (Sections 5.2.1, 5.2.2, and 5.2.3), ground coupled slab-on-grade analytical verfication tests (Section 5.2.4), space-cooling equipment performance tests (Section 5.3), space-heating equipment performance tests (Section 5.4), and air-side HVAC equipment analytical verifiction test (Section 5.5), along with the associated reporting (Section 6). Tools are permitted to be *approved* based on meeting a specified threshold for a jurisdiction. The *code official* shall be permitted to approve tools for a specified application or limited scope.
3. The test results and modeler reports shall be posted on a publicly available website and shall include the test results of the simulation programs and input files used for generating the results along with the results of the other simulation programs included in ASHRAE Standard 140 Annexes B8 and B16. The modeler report in Standard 140 Annex A2 Attachment A2.7 shall be completed for results exceeding the maximum or falling below the minimum of the reference values and for omitted results.
4. The simulation program shall have the ability to explicitly model part-load performance curves or other part-load adjustment methods based on manufacturer's part-load performance data for mechanical equipment.

C409.5.2 Climatic Data. The simulation program shall perform the simulation using hourly values of climatic data, such as temperature and humidity, using TMY3 data for the site as specified here:
https://buildingenergyscore.energy.gov/resources

C409.5.3 Documentation. Documentation conforming to the provisions of this section shall be provided to the *code official*.

C409.5.3.1 Compliance Report. Building permit submittals shall include:

1. A report produced by the simulation software that includes the following:
   1.1 Address of the building.
   1.2 Name of individual completing the compliance report.
   1.3 Name and version of the compliance software tool.
   1.4 The dimensions, floor heights and number of floors for each *block*.
   1.5 By *block*, the U-factor, C-factor, or F-factor for each simulated opaque envelope component and the U-factor and SHGC for each fenestration component.
   1.6 By *block* or by surface for each block, the fenestration area.
   1.7 By *block*, a list of the HVAC equipment simulated in the *proposed design* including the equipment type, fuel type, equipment efficiencies and system controls.
   1.8 Annual site HVAC energy use by end use for the proposed and baseline building
   1.9 Annual sum of heating and cooling loads for the baseline building.
   1.10 The HVAC total system performance ratio for both the *standard reference design* and the *proposed design*.

2. A mapping of the actual building HVAC component characteristics and those simulated in the *proposed design* showing how individual pieces of HVAC equipment identified above have been combined into average inputs as required by Section C409.6.1.10 including:
   2.1 Fans
   2.2 Hydronic pumps
   2.3 Air handlers
   2.4 Packaged cooling equipment
   2.5 Furnaces
   2.6 Heat pumps
   2.7 Boilers
   2.8 Chillers
   2.9 Heat rejection equipment (open and closed-circuit cooling towers; dry coolers)
   2.10 Electric resistance coils
   2.11 Condensing units
   2.12 Motors for fans and pumps
   2.13 Energy recovery devices

3. For each piece of equipment identified above include the following as applicable:
   3.1 Equipment name or tag consistent with that found on the design documents.
   3.2 Rated Efficiency level.
   3.3 Rated Capacity.
   3.4 Where not provided by the simulation program report in item a, documention of the calculation of any weighted equipment efficiencies input into the program.
   3.5 Electrical input power for fans and pumps (before any speed or frequency control device) at design condition and calculation of input value (W/cfm or W/gpm)

4. Floor plan of the building identifying:
   4.1 How portions of the buildings are assigned to the simulated *blocks*
   4.2 Areas of the building that are not covered under the requirements of Section C403.1.1.

C409.6 Calculation Procedures. Except as specified by this Section, the *standard reference design* and *proposed design* shall be configured and analyzed using identical methods and techniques

C409.6.1 Simulation of the proposed building design. The proposed design shall be configured and analyzed as specified in this section.

C409.6.1.1 Block Geometry. The geometry of buildings shall be configured using one or more *blocks*. Each *block* shall define attributes including *block* dimensions, number of floors, floor to floor height and floor to ceiling height. Simulation software may allow the use of simplified shapes (such as rectangle, L shape, H Shape, U shape or T shape) to represent *blocks*. Where actual building shape does not match these pre-defined shapes, simplifications are permitted providing the following requirements are met:

1. The *conditioned floor area* and volume of each *block* shall match the proposed design within 10 percent.
2. The area of each exterior envelope component from Table C402.1.4 is accounted for within 10 percent of the actual design.
3. The area of vertical fenestration and skylights is accounted for within 10 percent of the actual design.
4. The orientation of each component in 2 and 3 above is accounted for within 45 degrees of the actual design.

The creation of additional *blocks* may be necessary to meet these requirements. A more complex zoning of the building shall be allowed where all thermal zones in the reference and proposed model are the same and rules related to block geometry and HVAC system assignment to blocks are met with appropriate assignment to thermal zones.

> **Exception:** Portions of the building that are unconditioned or served by systems not covered by the requirements of Section C403.1.1 shall be omitted.

C409.6.1.1.1 Number of Blocks. One or more *blocks* may be required per building based on the following restrictions:

1. Each *block* can have only one occupancy type (multifamily *dwelling unit*, multifamily common area, office, library, education, hotel/motel or retail). Therefore, at least one single *block* shall be created for each unique use type.
2. Each *block* can be served by only one type of HVAC system. Therefore, a single *block* shall be created for each unique HVAC system and use type combination. Multiple HVAC units of the same type may be represented in one *block*. Table D601.10.2 provides directions for combining multiple HVAC units or components of the same type into a single *block*.
3. Each *block* can have a single definition of floor to floor or floor to ceiling heights. Where floor heights differ by more than two feet, unique *blocks* should be created for the floors with varying heights.
4. Each *block* can include either above grade or below grade floors. For buildings with both above grade and below grade floors, separate *blocks* should be created for each. For buildings with floors partially above grade and partially below grade, if the total wall area of the floor(s) in consideration is greater than or equal to 50 percent above grade, then it should be simulated as a completely above grade *block*, otherwise it should be simulated as a below grade *block*.
5. Each wall on a façade of a *block* shall have similar vertical fenestration. The product of the proposed design U-factor times the area of windows (UA) on each façade of a given floor cannot differ by more than 15 percent of the average UA for that façade in each *block*. The product of the proposed design SHGC times the area of windows (SHGCA) on each façade of a given floor cannot differ by more than 15 percent of the average SHGCA for that façade in each *block*. If either of these conditions are not met, additional *blocks* shall be created consisting of floors with similar fenestration.
6. For a building model with multiple *blocks*, the *blocks* should be configured together to have the same adjacencies as the actual building design.

C409.6.1.2 Thermal Zoning. Each floor in a *block* shall be modeled as a single thermal zone or as five thermal zones consisting of four perimeter zones and a core zone. Below grade floors shall be modeled as a single thermal *block*. If any façade in the *block* is less than 45 feet in length, there shall only be a single thermal zone per floor. Otherwise each floor shall be modeled with five thermal zones. A perimeter zone shall be created extending from each façade to a depth of 15 feet. Where facades intersect, the zone boundary shall be formed by a 45 degree angle with the two facades. The remaining area or each floor shall be modeled as a core zone with no exterior walls.

C409.6.1.3 Occupancy. Building occupancies modeled in the *standard reference design* and the *proposed design* shall comply with the following requirements.

C409.6.1.3.1 Occupancy Type. The occupancy type for each *block* shall be consistent with the building area type as determined in accordance with C405.4.2.1. Portions of the building that are building area types other than multifamily *dwelling unit*, multifamily common area, office, school (education), library, or retail shall not be included in the simulation. Surfaces adjacent to such building portions shall be modeled as adiabatic in the simulation program.

C409.6.1.3.2 Occupancy schedule, density, and heat gain.. The occupant density, heat gain, and schedule shall be for multifamily, office, retail, library, hotel/motel or school as specified by ASHRAE Standard 90.1 Normative Appendix C.

C409.6.1.4 Envelope Components. Building envelope components modeled in the *standard reference design* and the *proposed design* shall comply with the requirements of this Section.

C409.6.1.4.1 Roofs.. Roofs will be modeled with insulation above a steel roof deck. The roof U-factor and area shall be modeled as in the proposed design. If different roof thermal properties are present in a single *block*, an area weighted U-factor shall be used. Roof solar absorptance shall be modeled at 0.70 and emittance at 0.90.

C409.6.1.4.2 Above grade walls. Walls will be modeled as steel frame construction. The U-factor and area of above grade walls shall be modeled as in the proposed design. If different wall constructions exist on the façade of a *block* an area-weighted U-factor shall be used.

C409.6.1.4.3 Below grade walls. The C-factor and area of below grade walls shall be modeled as in the proposed design. If different slab on grade floor constructions exist in a *block*, an area-weighted C- factor shall be used.

C409.6.1.4.4 Above grade exterior floors. Exterior floors shall be modeled as steel frame. The U-factor and area of floors shall be modeled as in the proposed design. If different wall constructions exist in the *block* an area-weighted U-factor shall be used.

C409.6.1.4.5 Slab on grade floors. The F-factor and area of slab on grade floors shall be modeled as in the proposed design. If different below grade wall constructions exist in a *block*, an area-weighted F- factor shall be used.

C409.6.1.4.6 Vertical Fenestration.. The window area and area weighted U-factor and SHGC shall be modeled for each façade based on the proposed design. Each exterior surface in a *block* must comply with Section C409.6.1.1.1 item 5. Windows will be combined into a single window centered on each façade based on the area and sill height input by the user. When different U values, SHGC or sill heights exist on a single facade, area weighted average for each shall be input by the user.

C409.6.1.4.7 Skylights.. The skylight area and area weighted U-factor and SHGC shall be modeled for each floor based the proposed design. Skylights will be combined into a single skylight centered on the roof of each zone based on the area input by the user

C409.6.1.4.8 Exterior Shading.. Permanent window overhangs shall be modeled. When windows with and without overhangs or windows with different overhang projection factors exist on a façade, window width weighted projection factors shall be input by the user as follows.

$$P_{avg} = (A_1 \times L_{o1} + A2 \times L_{o2} ... + An \times L_{on}) / (Lw_1 + Lw_2 ... + L_{wn}) \quad \textbf{(Equation 4-19)}$$

where:

P_{avg} = Average overhang projection modeled in the simulation tool

A = Distance measured horizontally from the furthest continuous extremity of any overhang, eave, or permanently attached shading device to the vertical surface of the glazing.

L_o = Length off the overhang

L_w = Length of the window

C409.6.1.5 Lighting. Interior lighting power density shall be equal to the allowance in Table C405.4.2(1) for multifamily, office, retail, library, or school. The lighting schedule shall be for multifamily, office, retail, library, or school as specified by ASHRAE Standard 90.1 Normative Appendix C. The impact of lighting controls is assumed to be captured by the lighting schedule and no explicit controls shall be modeled. Exterior lighting shall not be modeled.

C409.6.1.6 Miscellaneous equipment.. The miscellaneous equipment schedule and power shall be for multifamily, office, retail, library, or school as specified by ASHRAE Standard 90.1 Normative Appendix C. The impact of miscellaneous equipment controls is assumed to be captured by the equipment schedule and no explicit controls shall be modeled.

Exceptions:

1. Multifamily dwelling units shall have a miscellaneous load density of 0.42 W/ft^2
2. Multifamily common areas shall have a miscellaneous load density of 0 W/ft^2

C409.6.1.7 Elevators. Elevators shall not be modeled.

C409.6.1.8 Service water heating equipment.. Service water heating shall not be modeled.

C409.6.1.9 On-site renewable energy systems.. On-site Renewable Energy Systems shall not be modeled.

C409.6.1.10 HVAC equipment.. HVAC systems shall meet the requirements of Section C403 Mechanical Systems.

C409.6.1.10.1 Supported HVAC systems.. At a minimum, the HVAC systems shown in Table CD105.2.10.1 shall be supported by the simulation program.

TABLE C409.6.1.10.1 PROPOSED BUILDING HVAC SYSTEMS SUPPORTED BY HVAC TSPR SIMULATION SOFTWARE

System No.	System Name
1	Packaged Terminal Air Conditioner (with electric or hydronic heat)
2	Packaged Terminal Air Heat Pump
3	Packaged Single Zone Gas Furnace[a] and/or air-cooled Air Conditioner (includes split systems[b])
4	Packaged Single Zone Heat Pump (air to air only)(includes split systems[b] and electric or gas supplemental heat)
5	Variable Refrigerant Flow (air cooled only)
6	Four Pipe Fan Coil
7	Water Source Heat Pump (Water Loop), water-sourc *Variable-Refrigerant-Flow-System*, or water-source air conditioner
8	Ground Source Heat Pump
9	Packaged Variable Air Volume (DX cooling)[a]
10	Variable Air Volume (hydronic cooling)[a]
11	Variable Air Volume with Fan Powered Terminal Units
12	Dedicated Outdoor Air System (in conjunction with systems 1-8)

a. Reheat or primary heat may be electric, hydronic, or gas furnace

b. Condensing units with DX air handlers are modeled as package furnace with air conditioners or heat pumps

C409.6.1.10.2 Proposed building HVAC system simulation.. The HVAC systems shall be modeled as in the proposed design at design conditions unless otherwise stated with clarifications and simplifications as described in Tables C409.6.1.10.2(1) and C409.6.1.10.2(2). System parameters not described in the following sections shall be simulated to meet the minimum requirements of Section C403. All zones within a *block* shall be served by the same HVAC system type as described in Section C409.6.1.1.1 item 2. Heat loss from ducts and pipes shall not be modeled. Table C409.6.1.10.2(1) Proposed Building System Parameters are based on input of full-load equipment efficiencies with adjustment using part-load curves integrated in the simulation program. Where other approaches to part-load adjustment are used, it is permitted for specific input parameter to vary. The simulation program shall model part-load HVAC equipment performance using either:

1. full-load efficiency adjusted for fan power input that is modeled separately and typical part-load performance adjustements for the proposed equipment.
2. part-load adjustments based on input of both full-load and part-load metrics, or
3. equipment-specific adjustments based on performance data provided by the equipment manufacturer for the proposed equipment.

Where multiple system components serve a *block*, average values weighed by the appropriate metric as described in this section shall be used.

1. Where multiple fan systems serve a single *block*, fan power shall be based on weighted average using the design supply air cfm
2. Where multiple cooling systems serve a single *block*, COP shall be based on a weighted average using cooling capacity. DX coils shall be entered as multi-stage if more than 50% of coil capacity serving the *block* is multi-stage with staged controls.
3. Where multiple heating systems serve a single *block*, thermal efficiency or heating COP shall be based on a weighted average using heating capacity.
4. Where multiple boilers or chillers serve a heating water or chilled water loop, efficiency shall be based on a weighted average for using heating or cooling capacity.
5. When multiple cooling towers serving a condenser water loop are combined, the cooling tower efficiency, cooling tower design approach and design range are based on a weighted average of the design water flow rate through each cooling tower.
6. Where multiple pumps serve a heating water, chilled water or condenser water loop, pump power shall be based on a weighted average for using design water flow rate.
7. When multiple system types with and without economizers are combined, the economizer maximum outside air fraction of the combined system shall be based on weighted average of 100% supply air for systems with economizers and design outdoor air for systems without economizers.
8. Multiple systems with and without ERVs cannot be combined.
9. Systems with and without supply air temperature reset cannot be combined.
10. Systems with different fan control (constant volume, multi-speed or VAV) for supply fans cannot be combined.

TABLE C409.6.1.10.2(1) PROPOSED BUILDING SYSTEM PARAMETERS

Category	Parameter	Fixed or User Defined	Required	Applicable Systems
HVAC System Type	System Type	User Defined	Selected from Table C409.6.1.10.1	All
System Sizing	Design Day Information	Fixed	99.6% heating design and 1% dry-bulb and 1% wet-bulb cooling design	All
	Zone Coil Capacity	Fixed	Sizing factors used are 1.25 for heating equipment and 1.15 for cooling equipment	All
	Supply Airflow	Fixed	Based on a supply-air-to-room-air temperature *set-point* difference of 20°F(11.11°C) or	1-11
		Fixed	Equal to required outdoor air ventilation	12
Outdoor Ventilation Air	Portion of supply air with proposed Filter ≥MERV 13	User-defined	Percentage of supply air flow subject to higher filtration (Adjusts baseline Fan Power higher. Prorated)	All
	Outdoor Ventilation Air Flow Rate	Fixed	As specified in ASHRAE Standard 90.1 Normative Appendix C, adjusted for proposed DCV control	All
	Outdoor *Ventilation* Supply Air Flow Rate Adjustments	Fixed	Based on ASHRAE Standard 62.1 Section 6.2.4.3 System Ventilation Efficiency (Evs) is 0.75	9-11
		Fixed	System Ventilation Efficiency (Evs) is 1.0	1-8, 12
		Fixed	Basis is 1.0 Zone Air Distribution Effectiveness	All
System Operation	Space temperature Set points	Fixed	As specified in ASHRAE Standard 90.1 Normative Appendix C, except -multifamily which shall use 68°F(20°C) heating and 76°F(24.4°C) cooling setpoints. -hotel/motel that shall be 70°F(21.1°C) heating and 72°F(22.2°C) cooling	1-11
	Fan Operation – Occupied	User Defined	Runs continuously during occupied hours or cycles to meet load. Multispeed fans reduce airflow related to thermal loads.	1-11
	Fan Operation – Occupied	Fixed	Fan runs continuously during occupied hours	12
	Fan Operation – Night Cycle	Fixed	Fan cycles on to meet setback temperatures	1-11
Packaged Equipment Efficiency	DX Cooling Efficiency	User Defined	Cooling COP without fan energy calculated in accordance with Section C409.6.1.10.2	1, 2, 3, 4, 5,7, 8, 9, 11,12
	DX Coil Number of Stages	User-defined	Single Stage or Multistage	3, 4, 9, 10, 11, 12
	Heat Pump Efficiency	User Defined	Heating COP without fan energy calculated in accordance with Section C409.6.1.10.2	2, 4, 5, 7, 8, 12
	Furnace Efficiency	User Defined	Furnace thermal efficiency	3, 9, 11, 12
Heat Pump Supplemental Heat	Heat Source	User-defined	Electric resistance or gas furnace	2, 4, 7, 8, 12
	Control	Fixed	Supplemental electric heat locked out above 40°F(4°C) OAT. Runs as needed in conjunction with compressor between 40°F(4°C) and 0°F(-17.8°C). Gas heat operates in place of the heat pump when the heat pump cannot meet load.	2, 4, 7, 8, 12
System Fan Power and Controls	Part-load Fan Controls			1-8 (CAV, two or three speed), 9, 10, 11 (VAV), 12 (CAV

Category	Parameter	Fixed or User Defined	Required	Applicable Systems
Controls	-Constant Volume -Two Speed or three speed -VAV	User-defined	Static pressure reset included for VAV.	11 (VAV), 12 (CAV and VAV)
	Design Fan Power (W/cfm)	User-defined	Input electric power for all fans required to operate at fan system design conditions divided by the supply airflow rate This is a "wire to air" value including all drive, motor *efficiency* and other losses.	All
	Low-speed and medium speed fan power	User Defined	Low speed input electric power for all fans required to operate at low-speed conditions divided by the low speed supply airflow rate. This is a "wire to air" value including all drive, motor *efficiency* and other losses. Also provide medium speed values for three-speed fans.	1-8
Variable Air Volume Systems	Supply Air Temperature (SAT) Controls	User defined	If not SAT reset then constant at 55°F(12.8°C). Options for reset based on outside air temperature (OAT) or warmest zone. If warmest zone, then the user can specify the minimum and maximum temperatures. If OAT reset, SAT is reset higher to 60°F(15.6°C) at outdoor low of 50°F(10°C). SAT is 55°F(12.8°C) at outdoor high of 70°F(21.1°C).	9, 10, 11
	Minimum Terminal Unit airflow percentage	User Defined	Average minimum terminal unit airflow percentage for *block* weighted by cfm or minimum required for outdoor air ventilation, whichever is higher.	9, 10, 11
	Terminal Unit Heating Source	User Defined	Electric or hydronic	9, 10, 11
	Dual *set point* minimum *VAV* damper position	User-defined	Heating maximum airflow fraction	9, 10
	Fan Powered Terminal Unit (FPTU) Type	User Defined	Series or parallel FPTU	11
	Parallel FPTU Fan	Fixed	Sized for 50% peak primary air at 0.35 W/cfm	11
	Series FPTU Fan	Fixed	Sized for 50% peak primary air at 0.35 W/cfm	11
Economizer	Economizer Presence	User Defined	Yes or No	3, 4, 5, 6, 9, 10, 11
	Economizer Control Type	Fixed	Lockout on Differential dry-bulb temperature (OAT>RAT) in 6A, 5A, All B & C climate zones; fixed enthalpy>28 Btu/lb (47kJ/kg) or fixed dry-bulb OAT>75°F(24°C) in 0A to 4A climate zones	3, 4, 5, 6, 9, 10, 11
Energy Recovery	Sensible Effectiveness	User Defined	Heat exchanger sensible effectiveness at design heating and cooling conditions	3, 4, 9, 10, 11, 12
	Latent Effectiveness	User Defined	Heat exchanger latent effectiveness at design heating and cooling conditions	3, 4, 9, 10, 11, 12
	Economizer Bypass	User Defined	If ERV is bypassed or wheel rotation is slowed during economizer conditions (Yes/No)	3, 4, 9, 10, 11, 12
	Economizer Bypass active	Fixed	If there is a bypass, it will be active between 45°F(7.2°C) and 75°F(23.9°C) outside air temperature.	3, 4, 9, 10, 11, 12
	Bypass SAT Setpoint	User Defined	If bypass, target supply air temperature	3, 4, 9, 10,

Category	Parameter	Fixed or User Defined	Required	Applicable Systems
				11, 12
	Fan Power Reduction during Bypass (W/cfm)	User Defined	If ERV system include bypass, static pressure set point and variable speed fan, fan power can be reduced during economizer conditions	3, 4, 9, 10, 11, 12
Demand Controlled Ventilation	DCV Application on/off	User Defined	Percent of *block* floor area under occupied standby controls, ON/OFF only with occupancy sensor and no variable control	3, 4, 9, 10, 11, 12
	DCV Application CO2	User Defined	Percentage of *block* floor area under variable DCV control (CO2); may include both variable and ON/OFF control	3, 4, 9, 10, 11, 12
DOAS	DOAS Fan Power W/cfm	User Defined	Fan electrical input power in W/cfm of supply airflow	12
	DOAS Supplemental Heating and Cooling	User Defined	Heating source, cooling source, energy recovery and respective efficiencies	12
	Maximum SAT Set point (Cooling)	User-defined	SAT set point if DOAS includes supplemental cooling	12
	Minimum SAT Set point (Heating)	User-defined	SAT set point if DOAS includes supplemental heating	12
Heating Plant	Boiler Efficiency	User Defined	Boiler thermal efficiency	1, 6, 7, 9, 10, 11, 12
	Heating Water Loop Configuration	User-defined	Constant flow primary only; Variable flow primary only; Constant flow primary – variable flow secondary, Variable flow primary and secondary	1, 6, 7, 9, 10, 11, 12
	Heating Water Primary Pump Power (W/gpm)	User-defined	Heating water primary pump input W/gpm heating water flow	1, 6, 7, 9, 10, 11, 12
	Heating Water Secondary Pump Power (W/gpm)	User-defined	Heating water secondary pump input W/gpm heating water flow (if primary/secondary)	1, 6, 7, 9, 10, 11, 12
	Heating Water Loop Temperature	User-defined	Heating water supply and return temperatures, °F(°C)	1, 6, 9, 10,11
	Heating Water Loop Supply Temperature Reset	Fixed	Reset HWS by 27.3% of design delta-T (HWS-70°F(21.1°C) Space Heating temperature set point) between 20°F(-6.7°C) and 50°F(10°C) OAT	1, 6, 7, 9, 10, 11, 12
	Boiler Type	Fixed	Non-condensing boiler where input thermal efficiency is less than 86%; Condensing boiler otherwise	1, 6, 7, 9, 10, 11, 12
Chilled Water Plant	Chiller Compressor Type	User Defined	Screw/Scroll, Centrifugal or Reciprocating	6,10, 11, 12
	Chiller Condenser Type	User Defined	Air cooled or water cooled	6, 10, 11, 12
	Chiller Full Load Efficiency	User Defined	Chiller COP	6, 10, 11, 12
	Chilled Water Loop Configuration	User Defined	Variable flow primary only, constant flow primary – variable flow secondary, variable flow primary and secondary	6, 10, 11,12
	Chilled Water Primary Pump Power (W/gpm)	User-defined	Primary pump input W/gpm chilled water flow	6, 10, 11,12

Category	Parameter	Fixed or User Defined	Required	Applicable Systems
	Chilled Water Secondary Pump Power (W/gpm)	User defined	Secondary Pump input W/gpm chilled water flow (if primary/secondary)	6, 10, 11,12
	Chilled Water Temperature Reset Included	User Defined	Yes/No	6, 10, 11,12
Chilled Water Plant (cont.)	Chilled Water Temperature Reset Schedule (if included)	Fixed	Outdoor air reset: CHW supply temperature of 44°F(6.7°C) at 80°F(26.7°C) outdoor air dry bulb and above, CHW supply temperature of 54°F(12.2°C) at 60°F(15.6°C) outdoor air dry bulb temperature and below, ramped linearly between	6, 10, 11,12
	Condenser Water Pump Power (W/gpm)	User Defined	Pump input W/gpm condenser water flow	6, 7, 8, ,10, 11, 12
	Condenser Water Pump Control	User Defined	Constant speed or variable speed	6, 7, 8, 10, 11,12
	Heat Rejection Equipment Efficiency	User Defined	gpm/hp tower fan	6, 7, 10, 11, 12
	Heat Rejection Fan Control	User Defined	Constant or variable speed	6, 7, 10, 11, 12
	Heat Rejection Approach and Range	User Defined	Design cooling tower approach and range temperature	6, 7, 10, 11,12
Heat Pump Loop	Loop flow and Heat Pump Control Valve	Fixed	Two position Valve with VFD on Pump. Loop flow at 3 gpm/ton	7, 8
	Heat Pump Loop minimum and maximum temperature control	User-defined	User input: restrict to minimum 20°F(11.1°C) and maximum 40°F(22.2°C) temperature difference	7
GLHP Well Field	-	Fixed	Bore depth = 250 ft(76 m) Bore length 200 ft/ton (1.5 m/kW) for the greater of cooling or heating load Bore spacing = 15 ft(4.6 m) Bore diameter = 5 in (127 mm) ¾” (19 mm)Polyethylene pipe Ground and grout conductivity = 4.8 Btu-in/h-ft2-°F (0.69 W/(mK))	8

a. Part load fan power and pump power modified in accordance with Table C409.6.1.10.2(2)

TABLE C409.6.1.10.2(2) FAN AND PUMP POWER CURVE COEFFICIENTS

Equation Term	Fan Power Coefficients	Pump Power Coefficients	
-	VSD + SP reset	Ride Pump Curve	VSD + DP/valve reset
b	0.0408	0	0
x	0.088	3.2485	0.0205
x^2	-0.0729	-4.7443	0.4101
x^3	0.9437	2.5295	0.5753

C409.6.1.10.3 Demand Control Ventilation.. Demand Controlled Ventilation (DCV) shall be modeled using a simplified approach that adjusts the design outdoor supply air flow rate based on the floor area of the building that is covered by DCV. The simplified method shall accommodate both variable DCV and on/off DCV, giving on/off DCV on third the effective floor control area of variable DCV. Outdoor air reduction coefficients shall be as stated in Table C409.6.1.10.3

Exception: On/off DCV shall receive full effective area adjustment for R-1 and R-2 occupancies.

C409.6.1.10.3 DCV OUTDOOR AIR REDUCTION CURVE COEFFICIENTS

Equation Term	DCV OSA reduction (y) as a function of effective DCV control floor area (x)			
	Office	School	Hotel; Motel; Multi-Family; Dormitory	Retail
b	0	0	0	0
x	0.4053	0.2676	0.5882	0.4623
x^2	-0.8489	0.7753	-1.0712	-0.848
x^3	1.0092	-1.5165	1.3565	1.1925
x^4	-0.4168	0.7136	-0.6379	-0.5895

C409.6.2 Simulation of the standard reference design. The standard reference design shall be configured and analyzed as specified in this section.

C409.6.2.1 Utility Rates. Same as *proposed design.*

C409.6.2.2 Blocks. Same as *proposed design.*

C409.6.2.3 Thermal zoning. Same as *proposed design.*

C409.6.2.4 Occupancy type, schedule, density, and heat gain. Same as *proposed design.*

C409.6.2.5 Envelope components.. Same as *proposed design.*

C409.6.2.6 Lighting. Same as *proposed design.*

C409.6.2.7 Miscellaneous equipment. Same as *proposed design.*

C409.6.2.8 Elevators. Not modeled. Same as *proposed design.*

C409.6.2.9 Service water heating equipment. Not modeled. Same as *proposed design.*

C409.6.2.10 On-site renewable energy systems. Not modeled. Same as *proposed design.*

C409.6.2.11 HVAC equipment. The *reference building design* HVAC equipment consists of separate space conditioning systems as described in Table C409.6.2.11(1) through Table C409.6.2.11(3) for the appropriate building use types. In these tables, 'Warm' refers to climate zones 0 to 2 and 3A and 'Cold' refers to climate zones 3B, 3C, and 4 to 8.

Table C409.6.2.11(1) Reference Building Design HVAC Complex Systems

Building Type Parameter	**Large Office (warm)**	**Large Office (cold)**	**School (warm)**	**School (cold)**
System Type	*VAV*/ RH Water-cooled Chiller/ Electric Reheat (PIU)	*VAV*/ RH Water-cooled Chiller/ Gas *Boiler*	*VAV*/ RH Water-cooled Chiller/ Electric Reheat (PIU)	*VAV*/ RH Water-cooled Chiller/ Gas *Boiler*
Fan control	VSD (No SP Reset)	VSD (No SP Reset)	VSD (No SP Reset)	VSD (No SP Reset)
Main fan power (W/CFM (W·s/L) Proposed ≥ MERV13	1.165 (2.468)	1.165 (2.468)	1.165 (2.468)	1.165 (2.468)
Main fan power (W/CFM (W·s/L) proposed < MERV13	1.066 (2.259)	1.066 (2.259)	1.066 (2.259)	1.066 (2.259)
Zonal fan power (W/CFM (W·s/L))	0.35 (0.75)	NA	0.35 (0.75)	NA
Minimum zone airflow fraction	1.5* Voz	1.5* Voz	1.2* Voz	1.2 * Voz
Heat/cool sizing factor	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15
Outdoor air economizer	No	Yes except 4A	No	Yes except 4A
Occupied OSA (= proposed)	Sum(Voz)/0.75	Sum(Voz)/0.75	Sum(Voz)/0.65	Sum(Voz)/0.65
Energy recovery ventilator *efficiency* ERR (Enthalpy Recovery Ratio) ERV bypass SAT *set point*	NA	NA	50% No Bypass	50% 60°F(15.6 °C)except 4A
DCV	No	No	No	No
Cooling Source	(2) Water-cooled Centrifugal Chillers	(2) Water- cooled Centrifugal Chillers	(2) Water- Cooled Screw Chillers	(2) Water- Cooled Screw Chillers
Cooling *COP* (net of fan)	Path B for profile	Path B for profile	Path B for profile	Path B for profile
Heating source (reheat)	*Electric resistance*	Gas *Boiler*	*Electric resistance*	Gas *Boiler*
Furnace or *boiler efficiency*	1.0	75% Et	1.0	80% Et
Condenser heat rejection	Axial Fan Open Circuit Cooling Tower			
Cooling tower *efficiency* (gpm/fan-hp (L/s·fan-*kW*))	38.2 (3.23)	38.2 (3.23)	38.2 (3.23)	38.2 (3.23)
Tower turndown (> 300 ton (1060 *kW*))	50%	50%	50%	50%
Pump (constant flow/variable flow)	Constant Flow; 10°F (5.6°C) range	Constant Flow; 10°F (5.6°C) range	Constant Flow; 10°F (5.6°C) range	Constant Flow; 10°F (5.6°C) range
Tower approach	25.72 – (0.24 x WB), where WB WB is the 0.4% evaporation design wet-bulb temperature (°F)			
Cooling condenser *pump* power (W/gpm (W·s/L))	19 (300)	19 (300)	19 (300)	19 (300)
Cooling primary *pump* power (W/gpm (W·s/L))	9 (142)	9 (142)	9 (142)	9 (142)
Cooling secondary *pump* power (W/gpm (W·s/L))	13 (205)	13 (205)	13 (205)	13 (205)
Cooling coil chilled water delta-T, °F (°C)	12 (6.7)	12 (6.7)	12 (6.7)	12 (6.7)
Design chilled water supply temperature, °F (°C)	44 (6.7)	44 (6.7)	44 (6.7)	44 (6.7)
Chilled water supply temperature (CHWST) reset *set point* vs Outside Air Temperature OAT, °F (°C)	CHWST: 44-54/OAT 80-60 (6.7-12.2/ 26.7-15.6)	CHWST: 44-54/OAT 80-60 (6.7-12.2/ 26.7-15.6)	CHWST: 44-54/OAT 80-60 (6.7-12.2/ 26.7-15.6)	CHWST: 44-54/OAT 80-60 (6.7-12.2/ 26.7-15.6)
Building Type Parameter	Large Office (warm)	Large Office (cold)	School (warm)	School (cold)

Building Type Parameter	Large Office (warm)	Large Office (cold)	School (warm)	School (cold)
CHW cooling loop *pumping* control	2-way Valves & *pump* VSD	2-way Valves & *pump* VSD	2-way Valves & *pump* VSD	2-way Valves & *pump* VSD
Heating *pump* power (W/gpm (W·s/L))	16.1 (254)	16.1 (254)	19	19
Heating oil HW dT. °F (°C)	50 (10)	50 (10)	50 (10)	50 (10)
Design Hot Water Supply Temperature (HWST). °F (°C)	180 (82.2)	180 (82.2)	180 (82.2)	180 (82.2)
HWST reset *set point* vs OAT, °F (°C)	HWST: 180-150/OAT 20-50 (82-65.6/ -6.7-10)	HWST: 180-150/OAT 20-50 (82-65.6/ -6.7-10)	HWST: 180-150/OAT 20-50 (82-65.6/ -6.7-10)	HWST: 180-150/OAT 20-50 (82-65.6/ -6.7-10)
Heat loop *pumping* control	2-way Valves & *pump* VSD	2-way Valves & *pump* VSD	2-way Valves & *pump* VSD	2-way Valves & *pump* VSD

Table C409.6.2.11(2)
TSPR Reference Building Design HVAC Simple Systems

Building Type Parameter	**Building Type**					
	Medium Office (warm)	**Medium Office (cold)**	**Small Office (warm)**	**Small Office (cold)**	**Retail (warm)**	**Retail (cold)**
System type	Package *VAV* - Electric Reheat	Package *VAV* - Hydronic Reheat	PSZ-HP	PSZ-AC	PSZ-HP	PSZ-AC
Fan control	VSD (No SP Reset)	VSD (No SP Reset)	Constant Volume	Constant Volume	Constant Volume	Constant Volume
Main fan power (W/CFM (W·s/L)) proposed ≥ MERV13	1.285 (2.723)	1.285 (2.723)	0.916 (1.941)	0.916 (1.941)	0.899 (1.905)	0.899 (1.905)
Main fan power (W/CFM (W·s/L)) proposed < MERV13	1.176 (2.492)	1.176 (2.492)	0.850 (1.808)	0.850 (1.801)	0.835 (1.801)	0.835 (1.801)
Zonal fan power (W/CFM (W·s/L))	0.35 (0.75)	NA	NA	NA	NA	NA
Minimum zone airflow fraction	30%	30%	NA	NA	NA	NA
Heat/cool sizing factor	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15
Supplemental heating availability	NA	NA	<40°F (<4.4°C) OAT	NA	<40°F (<4.4°C) OAT	NA
Outdoor air economizer	No	Yes except 4A	No	Yes except 4A	No	Yes except 4A
Occupied OSA source	Packaged unit, occupied damper, all *building* use types					
Energy recovery ventilator	No	No	No	No	No	No
DCV	No	No	No	No	No	No
Cooling source	DX, multi-stage	DX, multi-stage	DX, 1 stage (heat pump)	DX, single stage	DX, 1 stage (heat pump)	DX, single stage
Cooling *COP* (net of fan)	3.40	3.40	3.00	3.00	3.40	3.50
Heating source	*Electric resistance*	Gas *Boiler*	Heat Pump	Furnace	Heat Pump	Furnace
Heating *COP* (net of fan) / furnace or *boiler efficiency*	1.0	75% E_t	3.40	80% E_t	3.40	80% E_t

Table C409.6.2.11(3)
TSPR Reference Building Design HVAC Simple Systems

Parameter	**Building Type**			
	Hotel (warm)	**Hotel (cold)**	**Multifamily (warm)**	**Multifamily (cold)**
System type	*PTHP*	*PTAC*	*PTHP*	*PTAC*
Fan control	Constant Volume	Constant Volume	Constant Volume	Constant Volume
Main fan power (W/CFM (W·s/L))	0.300 (0.636)	0.300 (0.636)	0.300 (0.636)	0.300 (0.636)
Heat/cool sizing factor	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15
Supplemental heating availability	<40°F (<4.4°C)	NA	<40°F (<4.4°C)	NA
Outdoor air economizer	No	No	No	No
Occupied OSA source	Packaged unit, occupied damper	Packaged unit, occupied damper	Packaged unit, occupied damper	Packaged unit, occupied damper
Energy recovery ventilator	No	No	No	No
DCV	No	No	No	No
Cooling source	DX, 1stage (heat pump)	DX, 1 stage	DX, 1 stage (heat pump)	DX, 1 stage
Cooling *COP* (net of fan)	3.10	3.20	3.10	3.20
Heating source	*PTHP*	(2) Hydronic *Boiler*	*PTHP*	(2) Hydronic *Boiler*
Heating *COP* (net of fan) / furnace or *boiler efficiency*	3.10	75% E_t	3.10	75% E_t
Heating *pump* power (W/gpm (W·s/L))	NA	19 (300)	NA	19 (300)
Heating coil heating water delta-T, °F (°C)	NA	50 (27.8)	NA	50 (27.8)
Design HWST, °F (°C)	NA	180 (82.2)	NA	180 (82.2)
HWST reset *set point* vs OAT, °F (°C)	NA	HWST: 180-150/OAT 20-50 (82-65.6/ -6.7-10)	NA	HWST: 180-150/OAT 20-50 (82-65.6/ -6.7-10)
Heat loop *pump*ing control	NA	2-way Valves & ride *pump* curve	NA	2-way Valves & ride *pump* curve

C409.7 Target Design HVAC Systems. Target system descriptions described in Tables C409.7(1) through C409.7(3) are provided as reference for Section C403.1.1 Exception 10. The target systems are used for developing MPF values and do not need to be programmed into TSPR software.

Table C409.7(1)
Target Building Design Criteria HVAC Complex Systems

Parameter	Building Type			
	Large Office (warm)	**Large Office (cold)**	**School (warm)**	**School (cold)**
System Type	*VAV*/ RH Water-cooled Chiller/ Electric Reheat (PIU)	*VAV*/ RH Water-cooled Chiller/ Gas *Boiler*	*VAV*/ RH Water-cooled Chiller/ Electric Reheat (PIU)	*VAV*/ RH Water-cooled Chiller/ Gas *Boiler*
Fan control	VSD (No SP Reset)	VSD (No SP Reset)	VSD (No SP Reset)	VSD (No SP Reset)
Main fan power (W/CFM (W·s/L) Proposed ≥ MERV13	1.127 (2.388)	1.127 (2.388)	1.127 (2.388)	1.127 (2.388)
Zonal fan power (W/CFM (W·s/L))	0.35 (0.75)	NA	0.35 (0.75)	NA
Minimum zone airflow fraction	1.5* Voz	1.5* Voz	1.2* Voz	1.2 * Voz
Heat/cool sizing factor	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15
Outdoor air economizer	*Yes except 0-1*	Yes	*Yes except 0-1*	Yes
Occupied OSA (= proposed)	Sum(Voz)/0.75	Sum(Voz)/0.75	Sum(Voz)/0.65	Sum(Voz)/0.65
Energy recovery ventilator *efficiency* ERR	NA	NA	50%	50%
(Enthalpy Recovery Ratio)			No Bypass	60°F(15.6°C) except 4A
ERV bypass SAT *set point*				
DCV	Yes	Yes	Yes	Yes
% Area Variable Control	15%	15%	70%	70%
% Area On/Off Control	65%	65%	20%	20%
Cooling Source	(2) Water-cooled Centrif Chillers	(2) Water- cooled Centrif Chillers	(2) Water- Cooled Screw Chillers	(2) Water- Cooled Screw Chillers
Cooling *COP* (net of fan)	ASHRAE 90.1 Appendix G, Table G3.5.3	ASHRAE 90.1 Appendix G, Table G3.5.3	ASHRAE 90.1 Appendix G, Table G3.5.3	ASHRAE 90.1 Appendix G, Table G3.5.3
Heating source (reheat)	*Electric resistance*	Gas *Boiler*	*Electric resistance*	Gas *Boiler*
Furnace or *boiler efficiency*	1.0	90% Et	1.0	80% Et
Condenser heat rejection	Cooling Tower	Cooling Tower	Cooling Tower	Cooling Tower
Cooling tower *efficiency* (gpm/hp (L/s·*kW*))—See G3.1.3.11	40.2 (3.40)	40.2 (3.40)	40.2 (3.40)	40.2 (3.40)
Tower turndown (> 300 ton (1060 *kW*))	50%	50%	50%	50%
Pump (constant flow/variable flow)	Constant Flow; 10°F (5.6°C) range	Constant Flow; 10°F (5.6°C) range	Constant Flow; 10°F (5.6°C) range	Constant Flow; 10°F (5.6°C) range
Tower approach	ASHRAE 90.1 Appendix G, Table G3.1.3.11	ASHRAE 90.1 Appendix G, Table G3.1.3.11	ASHRAE 90.1 Appendix G, Table G3.1.3.11	ASHRAE 90.1 Appendix G, Table G3.1.3.11
Cooling condenser *pump* power (W/gpm (W·s/L))	19 (300)	19 (300)	19 (300)	19 (300)
Cooling primary *pump* power (W/gpm (W·s/L))	9 (142)	9 (142)	9 (142)	9 (142)
Cooling secondary *pump* power (W/gpm (W·s/L))	13 (205)	13 (205)	13 (205)	13 (205)

Parameter	Building Type			
	Large Office (warm)	Large Office (cold)	School (warm)	School (cold)
Cooling coil chilled water delta-T, °F (°C)	18 (10)	18 (10)	18 (10)	18 (10)
Design chilled water supply temperature, °F (°C)	42 (5.56)	42 (5.56)	42 (5.56)	42 (5.56)
Chilled water supply temperature (CHWST)reset *set point* vs OAT, °F (°C)	CHWS 44-54/OAT 80-60 (6.7-12.2)/26.7-15.6)	CHWS 44-54/OAT 80-60 (6.7-12.2)/26.7-15.6)	CHWS 44-54/OAT 80-60 (6.7-12.2)/26.7-15.6)	CHWS 44-54/OAT 80-60 (6.7-12.2)/26.7-15.6)
CHW cooling loop *pump*ing control	2-way Valves & *pump* VSD	2-way Valves & *pump* VSD	2-way Valves & *pump* VSD	2-way Valves & *pump* VSD
Heating *pump* power (W/gpm (W·s/L))	[illegible]	[illegible]	[illegible]	[illegible]
Heating HW dT. °F (°C)	50 (27.78)	20 (11.11)	50 (27.78)	20 (11.11)
Design HWST. °F (°C)	180 (82)	140 (60)	180 (82)	140 (60)
Hot water supply temperature (HWST) range vs outside air temperature (OAT) range	HWST: 180-150/OAT 20-50 (82-65.6/ -6.7-10)	HWST: 180-150/OAT 20-50 (82-65.6/ -6.7-10)	HWST: 180-150/OAT 20-50 (82-65.6/ -6.7-10)	HWST: 180-150/OAT 20-50 (82-65.6/ -6.7-10)
Heat loop *pumping* control	2-way Valves & *pump* VSD	2-way Valves & *pump* VSD	2-way Valves & *pump* VSD	2-way Valves & *pump* VSD

TABLE C409.7(2) Target Building Design Criteria HVAC Simple Systems

Parameter	Building Type					
	Medium Office (warm)	Medium Office (cold)	Small Office (warm)	Small Office (cold)	Retail (warm)	Retail (cold)
System type	Package VAV - Electric Reheat	Package VAV - Hydronic Reheat	PSZ-HP	PSZ-AC	PSZ-HP	PSZ-AC
Fan control	VSD (with SP Reset)	VSD (with SP Reset)	Constant Volume	Constant Volume	2-speed	2-speed
Main fan power (W/CFM (W·s/L))proposed ≥ MERV13	0.634 (1.343)	0.634 (1.343)	0.486 (1.03)	0.486 (1.03)	0.585 (1.245)	0.585 (1.245)
Zonal fan power (W/CFM (W·s/L))	0.35 (5.53)	NA	NA	NA	NA	NA
Minimum zone airflow fraction	1.5* Voz	1.5* Voz	NA	NA	NA	NA
Heat/cool sizing factor	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15
Supplemental heating availability	NA	NA	<40°F (<4.4°C) OAT	NA	<40°F (<4.4°C) OAT	NA
Outdoor air economizer	Yes except 0-1	Yes	Yes except 0-1	Yes	Yes except 0-1	Yes
Occupied OSA source	Packaged unit, occupied damper, all building use types					
Energy recovery ventilator	No	No	No	No	Yes, in 0A, 1A, 2A, 3A	Yes all A, 6,7,8 CZ
ERR					50%	50%
DCV	Yes	Yes	No	No	Yes	Yes
% Area Variable Control	15%	15%			80%	80%
% Area On/Off Control	65%	65%			0%	0%
Cooling source	DX, multi-stage	DX, multi-stage	DX, 1 stage (heat pump)	DX, single stage	DX, 2 stage (heat pump)	DX, 2 stage
Cooling COP (net of fan)	3.83	3.83	3.82	3.8248	3.765	3.765
Heating source	Electric resistance	Gas Boiler	Heat Pump	Furnace	Heat Pump	Furnace
Heating COP (net of fan) / furnace or boiler efficiency	100%	81% E_t	3.81	81% E_t	3.536	81% E_t
Heating coil HW dT. °F (°C)	NA	20 (11.11)	NA	NA	NA	NA
Design HWST. °F (°C)	NA	140 (60)	NA	NA	NA	NA
HWST reset set point vs OAT, °F (°C)	NA	HWST: 180-150/OAT 20-50 (82-65.6/ -6.7-10)	NA	NA	NA	NA
Heat loop pumping control	NA	2-way Valves & ride pump curve	NA	NA	NA	NA
Heating pump power (W/gpm (W·s/L))	NA	16.1	NA	NA	NA	NA

TABLE C409.7(3) Target Building Design Criteria HVAC Simple Systems

Parameter	Building Type			
	Hotel (warm)	**Hotel (cold)**	**Multifamily (warm)**	**Multifamily (cold)**
System type	*PTHP*	*PTAC with Hydronic Boiler*	*Split HP*	*Split AC*
Fan control	Cycling	Cycling	Cycling	Cycling
Main fan power (W/CFM (W·s/L))	0.300 (0.638)	0.300 (0.638)	0.246 (0.523)	0.271 (0.576)
Heat/cool sizing factor	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15
Supplemental heating availability	<40°F (<4.4°C)	NA	<40°F (<4.4°C)	NA
Outdoor air economizer	Only CZ 2, 3	No	No	No
Occupied OSA source	DOAS	DOAS	DOAS	DOAS except 3C
Energy recovery ventilator	NA	NA	Yes	Yes except 3C
ERR	NA	NA	60%	60%
DCV	Yes	Yes	No	No
% Area Variable Control	70%	70%		
% Area On/Off Control	0%	0%		
Cooling source	DX, 1stage (heat pump)	DX, 1 stage	DX, 1 stage (heat pump)	DX, 1 stage
Cooling *COP* (net of fan)	3.83	3.83	3.823	3.6504
Heating source	*Heat Pump*	(2) Hydronic *Boiler*	*Heat Pump*	Furnace
Heating *COP* (net of fan) / furnace or *boiler efficiency*	3.44	81% E_t	3.86	80% AFUE
Heating *pump* power (W/gpm (W·s/L))	NA	16.1	NA	NA
Heating coil heating water delta-T, °F (°C)	NA	20 (11.11)	NA	NA
Design HWST, °F (°C)	NA	140 (60)	NA	NA
HWST reset *set point* vs OAT, °F (°C)	NA	HWST: 180-150/OAT 20-50 (82-65.6/ -6.7-10)	NA	NA
Heat loop *pump*ing control	NA	2-way Valves & ride *pump* curve	NA	NA

Appendix CD
REQUIRED HVAC TSPR

CD 101 Required HVAC TSPR. For jurisdictions who wish to adopt a stretch code or HVAC incentive system, make the following changes to Section C403.

Replace Section C403.1 with the following:

C403.1 General. Mechanical systems and equipment serving the building heating, cooling, ventilating, or refrigerating needs shall comply with one of the following:

1. Sections C403.1.1 and C403.2 through C403.14 and also comply with Section C403.1.3
2. Data Centers shall comply with C403.1.1, C403.1.2 and C403.6 through C403.14

Replace Section C403.1.3 with the following.

C403.1.3 HVAC total system performance ratio (*HVAC TSPR*). For systems serving buildings or portions of buildings of the following types :

1. Office (including medical office) (occupancy group B),
2. Retail (occupancy group M), library (occupancy group A-3),
3. Education (occupancy group E), and
4. Hotel/motel occupancies (occupancy group R-1) and
5. The *dwelling units* and common areas within occupancy group R-2 multifamily buildings,

The *HVAC total system performance ratio* (*HVACTSPR*) of the *proposed design* HVAC systems shall be greater than or equal to the *HVACTSPR* of the *standard reference design* divided by the applicable mechanical performance factor (MPF) from Table C409.4 . *HVACTSPR* shall be calculated in accordance with Section C409 , Calculation of HVAC Total System Performance Ratio.

Exceptions to C403.1.3

1. Buildings with conditioned floor area less than 5,000 square feet.
2. Alterations to existing buildings that do not substantially replace the entire HVAC system and are not serving initial build-out construction
3. HVAC systems using district heating water, chilled water or steam.
4. Portions of buildings served by systems using:
   - 4.1. Small duct high velocity air cooled, space constrained air cooled, single package vertical air conditioner, single package vertical heat pump, or
   - 4.2. Double-duct air conditioner or double-duct heat pump as defined in subpart F to 10CFR part 431
   - 4.3. Packaged terminal air conditioners and packaged terminal heat pumps that have cooling capacity greater than 12,000 Btu/hr (3500 kW)
   - 4.4. A common heating source serving both HVAC and service water heating equipment
   - 4.5. HVAC systems not included in Table C409.5.2.10.1
   - 4.6. HVAC systems included in table C409.5.2.10.1 with parameters in Table C409.5.2.10.2, not identified as applicable to that HVAC system type.
   - 4.7. Underfloor air distribution and displacement ventilation HVAC systems.
   - 4.8. Space conditioning systems that do not include mechanical cooling.
   - 4.9. HVAC systems that provide recovered heat for service water heating
   - 4.10. HVAC systems with chilled water supplied by absorption chillers, heat recovery chillers, water to water heat pumps, air to water heat pumps, or a combination of air and water cooled chillers on the same chilled water loop.
   - 4.11. HVAC system served by heating water plants that include air to water or water to water heat pumps.
   - 4.12. HVAC systems meeting or exceeding all the requirements of the applicable Target Design HVAC System described in Tables C409.5.4(1) through C409.5.4(3) ,
   - 4.13. HVAC systems serving laundry rooms, elevator rooms, mechanical rooms, electrical rooms, data centers, and computer rooms.
   - 4.14. Buildings or areas of medical office buildings that comply fully with ASHRAE Standard 170, including but not limited to surgical centers, or that are required by other applicable codes or standards to provide 24/7 air handling unit operation
   - 4.15. HVAC systems serving laboratories with fume hoods
   - 4.16. Locker rooms with more than 2 showers
   - 4.17. Natatoriums and rooms with saunas
   - 4.18. Restaurants and commercial kitchens with total cooking capacity greater than 100,000 Btu/h
   - 4.19. Cafeterias and dining rooms
   - 4.20. Areas of buildings with commercial refrigeration equipment exceeding 100 kW of power input.

Replace Table C409.4 with the following, this provides a 5% reduction in HVAC energy:

	Climate Zone:	0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
Building type	Occupancy Group																			
Office (small and medium)[a]	B	0.68	0.68	0.67	0.67	0.65	0.62	0.67	0.65	0.61	0.76	0.67	0.74	0.8	0.73	0.76	0.82	0.79	0.83	0.85
Office (Large)[a]	B	0.79	0.79	0.8	0.8	0.75	0.78	0.68	0.77	0.73	0.64	0.72	0.6	0.67	0.68	0.6	0.69	0.67	0.67	0.67
Retail	M	0.57	0.54	0.48	0.52	0.44	0.44	0.41	0.48	0.38	0.43	0.54	0.65	0.44	0.65	0.64	0.48	0.43	0.42	0.36
Hotel/Motel	R-1	0.59	0.59	0.6	0.6	0.59	0.65	0.58	0.67	0.69	0.43	0.56	0.49	0.36	0.45	0.48	0.33	0.36	0.29	0.25
Multi-Family/ Dormitory	R-2	0.61	0.6	0.64	0.6	0.62	0.61	0.56	0.68	0.52	0.5	0.48	0.42	0.51	0.45	0.36	0.52	0.48	0.48	0.45
School/ Education and Libraries	E (A-3)	0.78	0.77	0.76	0.75	0.71	0.68	0.67	0.68	0.64	0.69	0.68	0.65	0.78	0.69	0.58	0.85	0.76	0.79	0.73

a. large office (gross conditioned floor area >150,000 ft^2 (14,000 m^2) or > 5 floors); all other offices are small or medium

Reason: The prescriptive path is traditionally the most widely used approach for commercial code compliance in the United States. Though easy to implement, the prescriptive approach does not discriminate between high-performing and poorly performing heating, ventilation, air conditioning (HVAC) system configurations that are both minimally compliant. For example, a high capacity PTAC is less efficient than a packaged rooftop air conditioner, but either one can be used in the prescriptive path. The packaged rooftop unit is a better design choice, both for energy savings and reduced noise in the space. To meet aggressive energy and carbon reduction goals, energy codes will need to transition from prescriptive to performance-based approaches, a transition that has several challenges.
This proposal includes 3 features:

· An alternative path in Section C403 that can be used optionally for tradeoffs, such as a more efficient system that does not have outside air economizers. This performance path uses minimum efficiency HVAC equipment for all the target systems with a selection of a reasonable and typical system type and related fan and pumping parameters. In this case, mandatory requirements and certain prescriptive requirements are maintained, while most prescriptive requirements can be traded off for improved efficiency in other parts of the system.

· An addition to the energy credits section (C406) of the code that accounts for the total HVAC system performance, not just heating and cooling efficiency.

· An optional appendix that can be adopted for stretch codes and utility incentive certification that requires TSPR analysis where it is applicable and requires a higher level of performance, saving 5% vs. minimum efficiency systems.

HVAC System Performance is a discipline performance path and provides a simpler solution to HVAC system evaluation compared to whole building performance, while keeping tradeoffs limited to specific building systems. The Total System Performance Ratio (TSPR) is a metric for evaluation of overall system efficiency instead of individual component efficiency, a solution that could also eventually facilitate the transition to a 100% performance-based code structure. TSPR is a ratio that compares the annual heating and cooling load of a building to the annual energy consumed by the building's HVAC system.

A web-based calculation tool has been developed for determining a building's TSPR. Already incorporated into the 2018 Washington State Energy Code, this approach has also been evaluated by the ASHRAE Standard 90.1 Project Committee and has the potential to provide a comprehensive performance-based approach for HVAC system evaluation and analysis

For the stretch code option, implementing a base TSPR minimum requirement for HVAC systems in relevant buildings will result in savings when the least efficient systems allowed under the prescriptive path are required to make some change to improve efficiency in line with a reasonably good prescriptive system. Such changes might include efficiency improvements, better duct design that reduces fan power, or the inclusion of options like economizers, demand controlled ventilation, improvement in energy recovery effectiveness or addition of energy recovery that might be excepted for the particular situation. The HVAC System performance path looks at the performance of all the systems in the building, so smaller systems do not necessarily need to meet higher requirements.

Additional Commentary for Section 409.3

1. Examples of *HVAC systems* that are intended to receive HVAC services from *systems* in the permit include future zonal water source heat pumps that will receive loop water that is heated by a *boiler* or cooled by a cooling tower included in the permit, any *system* that will receive outdoor *ventilation* air from a dedicated *outdoor air system* included in the permit, and future zone terminal units that will be connected to a central *VAV system* included in the permit.

2. An initial build-out with heating coils served from a previously installed *system* with a high-*efficiency* condensing *boiler* would use the installed *efficiency* if it exceeded the current requirements. If the installed *boiler* had a lower *efficiency* than the current requirements, the current requirement would be used

3. A partial central plant upgrade (e.g. chiller, but not *boiler* replacement) cannot use this method

Coordination with Proposal CEPI-193-21

Proposal CEPI-193-21 includes the following coordinating language that adds the HVAC TSPR approach as an HVAC energy credit.

1. Section 406.2.2 numbered list items 1 and 7.

2. Section C406.2.2.1,

3. the base energy credits for H01 in Tables C406.1.4(1) through C406.1.4(9).

If this Proposal CEPI-76-21 is not approved for publication in the 2024 IECC then the coordinating language for energy credit H01 in CEPI-193-21 needs to be removed prior to publication.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
For the base proposal, there is no cost impact, as TSPR is an optional path that is not required under the prescriptive path.

For the energy credits addition, this is one of many options, and the energy credits show cost effectiveness through one cost effective path that may not include this option. Adding TSPR to energy credits just increases efficiency.

For the stretch code appendix, there may be a cost increase; however, this option is a jurisdictional adoption choice where the jurisdiction may choose to require improved efficiency performance as a matter of policy, rather than focusing on individual building cost savings, including consideration for environmental externalities and societal costs.

Bibliography: Goel S., R Hart, M Tillou, M Rosenberg, J Gonzalez, K Devaprasad, and J Lerond. 2021.HVAC System Performance for Energy Codes. PNNL-31571. Richland, WA: Pacific Northwest National Laboratory.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Proposal provides an alternative compliance path with a focus on performance. Please also refer to the reason statement in the proposal.

Proposal # 121

CEPI-79-21

Proponents: Howard Ahern, representing Airex Manufacturing (howard.ahern@airexmfg.com)

2021 International Energy Conservation Code

Revise as follows:

C403.12.3 Piping insulation. Piping serving as part of a heating or cooling system shall be thermally insulated in accordance with Table C403.12.3(1) or Table C403.12.3(2).

Exceptions:

1. Factory-installed piping within HVAC equipment tested and rated in accordance with a test procedure referenced by this code.
2. Factory-installed piping within room fan-coils and unit ventilators tested and rated according to AHRI 440 (except that the sampling and variation provisions of Section 6.5 shall not apply) and AHRI 840, respectively.
3. Piping that conveys fluids that have a design operating temperature range between 60°F (15°C) and 105°F (41°C).
4. Piping that conveys fluids that have not been heated or cooled through the use of fossil fuels or electric power.
5. Strainers, control valves, and balancing valves associated with piping 1 inch (25 mm) or less in diameter.
6. Direct buried piping that conveys fluids at or below 60°F (15°C).
7. In radiant heating systems, sections of piping intended by design to radiate heat.

TABLE C403.12.3 MINIMUM PIPE INSULATION THICKNESS (in inches or R Value)[a, c]

Portions of table not shown remain unchanged.

FLUID OPERATING TEMPERATURE RANGE AND USAGE (°F)	INSULATION CONDUCTIVITY			NOMINAL PIPE OR TUBE SIZE (inches)				
	Conductivity Btu × in./(h × ft^2 × °F)[b]	Mean Rating Temperature, °F	Inches R Value	< 1	1 to < 1 1/2	1 1/2 to < 4	4 to < 8	~~>~~ ≥ 8
				Minimum Insulation Thickness (inches)				
> 350	0.32–0.34	250	Inches	4.5	5.0	5.0	5.0	5.0
			R Value	R32	R36	R34	R26	R21
251–350	0.29–0.32	200	Inches	3.0	4.0	4.5	4.5	4.5
			R Value	R20	R29	R32	R24	R20
201–250	0.27–0.30	150	Inches	2.5	2.5	2.5	3.0	3.0
			R Value	R17	R17	R17	R15	R13
141–200	0.25–0.29	125	Inches	1.5	1.5	2.0	2.0	2.0
			R Value	R9	R9	R11	R10	R9
105–140	0.21–0.28	100	Inches	1.0	1.0	1.5	1.5	1.5
			R Value	R5	R9	R8	R8	R7
40–60	0.21–0.27	75	Inches	0.5	0.5	1.0	1.0	1.0
			R Value	R2	R2	R5	R5	R4
< 40	0.20–0.26	50	Inches	0.5	1.0	1.0	1.0	1.5
			R Value	R 6	R9	R9	R8	R7

For SI: 1 inch = 25.4 mm, °C = [(°F) – 32]/1.8.

a. For piping smaller than 1 1/2 inches and located in partitions within conditioned spaces, reduction of these thicknesses by 1 inch shall be permitted (before thickness adjustment required in Note b) but not to a thickness less than 1 inch.

b. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows:

$$T = r\,[(1 + t/r)^{K/k} - 1]$$

where:
T = Minimum insulation thickness in inches.
r = Actual outside radius of pipe in inches.
t = Insulation thickness listed in the table for applicable fluid temperature and pipe size.
K = Conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu × in/h × ft^2 × °F).
k = The upper value of the conductivity range listed in the table for the applicable fluid temperature.

c. For direct-buried heating and hot water system piping, reduction of these thicknesses by 1 1/2 inches (38 mm) shall be permitted (before thickness adjustment required in Note b but not to thicknesses less than 1 inch.

Add new text as follows:

TABLE C403.12.3(2) MINIMUM PIPE INSULATION R-Value[a]

FLUID OPERATING TEMPERATURE RANGE AND USAGE (°F)	NOMINAL PIPE OR TUBE SIZE (inches)				
	≤1	1 TO <1 1/2	1 1/2 TO <4	4 TO <8	≥8
Minimum Insulation R-Value					
>350	R32	R36	R34	R26	R21
251-350	R20	R29	R32	R24	R20
201-250	R17	R17	R17	R15	R13
141-200	R9	R9	R11	R10	R9
105-140	R5	R9	R8	R8	R7
40-60	R2	R2	R5	R5	R4
<40	R6	R9	R9	R8	R7

For SI: R-1 = RSI-0.176228, °C = [(°F)-32]/1.8.

a. The *R-value* of cylindrical piping insulation shall be determined as follows:

$R=(r_o(\ln(r_o/r_i)))/k$

where:
R = The interior *R-value* of the cylindrical piping insulation in Btu x ft^2 x °F/h

r_o = The outer radius of the piping insulation in inches

r_i = The inner radius of the piping insulation in inches
k = the thermal conductivity of the insulation material in Btu x in/h x ft^2 x °F

Reason: All materials having the same R-value, regardless of type; thickness; or weight, are equal in insulating strength. Where a specific R-value is required all insulation materials can be compared equally.
This proposal seeks to harmonize the selection of pipe insulation requirements by allowing either thickness or R Value. The Chart has been changed to set minimum R valves required as an option to pipe insulation thickness . Optional R Values allows for materials with the same or higher R Values but lower thickness. “Since 2010, there have been a number of new mechanical insulation products and systems developed in North America. Some are modifications to previously commercially available materials, and some are completely new. Additionally, ASTM has developed several new specifications and revised a number of others.”*

New materials for Pipe insulation are readily available and comply with the minimum R values required but can have lower thicknesses. This proposal offers the option of using either R values or pipe insulation thickness to achieve desired energy savings.

2021 IECC C102.1General
The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been *approved*. The code official shall have the authority to approve an alternative material, design or method of construction upon the written application of the owner or the owner's authorized agent. The *code official* shall first find that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, not less than the equivalent of that prescribed in this code in quality, strength, effectiveness, *fire resistance*, durability, energy conservation and safety.

The code does allow for alternative material in C102.1 however, this would prove to be impractical as the code official would not know the R Value required without having to Calculate each size of piping to find the Pipe Insulations R Value and again would restrict new material that have the same R value required but in a lower thickness.

C303.1.2 already requires Insulating materials shall be installed such that the manufacturer’s *R*-value mark is readily observable upon inspection. This also would make it easier to inspect an R Value on the insulation then to view pipe insulation to determine its thickness.

Technical Report on Calculating Pipe Insulation R-Values

Using Dimensions and Thermal Conductivity Values

In the International Energy Code (IEC)

Written by Gordon H. Hart, P.E.

October 12, 2021

Technical Problem

: The International Energy Code (IEC) includes a Table C403.12.3 that specifies minimum pipe insulation thicknesses. These can be broken into rows for different pipe temperature ranges and columns for different pipe diameter ranges. For each pipe temperature range, there is an assumed range of thermal conductivity values from which the pipe insulation thickness is calculated.

There is an inverse relationship between thermal conductivity and R-value; hence, the greater the thermal conductivity, the lower the R-value and vice-versa. The higher thermal conductivity (i.e., value of k) will give the lower R-value for each range, when R-value is calculated. In the attached table, these lower R-values should be calculated using the standard equation that uses input of inner and outer pipe insulation radii and thermal conductivity of pipe insulation, namely:

First, since there is a range of values of k applicable to each temperature range, the higher value of k should be used to calculate the lower R-value. In addition, the inner and outer pipe insulation radii (radius is half the diameter) are not equal to nominal values. Rather, their exact radii values are different and should be taken from the ASTM standard C585. Making these modifications to the input to the above equation for R-value, we arrive at new, somewhat lower R-values for each temperature range and each pipe diameter range, as shown on the attached table (note that these only show the non-residential values):

	Nominal	Actual	Actual	Actual		R-value
105-140	Pipe Dia, NPS	r1 inside	r2 outside	th (inch)	k (max)	(min)
	< 1	0.72	1.72	1	0.28	5
	1 up to 1.5	0.72	2.22	1.5	0.28	9
	1.5 up to 4	1.015	2.515	1.5	0.28	8
	4 up to 8	2.35	3.99	1.64	0.28	8
	> 8	4.41	6.05	1.64	0.28	7
141-200	< 1	0.72	2.22	1.5	0.29	9
	1 up to 1.5	0.72	2.22	1.5	0.29	9
	1.5 up to 4	1.015	3.015	2	0.29	11
	4 up to 8	2.35	4.45	2.1	0.29	10
	> 8	4.41	6.59	2.18	0.29	9
201-250	< 1	0.72	3.31	2.59	0.3	17
	1 up to 1.5	0.72	3.31	2.59	0.3	17
	1.5 up to 4	1.015	3.81	2.795	0.3	17
	4 up to 8	2.35	5.375	3.025	0.3	15
	> 8	4.41	7.5	3.09	0.3	13
251-350	< 1	0.72	3.81	3.09	0.32	20
	1 up to 1.5	0.72	4.81	4.09	0.32	29
	1.5 up to 4	1.015	5.875	4.86	0.32	32
	4 up to 8	2.35	7	4.65	0.32	24
	> 8	4.41	9	4.59	0.32	20
>350	< 1	0.72	5.375	4.655	0.34	32
	1 up to 1.5	0.72	5.875	5.155	0.34	36
	1.5 up to 4	1.015	6.375	5.36	0.34	34
	4 up to 8	2.35	7.5	5.15	0.34	26
21	21	21	21	21	21	21

Temp Ran <40	Nominal Pipe Dia, NPS	Actual r1 inside	Actual r2 outside	Actual th (inch)	k (max)	R-value (min)
	< 1	0.72	1.72	1	0.26	6
	1 up to 1.5	0.72	2.22	1.5	0.26	10
	1.5 up to 4	1.015	2.515	1.5	0.26	9
	4 up to 8	2.35	3.99	1.64	0.26	8
	> 8	4.41	6.05	1.64	0.26	7
40-60	0.5 (non-res)	0.5	0.935	0.435	0.27	2
	1 up to 1.5 (non-res)	0.72	1.22	0.5	0.27	2
	1.5 up to 4	1.015	2.015	1	0.27	5
	4 up to 8	2.35	3.4	1.05	0.27	5
	> 8	4.41	5.5	1.09	0.27	4

Comments

: These minimum R-values, are calculated using the maximum values of k from the appropriate temperature range in the 2021 IECC Table C403.12.3. It's particularly interesting, however, to examine the smallest pipe in the

< 40°F temperature range since that previously required a minimum of .50-inch thickness, which results in a minimum R-value of 6.

Conclusions: The 2021 IECC Table C403.12.3 gives the minimum required thickness for pipe insulation used to insulate both cold and hot pipes. It is proposed that an alternative be to list the minimum required R-value for each pipe temperature range and each pipe size range, using calculated values of R-value. The new R-value calculations have used minimum values of thermal conductivity, k, and nominal dimensions of the pipe insulation. These calculations, as described above and as shown on the attached table, show the minimum R-values.

*Recent Developments in Mechanical Insulation Technolgy_Gordon H. Hart Insulation Outlook Magazine

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This code proposal does not change the current requirement for pipe insulation thickness thus not increasing cost but allows an option to comply based on R Values or thickness. As new materials can be higher R values and have lower thickness this could decrease labor and materials used.

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Attached Files

- **Recent Developments in Mechanical Insulation Technolgy_Gordon H. Hart.pdf**
  https://energy.cdpaccess.com/proposal/34/1213/files/download/183/

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: per the proponent's reason statement submitted.

CEPI-80-21

Proponents: Howard Ahern, representing Airex Manufacturing (howard.ahern@airexmfg.com)

2021 International Energy Conservation Code

Revise as follows:

C403.12.3.1 Protection of piping insulation. Piping insulation exposed to the weather shall be protected from physical damage, including that caused by sunlight, moisture, equipment maintenance and wind. The protection~~, and~~ shall provide shielding from solar radiation that can cause degradation of the material ~~and~~ . The protection shall be removable and reuseable for not less than 6 inches (150 mm) from the connection to the equipment piping for maintenance. Adhesive tape shall not be permitted as a means of insulation protection.

Reason: Purpose of code change: This proposal will clarify the intent of Section C403.12.3. The intent of these sections is not only protection of pipe insulation from weather but to insure the insulations thermal conductivity energy savings integrity lasts the life of the mechanical system asper the intent of the code. To remove the opportunity for misunderstanding so that the code has will have its intended result, the term “equipment maintenance” must be clarified that it is for physical damage.
The 2012,2015, & 2018 IECC Code and Commentary both state that Equipment maintenance is to protect from physical damage to the pipe insulation.
“The piping insulation should be protected from sunlight, moisture, wind and solar radiation but also from personal who may step on it, run in to it with equipment, etc. and cause it to be damaged.
“Protective covering must also protect from physical damage so if the protection covering does get damaged from stepping on it, dropping tools on it, birds, lawn trimmers etc.it can be repaired or replaced.
Keeping the insulations thermal conductivity integrity and insuring the insulation system last the life of the mechanical system and avoiding the costly replacement of the insulation. Repairing pipe insulation is done with adhesives and then adhesive seams are left to weather exposure leading to degradation. The seams open sun and moisture damage the insulation system. Removable protection is vital to ensure insulation can retard heat and condensation to provide energy savings and safety.

Pipe insulation is sold in minimum 6 foot sections at Contractor supply Distributors

The proposal states that protection be removable no less than 6 feet from the equipment to allow equipment maintenance without having to destroy the insulation or purchase additional pipe insulation to replace. The intent is in the original 2012 IECC code proposal, the proponent’s reason statement of this requirement EC207-09/10 stated this was to Harmonize the IECC with ASHRAE 90.1 the 2012 code the reason statement also stated -“All AC units require periodic maintenance. The frequency varies with how hard the unit operates, exterior temperature, preventive maintenance program, and many others. On every occasion, every maintenance provides an excuse for the Freon line insulation to be touched and removed.” The intent is clear that the protection be removable and independent of the pipe insulation for maintenance without damaging the pipe insulation. Removing protection without damaging the insulation is stated in EC207-09/10 “Adhesives Tape is not permitted as it will limit maintenance and damage insulations permeability characteristics. Removal of tape damages the integrity of the original insulation into pieces, specially, if the insulation has reached thermo set state. The main reason for pitting and corrosion of the piping in refrigerant lines is moisture intrusion into the pipe insulation from the termination point that are not protected. The gap between the piping and insulation creates a pathway for moisture to run the length and damage the system. It only takes a 1% moisture gain to equal to a 7.5 % loss in thermal efficiency. “The most likely area of intrusion is at the insulation system penetration Points, gauges, attachments etc. If the integrity or exterior of the insulation system is not installed correctly and moisture sources are present, moisture will more than likely penetrate the insulation system. Moisture intrusion can negatively affect all aspects of the insulation system such as thermal values, which can have a direct impact on process control, energy cost, condensation, control, safety, the potential of mold development etc. Not to mention the potential of corrosion under the insulation (CUI).” Insulation, the Forgotten Technology for Energy Conservation 2007 ACEE

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This change will not increase the cost of construction as removable protection has been used before and snice the IECC2012 when protection was required. In fact this will decrease the cost of construction on future equipment replacement and maintenance by nit having to replace pipe insulation.

Bibliography: Howard Ahern
Airex Manufacturing

760-250-1625

howard.ahern@airexmfg.com

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: This proposal will clarify the intent of Section C403.12.3. The intent of these sections is not only protection of pipe insulation from weather but to insure the insulations thermal conductivity energy savings integrity lasts the life of the mechanical system asper the intent of the code.

Proposal # 32

CEPI-82-21 Part I

Proponents: Nick Thompson, City of Aspen, representing Colorado Chapter of the ICC (nick.thompson@cityofaspen.com)

THIS IS A 2 PART PROPOSAL. PART I WILL BE HEARD BY THE IECC-COMMERCIAL COMMITTEE. PART II WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Energy Conservation Code

C403.13.2 Snow- and ice-melt system controls. Snow- and ice-melting systems shall include automatic controls configured to shut off the system when the pavement temperature is above 50°F (10°C) and precipitation is not falling, and an automatic or manual control that is configured to shut off when the outdoor temperature is above 40°F (4°C).

Add new text as follows:

C403.13.3 Roof and gutter deicing controls. Roof and gutter deicing systems, including but not limited to self-regulating cable, shall include automatic controls that are configured to shut off the system when the outdoor temperature is above 40°F (4°C) and that include one of the following:

1. A moisture sensor configured to shut off the system in the absence of moisture, or
2. A daylight sensor or other means configured to shut off the system between sunset and sunrise.

Revise as follows:

~~**C403.13.3**~~ **C403.13.4 Freeze protection system controls.** Freeze protection systems, such as heat tracing of outdoor piping and heat exchangers, including self-regulating heat tracing, shall include automatic controls configured to shut off the systems when outdoor air temperatures are above 40°F (4°C) or when the conditions of the protected fluid will prevent freezing.

Reason: Roof and gutter deicing, often in the form of heat tape, is used to prevent ice dams in buildings with inadequate roof insulation, air sealing, and/or attic/roof surface ventilation. These systems use energy and are often left running at times that are unnecessary for ice dam prevention. The intent is to have automatic controls limit the system from running when either of two conditions is present. The first condition is when the outdoor temperature is above 40°F (4.8°C). For the second condition, there is an option to either provide a moisture sensor or a timer. Running heat tape all day and night can lead to melt cavities with an air space that can insulate the ice from the heat tape. Shutting the system off at night or using moisture control helps alleviate this issue. Moisture control works well if done just right but can be problematic in practice on roofs. A timer provides an option to avoid this concern. A daylight sensor option was considered but deemed inappropriate for high latitudes that may be in darkness all day long.
This language applies to both self-regulating type cable and standard cable. Self-regulating cable automatically adjusts the wattage based on temperature; as temperature decreases, the heat output of the cable increases. However, controls are needed as some current will still flow through at temperatures above 40°F (4.8°C) and the moisture/timer condition is needed to avoid air cavities.

Cost Impact: The code change proposal will increase the cost of construction.
Upfront cost will increase but will be made up for by reducing energy bills over the useful life of the system. Electric resistant heat is very expensive to run when it is not needed. Manual controls require user interaction which is unlikely to be effective. Anecdotally, many people have systems installed without automatic controls and then wonder why their electric bills are so high until they realize their heat tape system has been running all summer long.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: To clarify the original reason statement, ice damming can occur even on new buildings built to current code provisions, such as warm roofs that are unvented.

CEPI-83-21

Proponents: Nicholas O'Neil, representing NEEA (noneil@energy350.com); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Add new definition as follows:

BEST EFFICIENCY POINT (BEP). The pump hydraulic power operating point (consisting of both flow and head conditions) that results in the maximum efficiency.

CLEAN WATER PUMP. A device that is designed for use in pumping water with a maximum nonabsorbent free solid content of 0.016 lb/ft^3 (0.256 kg/m^3) and with a maximum dissolved solid content of 3.1 lb/ft^3 (49.66 kg/m^3), provided that the total gas content of the water does not exceed the saturation volume, and disregarding any additives necessary to prevent the water from freezing at a minimum of 14°F (-10°C).

Add new text as follows:

C403.15 Clean water pumps. *Clean water pumps* meeting all the following criteria shall achieve a PEI rating not greater than 1.0:

1. Shaft input power is greater than or equal to 1.0 hp (0.75 kW) and less than or equal to 200 hp (149.1 kW) at its BEP.
2. Designated as either an End suction Close-coupled, End Suction Frame Mounted, In-line, Radially Split Vertical, or Submersible Turbine pump.
3. A flow rate of 25 gal/min (1.58 L/s) or greater at its *best efficiency point (BEP)* at full impeller diameter
4. Maximum head of 459 ft at its *BEP* at full impeller diameter and the number of stages required for testing
5. Design temperature range from 14°F (-10°C) to 248°F (120°C)
6. Designed to operate with either:
   - 6.1. a 2- or 4-pole induction motor, or
   - 6.2. a non-induction motor with a speed of rotation operating range that includes speeds of rotation between 2880 and 4320 rpm and/or 1440 and 2160 rpm, and
   - 6.3. in either (1) or (2), the driver and impeller must rotate at the same speed
7. For submersible turbine pumps, a 6 inches (152 mm) or smaller bowl diameter
8. For end-suction close-coupled pumps and end-suction frame-mounted/own bearings pumps, specific speed less than or equal to 5000 rpm when calculated using U.S. customary units

Exceptions: The following pumps are exempt from these requirements:

1. Fire pumps
2. Self-priming pumps
3. Prime-assisted pumps
4. Magnet-driven pumps
5. Pumps designed to be used in a nuclear facility subject to 10 CFR 50, “Domestic Licensing of Production and Utilization Facilities.”
6. Pumps meeting the design and construction requirements set forth in U.S. Military Specification MIL-P-17639F, “Pumps, Centrifugal, Miscellaneous Service, Naval Shipboard Use” (as amended); MIL-P-17881D, “Pumps, Centrifugal, Boiler Feed, (Multi-Stage)” (as amended); MIL-P-17840C, “Pumps, Centrifugal, Close-Coupled, Navy Standard (For Surface Ship Application)” (as amended); MIL-P-18682D, “Pump, Centrifugal, Main Condenser Circulating, Naval Shipboard” (as amended); MIL-P-18472G, “Pumps, Centrifugal, Condensate, Feed Booster, Waste Heat Boiler, And Distilling Plant” (as amended).

Add new definition as follows:

PUMP ENERGY INDEX (PEI). The ratio of a pump’s energy rating divided by the energy rating of a minimally compliant pump. For pumps with the constant load operating mode, the relevant PEI is PEI_{CL}. For pumps with the variable load operating mode, the relevant PEI is PEI_{VL}.

Add new text as follows:

DoD

U.S. Department of Defense
Pentagon
3010 Defense
Washington, DC 20301

DoD MIL-P-17639F (1996). Pumps, Centrifugal, Miscellaneous Service, Naval Shipboard Use

DoD MIL-P-17840C (1986). Pumps, Centrifugal, Close-Coupled, Navy Standard (For Surface Ship Application)

DoD MIL-P-17881D (1972). Pumps, Centrifugal, Boiler Feed (Multi-Stage)

DoD MIL-P-18472 (1989). Pumps, Centrifugal, Condensate, Feed Booster, Waste Heat Boiler, and Distilling Plant

DoD MIL-P-18682D. Pump, Centrifugal, Main Condenser Circulating, Naval Shipboard

Reason: As of January 27th, 2020, DOE published new minimum efficiency requirements for clean-water pumps which increased the minimum efficiency requirements for commercial and industrial pumping applications. This requirement applies to all pumps manufactured on or after January 27, 2020.

To rate the energy performance of pumps, the DOE established a new metric, the pump energy index (PEI). A value of PEI greater than 1.00 indicates the pump does not comply with the energy conservation standard, while a value less than 1.00 indicates the pump is more efficient than the standard requires. A pump model is considered compliant if its PEI rating is less than or equal to the adopted standard. The DOE based its final rule on the test methods recommended by the Hydraulic Institute and contained in its “Methods for Rotodynamic Pump Efficiency Testing.” THis PEI rating is now included on pump submittals as manufacturers have had 4 years to comply with the standard.

The methodology, requirements, and exceptions contained in this proposal mirror what is already included in ASHRAE 90.1-2019 and what is required by DOE to demonstrate compliance. Listing them in the IECC will provide designers with the necessary information on how to calculate PEI and which pumping systems are required to comply.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
As this proposal simply includes the minimum efficiency provisions adopted by DOE for clean water pumps, there it will not increase or decrease the cost of construction.

Bibliography: DEPARTMENT OF ENERGY 10 CFR Parts 429 and 431 [Docket Number EERE–2011–BT–STD–0031] RIN 1904-AC54
https://www.energy.gov/sites/prod/files/2015/12/f28/Pumps%20ECS%20Final%20Rule.pdf

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Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Simplified version preferred by the committee. The methodology, requirements, and exceptions contained in this proposal mirror what is already included in ASHRAE 90.1-2019 and what is required by DOE to demonstrate compliance. Listing them in the IECC will provide designers with the necessary information on how to calculate PEI and which pumping systems are required to comply.

CEPI-84-21

Proponents: Diana Burk, New Buildings Institute, representing New Buildings Institute (diana@newbuildings.org)

2021 International Energy Conservation Code

Add new definition as follows:

INDOOR GROW. a space, other than a greenhouse, used exclusively for, and essential to horticultural production, cultivation or maintenance.

DESSICANT DEHUMIDIFICATION SYSTEM. A mechanical dehumidification technology that uses a solid or liquid material to remove moisture from the air.

INTEGRATED HVAC SYSTEM. An HVAC system designed to handle both sensible and latent heat removal. Integrated HVAC systems include, but are not limited to HVAC systems with a sensible heat ratio of 0.65 or less and the capability of providing cooling, dedicated outdoor air systems, single package air conditioners with at least one refrigerant circuit providing hot gas reheat, and *dehumidifiers* modified to allow external heat rejection.

DEHUMIDIFIER. A self-contained, electrically operated, and mechanically encased product with the sole purpose of dehumidifying the space consisting of:

1. A refrigerated surface (evaporator) that condenses moisture from the atmosphere,
2. A refrigerating system, including an electric motor,
3. An air-circulating fan, and
4. A means for collecting or disposing of the condensate.

A dehumidifier does not include a portable air conditioner, room air conditioner, or packaged terminal air conditioner.

Add new text as follows:

C403.15 Dehumidification in spaces for plant growth and maintenance. Equipment that dehumidifies *indoor grow* and *greenhouse* spaces shall be one or more of the following:

1. *Dehumidifiers* tested in accordance with the test procedure listed in DOE 10 CFR 430 and DOE 10 CFR 430, Subpart B, Appendix X or X1.
2. *Integrated HVAC system* with on-site heat recovery designed to fulfill not less than 75 percent of the annual energy for dehumidification reheat;
3. Chilled water system with on-site heat recovery designed to fulfill not less than 75 percent of the annual energy for dehumidification reheat; or
4. Solid or liquid *desiccant dehumidification system* for system designs that require dewpoint of not more than 50°F (10°C).

Revise as follows:

DOE

US Department of Energy
c/o Superintendent of Documents 1000 Independence Avenue SW
Washington, DC 20585

10 CFR, Part 430—2015	Energy Conservation Program for Consumer Products: Test Procedures and Certification and Enforcement Requirement for Plumbing Products; and Certification and Enforcement Requirements for Residential Appliances; Final Rule Table C403.3.2(1), Table C403.3.2(2), Table C403.3.2(5), Table C403.3.2(6), Table C403.3.2(14), Table C404.2, C403.15

Reason: Indoor agriculture energy usage is projected to grow significantly nationwide in this decade, driven in large part by state legalization of medical and recreational marijuana across the country. In 2017, a total of 20 million square feet of building space was dedicated to growing crops indoors. Energy use by HVAC systems in indoor horticulture facilities can account for 30 to 65% of energy use - primarily because these systems must maintain specific humidity and temperature levels to promote plant growth. Section 403 already requires HVAC systems meet a certain efficiency threshold but does not address the efficiency of dehumidification systems.

The proposed language provides projects with a range of efficient dehumidification strategies. Indoor grow facilities can install dehumidifiers that meet federal minimum efficiency requirements. The proposal also provides options for solid or liquid desiccant dehumidification systems, for utilizing recovered energy in integrated HVAC systems, and for chilled water systems that can meet dehumidification reheat needs.

This proposal is based largely on the requirements listed in Section 120.6(h)1 of Title 24-2022 and is similar to requirements adopted in Denver, CO and being considered for adoption in Washington State, Michigan, and Illinois.

Cost Impact: The code change proposal will increase the cost of construction.
The incremental cost of installing more efficient dehumidification systems is around $8.11 per square foot of canopy. This measure results in significant energy savings of between 212 to 255 TDV kBtu/yr per square foot of canopy in Climate Zones 2-4. Every dollar spent to install more efficient equipment resulted in between $2.33 and $2.80 in operating and maintenance cost savings over the life of the system.

Bibliography: *Energy Savings Potential of SSL in Horticultural Applications*. U.S. Department of Energy, Dec. 2017, https://www.energy.gov/sites/prod/files/2017/12/f46/ssl_horticulture_dec2017.pdf.
Schimelpfenig, Gretchen. *Energy Efficiency for Massachusetts Marijuana Cultivators*, Resource Innovation Institute, Sept. 2020, resourceinnovationinstitute.wildapricot.org/RII-REPORTS/.

Final CASE Report: Controlled Environment Horticulture, California Statewide Codes and Standards Enhancement (CASE) Program, Oct. 2020, https://title24stakeholders.com/wp-content/uploads/2020/10/2022-T24-NR-CEH-Final-CASE-Report.pdf.

15-Day Express Terms 2022 Energy Code - Residential and Nonresidential, California Energy Commission, 14 July 2021, https://efiling.energy.ca.gov/GetDocument.aspx?tn=238848.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Section 403 already requires HVAC systems meet a certain efficiency threshold but does not address the efficiency of dehumidification systems. The proposed language provides projects with a range of efficient dehumidification strategies.

Proposal # 193

CEPI-85-21

Proponents: Nicholas O'Neil, representing NEEA (noneil@energy350.com); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Add new text as follows:

C403.16 Service Water Pressure-Booster Systems. Service water pressure-booster *systems* shall be designed such that the following apply:

1. One or more pressure sensors shall be used to vary pump speed and/or start and stop pumps. The sensors shall either be located near the critical fixtures that determine the pressure required, or logic shall be employed that adjusts the set point to simulate operation of remote sensors.
2. No devices shall be installed for the purpose of reducing the pressure of all of the water supplied by any booster *system* pump or booster *system*, except for safety devices.
3. No booster *system* pumps shall operate when there is no service water flow.

Reason: The IECC does not have any requirements over pressure boost system operation currently. ASHRAE has had these requirements in place since 90.1-2010 and found them to be a cost-effective requirement for new buildings. Many modern pressure boost systems already comply with ASHRAE standards and have the sensor controls on-board, eliminating the need for a field mounted remote pressure sensor. Furthermore, the energy savings from variable speed pressure boost systems can be substantial, ranging from 20%-50% (depending on the type of pressure control method) as shown in the attached whitepaper.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Modern pressure boost systems have software to control logic on the booster pump skid that adjusts the set point to simulate the operation of remote sensor, foregoing the need to install a remote pressure sensor at the critical fixtures.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: The IECC does not have any requirements over pressure boost system operation currently. ASHRAE has had these requirements in place since 90.1-2010 and found them to be a cost-effective requirement for new buildings. Many modern pressure boost systems already comply with ASHRAE standards and have the sensor controls on-board, eliminating the need for a field mounted remote pressure sensor. Furthermore, the energy savings from variable speed pressure boost systems can be substantial, ranging from 20%- 50% (depending on the type of pressure control method).

Proposal # 146

CEPI-86-21

Proponents: William Fay, representing Energy Efficient Codes Coalition (bill@energyefficientcodes.org); Amy Boyce, representing Energy Efficient Codes Coalition (amy.boyce@imt.org); Jason Reott, representing Energy Efficient Codes Coalition

2021 International Energy Conservation Code

Revise as follows:

C403.2.3 Fault detection and diagnostics. New buildings with ~~an~~ one or more HVAC ~~system~~ systems serving a gross conditioned floor area of 100,000 square feet (9290 m^2) or larger and controlled by a direct digital control (DDC) system shall include a fault detection and diagnostics (FDD) system to monitor ~~the~~ HVAC system~~'s~~ performance and automatically identify faults. The FDD system shall:
Buildings with gross conditioned floor area of not less than 100,000 square feet (9290 m^2) served by one or more HVAC systems that are controlled by a direct digital control (DDC) system shall include a fault detection and diagnostics (FDD) system to monitor ~~the~~ HVAC system~~'s~~ performance and automatically identify faults. The FDD system shall:

1. Include permanently installed sensors and devices to monitor ~~the~~ HVAC system~~'s~~ performance.
2. Sample ~~the~~ HVAC system~~'s~~ performance at least once every 15 minutes.
3. Automatically identify and report HVAC system faults.
4. Automatically notify authorized personnel of identified HVAC system faults.
5. Automatically provide prioritized recommendations for repair of identified faults based on analysis of data collected from the sampling of HVAC system performance.
6. Be capable of transmitting the prioritized fault repair recommendations to remotely located authorized personnel.

Exception: R-1 and R-2 occupancies.

C406.11 Fault detection and diagnostics system. A fault detection and diagnostics system shall be installed to monitor ~~the~~ HVAC system~~'s~~ performance and automatically identify faults. The system shall do all of the following:

1. Include permanently installed sensors and devices to monitor ~~the~~ HVAC system~~'s~~ performance.
2. Sample ~~the~~ HVAC system~~'s~~ performance at least once every 15 minutes.
3. Automatically identify and report HVAC system faults.
4. Automatically notify authorized personnel of identified HVAC system faults.
5. Automatically provide prioritized recommendations for repair of identified faults based on analysis of data collected from the sampling of ~~the~~ HVAC system performance.
6. Be capable of transmitting the prioritized fault repair recommendations to remotely located authorized personnel.

Reason: The purpose of this proposal is to clarify the code provisions related to Fault Detection and Diagnostics (FDD) systems. This proposal does not change any requirements of the code, but will make compliance and enforcement more straightforward. Since the FDD provisions were added to the 2021 IECC, some code users have questioned whether the existing language could be interpreted in a way that allows buildings with multiple HVAC systems to avoid complying with the requirement, and whether a building with no direct digital control system (DDC) should be required to comply. This code change proposal clarifies the original intent of the proposal, which is to require all new buildings with HVAC systems (whether a single HVAC system or multiple systems) serving at least 100,000 square feet of conditioned floor area--and controlled by a direct digital control (DDC) system--to include an FDD system. If the building does not include a DDC system, the FDD requirement does not apply.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Because this code change proposal does not introduce any new measures into the code, but simply clarifies the intent of the requirement, there is no impact on cost of construction.

COST-EFFECTIVENESS

Because this code change proposal does not change the requirements of the code, a cost-effectiveness analysis does not apply.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: Good clarifications that will improve enforcement.

Proposal # 328

CEPI-97-21

Proponents: Nicholas O'Neil, representing NEEA (noneil@energy350.com); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Add new definition as follows:

PROCESS APPLICATION. A manufacturing, industrial, or commercial procedure or activity where the primary purpose is other than conditioning spaces and maintaining comfort and amenities for the occupants of a building.

Add new text as follows:

C403.3.4 Boilers. *Boiler Systems* shall comply with the following:

1. Combustion air positive shut-off shall be provided on all newly installed *boiler systems* as follows:
   1.1. All *boiler systems* with an input capacity of 2,500,000 Btu/h and above, in which the boiler is designed to operate with a nonpositive vent static pressure.
   1.2. All *boiler systems* where one stack serves two or more boilers with a total combined input capacity per stack of 2,500,000 Btu/h.
2. *Boiler system* combustion air fans with motors 10 horsepower or larger shall meet one of the following for newly installed boilers:
   2.1. The fan motor shall be variable speed, or
   2.2. The fan motor shall include controls that limit the fan motor demand to no more than 30 percent of the total design wattage at 50 percent of design air volume.

C403.3.4.1 Boileroxygen concentration controls. Newly installed boilerswith an input capacity of 5,000,000 Btu/h and steady state full-load less than 90 percent shall maintain stack-gas oxygen concentrations not greater than the values specified in Table C403.3.4.1. Combustion air volume shall be controlled with respect to measured flue gas oxygen concentration. The use of a common gas and combustion air control linkage or jack shaft is prohibited.

TABLE C403.3.4.1 BOILER OXYGEN CONCENTRATIONS

Boiler System Application	**Minimum stack-gas oxygen concentration[a]**
≤ 10% of the boiler system capacity is used for *process applications* at design conditions	5%
Process Boilers	3%

a. Concentration levels measured by volume on a dry basis over firing rates of 20 to 100 percent.

Exception: These concentration limits do not apply 50% or more of the boiler system capacity serves Group R-2 occupancies.

Revise as follows:

~~**C403.3.4**~~ **C403.3.4.2 Boiler turndown.** *Boiler systems* with design input of greater than 1,000,000 Btu/h (293 kW) shall comply with the turndown ratio specified in Table ~~C403.3.4~~ C403.3.4.2.
The system turndown requirement shall be met through the use of multiple single-input boilers, one or more *modulating boilers* or a combination of single-input and *modulating boilers*.

TABLE ~~C403.3.4~~ C403.3.4.2 BOILER TURNDOWN

BOILER SYSTEM DESIGN INPUT (Btu/h)	MINIMUM TURNDOWN RATIO
≥ 1,000,000 and ≤ 5,000,000	3 to 1
> 5,000,000 and ≤ 10,000,000	4 to 1
> 10,000,000	5 to 1

For SI: 1 British thermal unit per hour = 0.2931 W.

Reason: Boiler oxygen controls, combustion air controls, and variable fan motors have been commonplace in state codes on larger boilers for quite some time. This proposal would align existing requirements in state codes with IECC. The effect will be an improvement in the part-load operation of larger boilers.
Savings are estimated at 2.116 kBtu/sqft and derived from the Title 24 CASE study as follows:

Flue damper – 2.5 mmbtu boiler 229 therms

VFD – 10 hp fan 4080 kWh

O2 trim controls – 5 mmBtu boiler 2746 therms

Based on EnergyPlus modeling of prototype buildings for California CASE study for 2022 Title 24. Savings shown above are an example assuming a large office building in CA Climate Zone 2 which is 13 stories. Provisions shown to be cost-effective for commercial boilers in all modeled scenarios except mixed use and apartment high-rise. Process boilers shown to be cost-effective in all cases due to constant load assumptions.

Final CASE report available here: https://title24stakeholders.com/wp-content/uploads/2020/08/NR-Boilers-and-Water-Heating_Final-CASE-Report.pdf

Cost Impact: The code change proposal will increase the cost of construction.
Expected cost to implement boiler controls is estimated at $0.098/sqft and derived from the Title 24 CASE study as follows:

Flue damper cost = $1665 ($1500 2013 inflated 11% to 2021) + $166 ($150 2013 inflated 11%) every 10 years
VFD cost = $4716 ($4249 2013 inflated 11% to 2021) + ½ hour per year in maintenance @$100/hr
O2 trim controls cost = $7500 (2022) + 4 hours per year in maintenance @$100/hr

https://title24stakeholders.com/wp-content/uploads/2020/08/NR-Boilers-and-Water-Heating_Final-CASE-Report.pdf

Bibliography: Codes and Standards Enhancement (CASE) Initiative 2022 California Energy Code - High Efficiency Boilers and Service Water Heating, 2022-NR-HVAC3-F Final Case Report, August 2020

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Boiler oxygen controls, combustion air controls, and variable fan motors have been commonplace in state codes on larger boilers for

quite some time. This proposal would align existing requirements in state codes with IECC. The effect will be an improvement in the part-load operation of larger boilers.

CEPI-77-21

Proponents: Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Add new text as follows:

C403.10 Buildings with High-Capacity Space-Heating Gas Boiler Systems. Gas hot-water boiler systems for space heating with system input capacity capacities of at least not less than 1,000,000 Btu/h but not more and not greater than 10,000,000 Btu/h in new buildings shall comply with Sections C403.10.1 and C403.10.2

Exceptions:

1. Where 25% of the annual space heating requirement is provided by on-site renewable energy, site-recovered energy, or heat recovery chillers.
2. Space heating boilers installed in individual dwelling units.
3. Where 50% or more of the design heating load is served using perimeter convective heating, radiant ceiling panels, or both.
4. Individual gas boilers with input capacity less than 300,000 Btu/h (87 kW) shall not be included in the calculations of the total system input or total system efficiency.

C403.10.1 Boiler Efficiency. Gas hot-water boilers shall have a thermal efficiency (E_t) of not less than 90% where rated in accordance with the test procedures in Table C403.3.2(6). Systems with multiple boilers are allowed to meet this requirement where the space heating input provided by equipment with thermal efficiency (E_t) above or below 90% provides an input capacity-weighted average thermal efficiency of not less than 90%. For boilers rated only for combustion efficiency, the calculation for the input capacity-weighted average thermal efficiency shall use the combustion efficiency value.

C403.10.2 Hot-Water Distribution System Design. The hot-water distribution system shall be designed to meet the following:

1. Coils and other heat exchangers shall be selected so that at design conditions the hot water return temperature entering the boilers is 120°F or less.
2. Under all operating conditions, the water temperature entering the boiler is not greater than 120°F, or the flow rate of supply hot water that recirculates directly into the return system, such as by three-way valves or minimum flow bypass controls, shall be no greater than 20% of the design flow of the boilers.

Reason: This proposal adds an implementation of condensing boilers for new construction to achieve condensing-level efficiency (i.e., 90% Et) for large boiler systems (i.e., between 1 million and 10 million Btuh), where the proper design considerations are included so that the condensing boilers will operate properly. To ensure condensing occurs, requirements are added to ensure boiler entering water temperature is designed to be low, and able to be maintained low, by minimizing recirculation of hot-water supply into the return.
The introduction of these new requirements is important because boilers represent 40% of the heating in commercial buildings and are especially prevalent in cold climates and current levels specified in Table C403.3.2(6) are not enough to achieve condensing boiler level efficiency. A challenge for condensing boilers for hot-water heating is that they require system design changes and the use of higher delta entering and leaving temperature to maintain condensing operation to ensure they operate efficiently.

The proposed text seen here was approved for publication in 90.1-2019 as addendum bc to 90.1-2016. There is a slight modification to the charging language to clarify that the capacity threshold applies to individual systems and not the total boiler capacity for the building.

This addendum was closely reviewed by designers, manufacturers, and users. The boiler working group held meetings with all stakeholders to ensure that all concerns were addressed.

Cost Impact: The code change proposal will increase the cost of construction.
First cost was determined from the 2012 GSA Condensing Boiler Study, which estimates $38.50/MBtu for noncondensing and $42.60/MBtu for condensing boilers. In addition, the study estimates an additional average annual maintenance cost of $400 for condensing boilers. Energy savings were found using energy modeling simulations run using USDOE's EnergyPlus. Three prototype buildings were used—large office, hospital, and secondary school—in various U.S. climate zones.

Using the Standard 90.1 scalar ratio, the economic analysis shows an average scalar ratio of 4.2. The maximum scalar ratio is 17.2 for boilers with a life expectancy of 25 years, so this measure is highly cost-effective. Models and estimates show that all prototypes fall within the maximum scalar ratio and are cost-effective.

Bibliography: ANSI/ASHRAE/IES Standard 90.1-2019: Energy Standard for Buildings Except Low-Rise Residential Buildings

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: This proposal adds an implementation of condensing boilers for new construction to achieve condensing-level efficiency (i.e., 90% Et) for large boiler systems (i.e., between 1 million and 10 million Btuh), where the proper design considerations are included so that the condensing boilers will operate properly. To ensure condensing occurs, requirements are added to ensure boiler entering water temperature is designed to be low, and able to be maintained low, by minimizing recirculation of hot-water supply into the return. The introduction of these new requirements is important because boilers represent 40% of the heating in commercial buildings and are especially prevalent in cold climates and current levels specified in Table C403.3.2(6) are not enough to achieve condensing boiler level efficiency. A challenge for condensing boilers for hot-water heating is that they require system design changes and the use of higher delta entering and leaving temperature to maintain condensing operation to ensure they operate efficiently.

The proposed text seen here was approved for publication in 90.1-2019 as addendum bc to 90.1-2016. There is a slight modification to the charging language to clarify that the capacity threshold applies to individual systems and not the total boiler capacity for the building.
This addendum was closely reviewed by designers, manufacturers, and users. The boiler working group held meetings with all stakeholders to ensure that all concerns were addressed.

CEPI-99-21

Proponents: Kim Cheslak, NBI, representing NBI (kim@newbuildings.org); Josh Keeling, representing Cadeo Group (jkeeling@cadeogroup.com); Ben Rabe, representing Fresh Energy (rabe@fresh-energy.org); Bryan Bomer, representing Department of Permitting Services (bryan.bomer@montgomerycountymd.gov); Lauren Urbanek, representing Natural Resources Defense Council (lurbanek@nrdc.org); Howard Wiig, representing Hawaii State Energy Office (howard.c.wiig@hawaii.gov); Kim Burke, representing Colorado Energy Office (kim.burke@state.co.us); Brad Smith, representing City of Fort Collins (brsmith@fcgov.com); Matt Tidwell, representing Portland General Electric (matthew.tidwell@pgn.com); Chris Castro, representing City of Orlando (chris.castro@orlando.gov); Amber Wood, representing ACEEE (awood@aceee.org)

2021 International Energy Conservation Code

Add new definition as follows:

DEMAND RESPONSE SIGNAL. A signal that indicates a price or a request to modify electricity consumption.

DEMAND RESPONSIVE CONTROL. A control capable of receiving and automatically responding to a *demand response signal.*

Revise as follows:

C403.4 Heating and cooling system controls. ~~Each h~~ Heating and cooling system shall be provided with controls in accordance with Sections C403.4.1 through C403.4.~~5~~ 6.

Add new text as follows:

C403.4.6 Demand responsive controls. Buildings shall be provided with demand responsive controls capable of executing the following actions in response to a demand response signal:

1. Automatically increasing the zone operating cooling set point by the following values: 1°F (0.5°C), 2°F (1°C), 3°F (1.5°C), and 4°F (2°C).
2. Automatically decreasing the zone operating heating set point by the following values: 1°F (0.5°C), 2°F (1°C), 3°F (1.5°C), and 4°F (2°C).

Where a *demand response signal* is not available the heating and cooling system controls shall be capable of performing all other functions. Where thermostats are controlled by *direct digital control* including, but not limited to, an energy management system, the system shall be capable of *demand responsive control* and capable of adjusting all thermal setpoints to comply. The demand responsive controls shall comply with either C403.4.6.1 or C403.4.6.2

Exceptions:

1. Group I occupancies
2. Group H occupancies
3. Controls serving *data center systems*
4. Occupancies or applications requiring precision in indoor temperature control as *approved* by the *code official*
5. Controls that serve only fossil fuel equipment

C403.4.6.1 Air conditioners and heat pumps with two or more stages of control and cooling capacity of less than 65,000 Btu/h. . Thermostats for Air conditioners and heat pumps with two or more stages of control and a cooling capacity less than 65,000 Btu/h shall be provided with a demand responsive control that complies with the communication and performance requirements of AHRI 1380.

C403.4.6.2 All other HVAC systems. Thermostats for HVAC systems shall be provided with a *demand responsive control* that complies with one of the following:

1. Certified OpenADR 2.0a VEN, as specified under Clause 11, Conformance
2. Certified OpenADR 2.0b VEN, as specified under Clause 11, Conformance
3. Certified by the manufacturer as being capable of responding to a demand response signal from a certified OpenADR 2.0b VEN by automatically implementing the control functions requested by the VEN for the equipment it controls
4. IEC 62746-10-1
5. The communication protocol required by a controlling entity, such as a utility or service provider, to participate in an automated demand response program
6. The physical configuration and communication protocol of CTA 2045-A or CTA 2045-B.

Add new standard(s) as follows:

AHRI

Air-Conditioning, Heating, & Refrigeration Institute
2111 Wilson Blvd, Suite 500
Arlington, VA 22201

1380-2019 Demand Response through Variable Capacity HVAC Systems in Residential and Small Commercial Applications

ANSI

American National Standards Institute
25 West 43rd Street, 4th Floor
New York, NY 10036

ANSI/CTA-2045-A-2018 Modular Communications Interface for Energy Management

ANSI/CTA-2045-B-2019 Modular Communications Interface for Energy Management

Add new text as follows:

IEC

IEC Regional Centre for North America
IEC International Electrotechnical Commission
446 Main Street 16th Floor
Worcester, MA 016808

IEC IEC Regional Centre for North America. IEC 62746-10-1 - 2018 Systems interface between customer energy management system and the power management system – Part 10-1: Open automated demand response

OpenADR

OpenADR Alliance
OpenADR OpenADR Alliance
111 Deerwood Road Suite 200
San Roman, CA 94583

OpenADR OpenADR OpenADR Alliance . OpenADR 2.0a and 2.0b – 2019: Profile Specification Distributed Energy Resources

Reason: Grid-integrated controls for thermostats are added based on language from California Title 24 and ASHRAE Standard 189.1. Any thermostat listed as "Title 24 compliant" would meet this requirement. The controls allow for dialing back heating and cooling, as well as to accept additional heating or cooling when renewable energy generation is high or energy prices are low, and both ramp up and down requirements in relationship to the utility/grid operator/third party aggregator signal to prevent rebound issues on the grid after the signal is released.
In health care and assisted living facilities, thermostat setpoints can impact more than just thermal comfort, and temperature can be part of the health care being provided. To ensure that this requirement cannot have an adverse impact on those services, these facilities have been exempted from this requirement.

HVAC system control, often through thermostats, has been at the center of demand response (DR) programs for decades. DR programs continue to rely deeply on thermostat control strategies, but the need for such controls is fast growing. As electricity systems transform to include more variable wind and solar energy, demand flexibility becomes increasingly critical to both grid operation and further transformation. Building systems that can use energy when it is abundant, clean, and low-cost not only help decarbonize the entire energy system, they also insulate their owners from future increases in demand charges and peak hour energy rates – a current and accelerating trend.

Today's demand response programs typically set event (call) durations between 15 minutes and 4 hours. The preconditioning strategies (cooling set point reduction / heating set point increase) and temporary setback strategies (cooling set point increase / heating set point reduction) will enable substantial HVAC system energy savings over this time frame. In many cases, in a building compliant with this code, tenants are unlikely to even notice a change in their thermal comfort. The inclusion of preconditioning helps ensure that the building is able to reduce electrical demand by adjusting HVAC setpoints while minimizing the risk of tenant disruption: in many cases the event will end before the higher cooling (or lower heating) set point is reached in the space.

Based on modeling by LBNL (foundational modeling supporting the May 2021 DOE Grid-integrated Efficient Buildings Roadmap), thermostat controls configured to deliver preconditioning and/or space temperature adjustments can reduce building peak demand by roughly 10% in many cases.

Cost Impact: The code change proposal will increase the cost of construction.
For larger commercial buildings with building management systems, it is not common to install a thermostat without demand response capabilities. Therefore, there is no incremental equipment cost associated with this measure for those building types. However, there could be soft costs to ensure those demand responsive controls function properly with the building management system. Conversations with industry experts indicate these soft costs can be around $0.25/s.f. for a medium office building. The primary cost drivers in thermostats are not the grid-integration controls but rather other features. Therefore, incremental costs vary. An entry-level grid-integrated thermostat currently available from a national retailer costs about $70, while the same retailer lists a similar non-grid-integrated programmable unit for just over $35, indicating an incremental cost of about $35. This cost has dropped in the last (X years) – A 2017 study out of Vermont cited incremental costs for smart thermostats in new

construction at roughly $150 – *a decrease in incremental costs of $115 over just 4 years.*

However, smart thermostats (i.e., those with grid-integrated controls) are very common in new construction and represent a growing share of the retrofit market. All major smart thermostat brands already include grid-integration controls that comply with this requirement, so there is generally no incremental cost to include these controls assuming a smart thermostat is installed either based on customer preference or efficiency requirements. Multifamily buildings and smaller commercial buildings that install direct-attached thermostats, demand responsive thermostats (which were estimated in a 2011 study to cost $68 more than a programmable thermostat) were found to be extremely cost effective. It was estimated that installing demand responsive thermostats in a 10,000 s.f. office building resulted in 83kWh to 274 kWh of electricity savings and between 0.19 to 1.97kW in demand savings in Climate Zones 2-4. Every dollar spent on demand responsive thermostats yielded between $1.20 to $7 in operating cost savings over a 15-year period for office buildings. In the 10 years since, equipment prices have decrease and incremental costs are estimated to be only $40 making this measure even more cost effective than estimated previously for buildings without building management systems. This measure will not only result in cost savings for consumers but will also result in other significant societal benefits. According to DOE's report, "A National Roadmap for Grid-Interactive Efficient Buildings," every watt in peak demand savings was found to create 17 cents in annual electric grid system value. This value included energy savings, capacity savings, transmission deferral and ancillary services. A 10,000 square foot office building with a demand responsive thermostat which is estimated to reduce peak demand savings between 0.26 to 1.09kW would result in $44 to $334 in annual electric grid system value. Demand responsive thermostats which allow grid operators to reduce demand on the grid during the times when the carbon intensity of the electric grid is high also results in reduced carbon emissions generating additional significant societal benefits.

Bibliography: A National Roadmap for Grid-Interactive Efficient Buildings, U.S. Department of Energy, 17 May 2021, https://gebroadmap.lbl.gov/A%20National%20Roadmap%20for%20GEBs%20-%20Final.pdf.
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2017 Tier III TRM Characterizations, Advanced Thermostat *https://publicservice.vermont.gov/sites/dps/files/documents/2017%20Tier%20III%20TRM%20Characterizations.pdf.*

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: HVAC system control, often through thermostats, has been at the center of demand response (DR) programs for decades. DR programs continue to rely deeply on thermostat control strategies, but the need for such controls is fast growing.

CEPI-100-21

Proponents: Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Revise as follows:

C403.4.2.3 ~~Automatic~~ Optimum start and stop. ~~Automatic~~ Optimum start and stop controls shall be provided for each HVAC system with direct digital control of individual zones. The ~~automatic~~ optimum start controls shall be configured to automatically adjust the daily start time of the HVAC system in order to bring each space to the desired occupied temperature immediately prior to scheduled occupancy. ~~Automatic stop controls shall be provided for each HVAC system with direct digital control of individual *zones*.~~ The ~~automatic~~ optimum stop controls shall be configured to reduce the HVAC system's heating temperature setpoint and increase the cooling temperature setpoint by not less than 2°F (~~-16.6~~ 1.11ºC) before scheduled unoccupied periods based on the thermal lag and acceptable drift in space temperature that is within comfort limits.

Exception: Dwelling units and sleeping units are not required to have optimum start controls.

Reason: Based on addendum r to 90.1-2019.
This proposal:

1. Exempts residential occupancies because they do not start and stop equipment based on an occupancy schedule to which the requirement can be applied.
2. Makes an editorial change to make it clear that this applies to DDC-controlled systems. Though there are non-DDC systems that have a primitive automatic start and stop optimization capability, their savings are unproven.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
As it is unlikely that automatic start and stop is applied to Group R occupancies in practice, this exception will likely not have an effect on the cost of construction.

Bibliography: ANSI/ASHRAE/IES Standard 90.1-2019 Energy Standard for Buildings Except Low-Rise Residential Buildings, Addendum r
https://www.ashrae.org/technical-resources/standards-and-guidelines/standards-addenda/addenda-to-standard-90-1-2019

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Based on addendum r to 90.1-2019.

This proposal:

. Exempts residential occupancies because they do not start and stop equipment based on an occupancy schedule to which the requirement can be applied.

. Makes an editorial change to make it clear that this applies to DDC-controlled systems. Though there are non-DDC systems that have a primitive automatic start and stop optimization capability, their savings are unproven.

Proposal # 111

CEPI-102-21

Proponents: Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Add new definition as follows:

HUMIDISTATIC CONTROLS. Automatic controls used to maintain humidity at a fixed or adjustable setpoint.

Add new text as follows:

C403.4.6 Humidification and dehumidification controls.. Humidification and dehumidification controls shall be in accordance with this section.

C403.4.6.1 Dehumidification. *Humidistatic controls* shall not use mechanical cooling to reduce the humidity below the lower of a dew point of 55°F or relative humidity of 60% in the coldest zone served by the system. Lower humidity shall be permitted where mechanical cooling is being used for temperature control.

Exceptions:

1. Where approved, systems serving zones where specific humidity levels are required, such as museums and hospitals, and where *humidistatic controls* are capable of and configured to maintain a dead band of at least 10% relative humidity where no active humidification or dehumidification takes place.
2. Systems serving zones where humidity levels are required to be maintained with precision of not more than ±5% relative humidity to comply with applicable codes or accreditation standards or as approved by the authority having jurisdiction.

C403.4.6.2 Humidification. *Humidistatic controls* shall not use fossil fuels or electricity to produce relative humidity above 30% in the warmest zone served by the system.

Exceptions:

1. Where approved, systems serving zones where specific humidity levels are required, such as museums and hospitals, and where *humidistatic controls* are capable of and configured to maintain a dead band of at least 10% relative humidity where no active humidification or dehumidification takes place.
2. Systems serving zones where humidity levels are required to be maintained with precision of not more than ±5% relative humidity to comply with applicable codes or accreditation standards or as approved by the authority having jurisdiction.

C403.4.6.3 Control Interlock. Where a zone is served by a system or systems with both humidification and dehumidification capability, means such as limit switches, mechanical stops, or, for DDC systems, software programming shall be provided capable of and configured to prevent simultaneous operation of humidification and dehumidification equipment.

Exception: Systems serving zones where humidity levels are required to be maintained with precision of not more than ±5% relative humidity to comply with applicable codes or accreditation standards or as approved by the authority having jurisdiction.

Reason: The proposal adds requirements for control of HVAC systems when they are explicitly controlled to maintain humidity at maximum or minimum values or within a range.They prevent wasting of energy by dehumidifying or humidifying beyond the requirements for human comfort and health. Exceptions that allow designers to meet other code or accreditation requirements are included. These requirements do not apply when the space is only controlled by a thermostat and dehumidification is incidental to the cooling.
These requirements have been in ASHRAE 90.1 for many years. The text was updated in the 2019 version of the standard for clarity, including an informative note that explains lower humidity levels are allowed when the space conditions are controlled based on temperature.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The proposal does not require the use of humidistatic controls nor does it require equipment with capacities that are greater than a designer would have otherwise selected.

Bibliography: ANSI/ASHRAE/IES Standard 90.1-2019 Energy Standard for Buildings Except Low-Rise Residential Buildings

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Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: This proposal would prevent wasting of energy by dehumidifying or humidifying beyond the requirements for human comfort and health. Exceptions that allow designers to meet other code or accreditation requirements are included. This proposal creates alignment with existing ASHRAE 90.1 requirements.

CEPI-103-21

Proponents: John Bade, representing California Investor Owned Utilities (johnbade@2050partners.com)

2021 International Energy Conservation Code

Revise as follows:

C403.5 Economizers. Economizers shall comply with Sections C403.5.1 through C403.5.5.
An air or water economizer shall be provided for the following cooling systems:

1. Chilled water systems with a total cooling capacity, less cooling capacity provided with air economizers, as specified in Table C403.5(1).
2. Individual fan systems with cooling capacity greater than or equal to 54,000 Btu/h (15.8 kW) in buildings having other than a *Group R* occupancy,

   The total supply capacity of all fan cooling units not provided with economizers shall not exceed 20 percent of the total supply capacity of all fan cooling units in the building or 300,000 Btu/h (88 kW), whichever is greater.
3. Individual fan systems with cooling capacity greater than or equal to 270,000 Btu/h (79.1 kW) in buildings having a *Group R* occupancy.

   The total supply capacity of all fan cooling units not provided with economizers shall not exceed 20 percent of the total supply capacity of all fan cooling units in the building or 1,500,000 Btu/h (440 kW), whichever is greater.

Exceptions: Economizers are not required for the following systems.

1. Individual fan systems not served by chilled water for buildings located in *Climate Zones* 0A, 0B, 1A and 1B.
2. Where more than 25 percent of the air designed to be supplied by the system is to spaces that are designed to be humidified above 35°F (1.7°C) dew-point temperature to satisfy process needs.
3. Systems expected to operate less than 20 hours per week.
4. Systems serving supermarket areas with open refrigerated casework.
5. Where the cooling efficiency is greater than or equal to the efficiency requirements in Table C403.5(2).
6. Systems that include a heat recovery system in accordance with Section C403.10.5.
7. ~~VRF systems~~ <u>Direct-expansion fancoils or unitary equipment with a capacity less than 54,000 Btu/h and multiple stages of conpressor capacity</u> installed with a dedicated outdoor air system.

Reason: The exemption from economizer requirements for variable refrigerant flow (VRF) systems employed with a dedicated outdoor air system added in IECC 2021 was reasonable. However, limiting the exception to only VRF systems created an unfair advantage in the market for those systems. Other zone-level DX fan coil systems with multi-stage compressors, such as water-source heat pumps, provide equal or better energy savings. This proposal levels the playing field and eliminates the need to provide water coils in those products.
The limit to fan coils with a capacity of less than 54,000 Btu/h aligns the exception with the requirements in the body. VRF systems tested under AHRI 1230 do not include fan coils with a capacity of 54,000 Btu/h or more, and engineering analysis indicates that VRF systems that employ such fan coils very likely do not operate at the same level of efficiency as those that employ smaller capacity coils.

Cost Impact: The code change proposal will decrease the cost of construction.
This proposal will eliminate the need to provide economizer water coils in DX fan coils in non-VRF systems. Since the market share of VRF fan coils with a capacity of 54,000 Btu/h or greater is very small, the net change in cost to builders will be negative.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: proposal provides an exception for small units being used with DOAS and expands exception to WSHPs.

CEPI-106-21

Proponents: Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Revise as follows:

C403.5.3.4 Relief of excess outdoor air. Systems shall ~~be~~ provide one of the following means ~~capable of~~ to ~~relieving~~ relieve excess *outdoor air* during air economizer operation to prevent overpressurizing the building.

1. Return or relief fan(s) meeting the requirements of Section C403.10.1.
2. Barometric or motorized damper relief path with a total pressure drop at design relief airflow rate less than 0.10 inches water column (25 Pa) from the occupied space to outdoors. Design relief airflow rate shall be the design supply airflow rate minus any continuous exhaust flows, such as toilet exhaust fans, whose makeup is provided by the economizer system.

The relief air outlet shall be located to avoid recirculation into the building.

Reason: Based on addendum g to ASHRAE 90.1-2019.
The current language in Section 403.5.3.4 is vague and unenforceable. Consequently, it is often ignored and violated. The language added in the proposal is specific and enforceable and will achieve the desired intent of the current language.When the relief path has a high static resistance, and the relief is not fan-powered, economizer use results in overpressurization of the building. When the building is overpressurized, occupants often have difficulty opening or closing doors and complain of high air velocities through openings to the outside. The problem is too often resolved by disabling economizer operation and losing the associated energy savings. Requiring return/relief fans or properly sized barometric relief will prevent overpressurization and thus save energy by allowing 100% economizing and eliminating the need for building operators to disable economizers.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This change only clarifies the requirements for the prevention of building overpressurization.

Bibliography: ANSI/ASHRAE/IES Standard 90.1-2019 Energy Standard for Buildings Except Low-Rise Residential Buildings, Addendum g
https://www.ashrae.org/technical-resources/standards-and-guidelines/standards-addenda/addenda-to-standard-90-1-2019

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Based on addendum g to ASHRAE 90.1-2019.
Proposal will improve code clarity and enforceability and will lead to better economizer operation and achievement of associated energy savings.

CEPI-107-21

Proponents: Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Revise as follows:

C403.6.1 Variable air volume and multiple-zone systems. Supply air systems serving multiple zones shall be variable air volume (VAV) systems that have zone controls configured to reduce the volume of air that is reheated, recooled or mixed in each zone to one of the following:

1. ~~Twenty~~ Thirty percent of the zone design peak supply for systems ~~with~~ without *direct digital control* (DDC) ~~and 30 percent for other systems~~.
2. Systems with DDC where all of the following apply:
   2.1. The airflow rate in the deadband between heating and cooling does not exceed ~~20 percent of the zone design peak supply rate or~~ the ~~higher~~ highest of the allowed rates under Items 3, 4 , ~~and~~ 5 , or 6 of this section.
   2.2. The first stage of heating modulates the zone supply air temperature setpoint up to a maximum setpoint while the airflow is maintained at the deadband flow rate.
   2.3. The second stage of heating modulates the airflow rate from the deadband flow rate up to the heating maximum flow rate that is less than 50 percent of the zone design peak supply rate.
3. The outdoor airflow rate required to meet the minimum ventilation requirements of Chapter 4 of the International Mechanical Code.
4. The minimum primary airflow rate required to meet the Simplified Procedure ventilation requirements of ASHRAE Standard 62.1 for the zone and is permitted to be the average airflow rate as allowed by ASHRAE Standard 62.1

~~4~~ 5. Any higher rate that can be demonstrated to reduce overall system annual energy use by offsetting reheat/recool energy losses through a reduction in outdoor air intake for the system as approved by the code official.

~~5~~ 6. The airflow rate required to comply with applicable codes or accreditation standards such as pressure relationships or minimum air change rates.

Exception: The following individual zones or entire air distribution systems are exempted from the requirement for VAV control:

1. *Zones* or supply air systems where not less than 75 percent of the energy for reheating or for providing warm air in mixing systems is provided from a site-recovered, including condenser heat, or site-solar energy source.
2. Systems that prevent reheating, recooling, mixing or simultaneous supply of air that has been previously cooled, either mechanically or through the use of economizer systems, and air that has been previously mechanically heated.

Add new standard(s) as follows:

ASHRAE

ASHRAE
180 Technology Parkway NW
Peachtree Corners, GA 30092

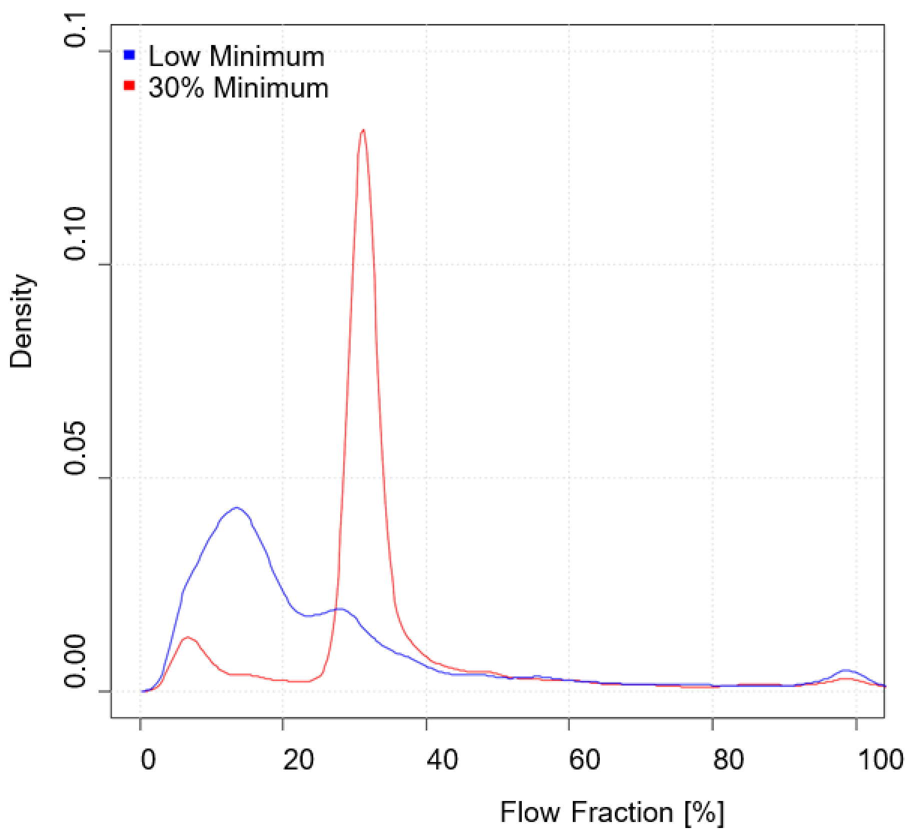
62.1-2019 Ventilation for Acceptable Indoor Air Quality

Staff Note: ASHRAE 62.1 is only referenced in the IMC as an alternate method to select the system ventilation efficiency in Section 403.3.1.1.2.3.2, by using Appendix A of the standard.

Reason: C403.6.1- Variable air volume and multiple-zone systems provides six options to determine the minimum air in each zone for a VAV system. For systems with DDC controls, there are two paths.

- Option 1 is a simplified method that allows the designer to assign a minimum of 20% of peak design airflow with no other requirements.
- Option 2 allows the user to use 20% of peak design airflow, or a higher value if required by the IMC or other codes or accreditation standards, or if it can be shown to otherwise save energy by reducing outdoor airflow. Unlike Option 1, the energy-saving dual max strategy during heating mode must be applied.

This proposal eliminates the blanket allowance to use 20% of the peak airflow rate in option 1 and the 20% floor in Option 2. Outdoor air rates are generally much lower than 20% of the maximum rate, but designers have felt they needed a higher percentage to meet the requirements of the IMC for multiple zone systems.Moreover, using percentages to determine minimums is problematic because VAV boxes are almost always oversized due to conservative load assumptions for occupants, lights, plug loads, etc. It is not unusual for boxes to be sized 3 or more times larger than they need to be, as was found to be the case in ASHRAE RP-1515 “Thermal and air quality acceptability in buildings that reduce energy by reducing minimum airflow from overhead diffusers." The figure below from RP-1515 shows measured frequency of airflow rates in 7 California office buildings using 30% minimums (based on earlier versions of Standard 90.1) compared to the current "dual maximum" under Option 2. The figure shows that even if the minimums were set to 20% instead of 30%, excess air would have been supplied due to the oversized cooling maximum setpoint, wasting fan energy, heating energy, and cooling energy. RP-1515 also demonstrated that high minimums increased discomfort by "pushing" zones into heating mode in the summer months, causing overcooling complaints. Thus, based on RP-1515 results, we expect this addendum to both reduce energy costs and improve comfort.



The 20% floor was also removed from Option 2, which saves a lot of energy but does remove a "simplified" option for calculating the minimum airflow. The proposal suggests allowing an alternate simplified method from ASHRAE 62.1 which would save energy vs. the existing 20% floor. While the inclusion of the ASHRAE Simplified Method is not absolutely needed in the code, it would offer a simpler and easier to enforce path.

Addendum f to Standard 62.1 created a simplified way of determining outdoor air rates for multiple zone recirculating air handling systems that includes a simple prescriptive requirement for calculating minimum air handler outdoor air rates and minimum setpoints for VAV zones:

6.2.5.2 System Ventilation Efficiency. The system ventilation efficiency (Ev) shall be determined in accordance with Section 6.2.5.3 for the Simplified Procedure or Normative Appendix A for the Alternative Procedure.

6.2.5.3 Simplified Procedure

6.2.5.3.1 System Ventilation Efficiency. System Ventilation Efficiency (Ev) shall be determined in accordance with Equation 6.2.5.3.1A or B.

Ev = 0.88*D + 0.22 for D<0.60 (6.2.5.3.1A)

Ev = 0.75 for D≥0.60 (6.2.5.3.1B)

6.2.5.3.2

Zone Minimum Primary Airflow. For each zone, the minimum primary airflow (*Vpz-min*) shall be determined in accordance with equation 6.2.5.3.2.

Vpz-min = *Voz**1.5 (6.2.5.3.2)

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Cost impact. This addendum is not expected to increase the cost of construction. The requirement is simply for existing VAV terminal boxes to be set with a different dead band primary air minimum for dual maximum boxes.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: Reason: Subcommittee referred to the reason statement in the original proposal. To summarize, this proposal modifies language for options to determine minimum air for each zone in a VAV system. The revised language is supported by studies and research showing the current language and practice often leads to oversizing systems. This proposal is expected to both reduce energy costs and improve comfort.

Proposal # 50

CEPI-108-21

Proponents: Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Add new definition as follows:

OCCUPIED-STANDBY MODE. Mode of operation when an HVAC zone is scheduled to be occupied and an occupant sensor indicates no occupants are within the zone.

Revise as follows:

C403.7 Ventilation and exhaust systems. In addition to other requirements of Section C403 applicable to the provision of ventilation air or the exhaust of air, ventilation and exhaust systems shall be in accordance with Sections C403.7.1 through C403.7.~~7~~ 8.

Add new text as follows:

C403.7.8 Occupied Standby Controls. Occupied-standby controls are required for zones and systems serving zones where all spaces served by the zone are required to have occupant sensor lighting controls by Section C405.2.1 and are an ASHRAE Standard 62.1 occupancy category where the 62.1 Ventilation Rate Procedure allows the ventilation air to be reduced to zero when the space is in *occupied-standby mode*. Spaces meeting these criteria include:

1. Post-secondary classrooms/lecture/training rooms
2. Conference/meeting/multipurpose rooms
3. Lounges/breakrooms
4. Enclosed offices
5. Open plan office areas
6. Corridors

C403.7.8.1 Occupied Standby Zone Controls. For zones meeting the occupied-standby control criteria, within five (5) minutes of all rooms in that zone entering *occupied-standby mode*, the zone control shall operate as follows:

1. Active heating set point shall be setback at least 1°F.
2. Active cooling set point shall be setup at least 1°F.
3. All airflow supplied to the zone shall be shut off whenever the space temperature is between the active heating and cooling set points.

Exception: Multiple zone systems without automatic zone flow control dampers.

C403.7.8.2 Occupied Standby System Controls. Multiple zone systems that can *automatically* reset the effective minimum outdoor air setpoint and that serve zones with occupied-standby zone controls shall reset the effective minimum outdoor air setpoint based on a zone outdoor air requirement of zero for all zones in *occupied-standby mode*. Sequences of operation for system outside air reset shall comply with an *approved* method.

Reason: This proposal would bring into the IECC, the benefits of occupied standby controls that are currently in ASHRAE 90.1 and other building codes. This saves energy by turning off ventilation air to zones that occupancy sensors identify as unoccupied but are scheduled to be occupied. This proposal also expands upon the ASHRAE standard by making explicit that for multiple zone systems, the system outside air also needs to be proportionately reduced when ventilation air has been shut off to one or more zones.
Standard 62.1-2019 allows zero ventilation in occupied standby mode for some occupancy categories including classrooms and offices (see TABLE 6.2.2.1 Minimum Ventilation Rates in Breathing Zone). Section C405.2.1 of the IECC already requires occupancy sensors for lighting control in certain spaces including classrooms, conference rooms, and offices of all sizes. Occupied standby was introduced into the 2019 of ASHRAE 90.1. We are recommending that IECC also capture tremendous global energy savings by reducing deadband airflow and thereby reducing fan energy, cooling energy and reheat. For the spaces chosen, the occupancy sensors are already in the spaces, this proposal requires a modest levels of cost for lighting systems and HVAC integration to realize the energy and operating cost savings.

The occupied standby requirement in 90.1-2019 requires shutting off ventilation air to unoccupied zones. For single zone systems this saves fan energy and the thermal energy associated with conditioning outside air. For multi-zone systems, the zone ventilation air is shut off which reduces fan energy and reheat energy, but currently there is not an explicit requirement in ASHRAE 90.1 to reset the outside air amounts at the system level and thus there is not the thermal energy savings associated with conditioning less outside air. Significant energy savings can be achieved by also resetting the minimum outside airflow setpoint at the air handler. Thus this proposal makes explicit what was implied in ASHRAE 90.1 in regards to resetting multiple zone system outside air amounts.

For systems that already have the ability to reset the minimum outside airflow setpoint this is a minor sequence change. No additional hardware or software is required. ASHRAE Guideline 36-2021 already includes the sequences needed for multiple zone systems to reset the effective minimum outdoor air setpoint based on a zone outdoor air requirement of zero for all zones in occupied standby mode.

Cost Impact: The code change proposal will increase the cost of construction.
There is a first cost impact associated with this measure. For the analysis done for ASHRAE 90.1, the estimated cost was $100 per zone plus $20 per room. The cost of the occupancy sensor is not included as this proposal only applies to those zones where all the spaces served by the zone are already required to have occupant sensor control of the lighting.

For the 2019 ASHRAE 90.1 proposal, a typical office building was simulated in eQuest in 3 climates. Assumptions:

- 50,000 ft2, 5 story office
- Packaged VAV with HW reheat
- Standby control reduces zone flow by 0.3 cfm/ft2 in standby mode
- Average single room zone size of 800 ft2
- Average multiple room zone size of 200 ft2/room
- Average utility rates of $0.10/kwh and $1.0/therm
- Required scalar: 10yr simple payback
- Total incremental cost: $100/zone + $20 per additional room if more than one room in the zone.

Life Cycle Cost-Effectiveness Results

In order to meet the scalar a single room zone would only have to be unoccupied 8% of the time in Los Angeles, 9% in Atlanta and 10% is Chicago.

A zone with (5) 200 ft2 rooms must have all rooms unoccupied at least 12% of the time in Los Angeles, 13% in Atlanta and 14% in Chicago. In comparison, the LBNL meta-study of lighting controls found that on average occupancy sensors reduced the operating hours of lighting by 30%. Thus, the savings on average are at least twice that needed to render the measure cost-effective.
Texas A&M ARPA-E Projects (Pang et al and Ye et al Occupant-centric controls studies)
These projects compared a Baseline Case with no occupancy sensing, Advanced Case I with occupancy presence sensing, and Advanced Case II with occupant counting sensing. Advanced Case I is essentially occupied-standby control (turn off ventilation when no one is in the zone) and Advanced Case II is occupied standby control plus demand control ventilation (reduce ventilation based on the number of people in the zone and turn off ventilation when no one is in the zone). The following figure is from the Pang et al paper for the medium office building prototype simulated in the IECC climate zones. The three bars in each climate zone correspond to the baseline case, Advanced Case I, and Advanced Case II from left to right. The yellow and orange texts on top of the bars show the HVAC energy saving fractions of Advanced Case I and Advanced Case II against the baseline. These savings range from 19% to 43% of total HVAC site energy consumption.

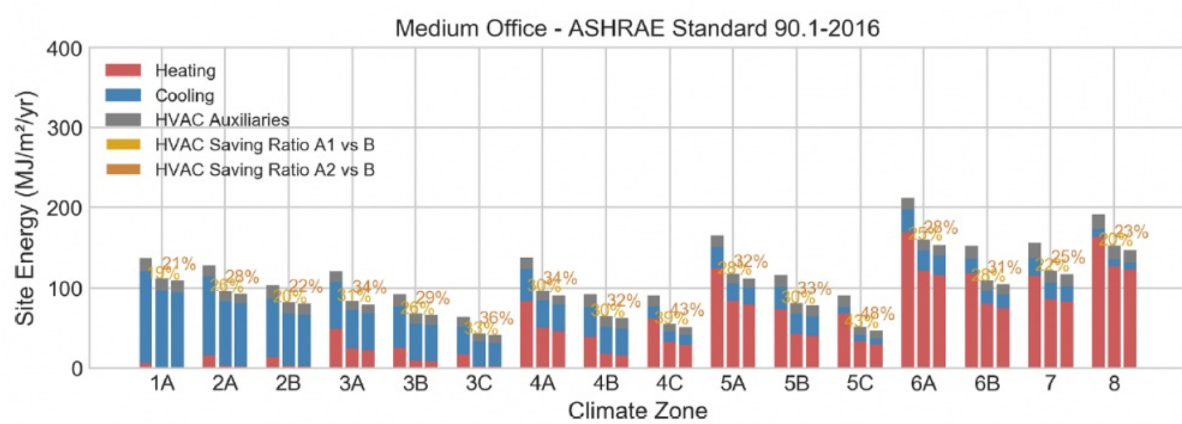
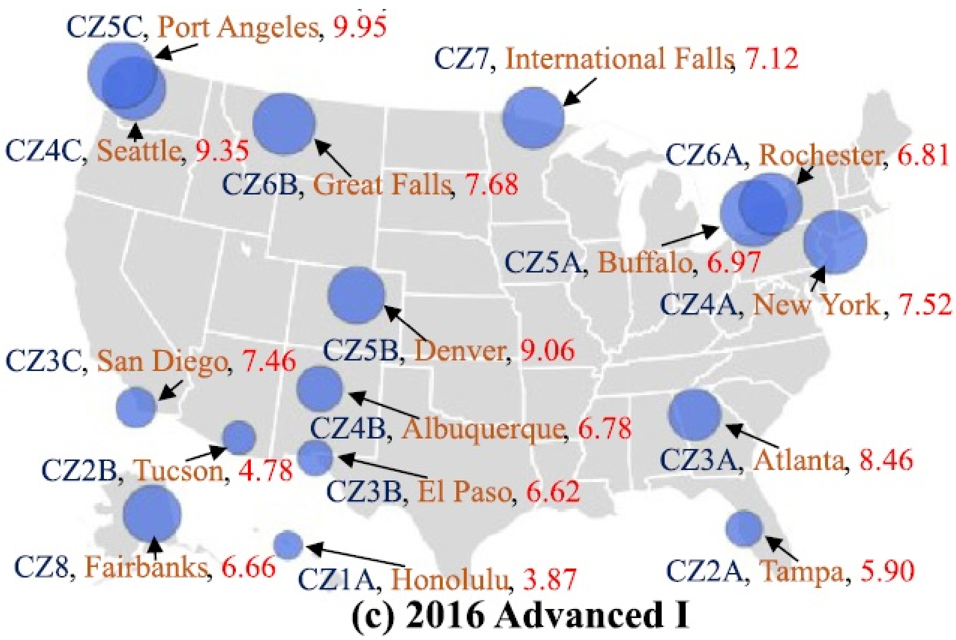


Fig. 18. HVAC energy simulation results of the medium office building per ASHRAE Standard 90.1 – 2016.

The second figure is from the Ye et al paper which conducts the same evaluation for schools. The savings from "Advanced Control 1" represent the occupied-standby control percent savings for the school prototype for all of the reference cities for the various IECC climate zones. These values range between 3% and almost 10% of whole building site energy savings. These are massive savings. More details are in the papers listed in the Bibliography.



Bibliography: ASHRAE Standard 90.1-2019 *Energy Standard for Buildings Except Low-rise residential Buildings.* Section 6.5.3.8 Occupied-Standby Controls. American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASHRAE Standard 62.1-2019. *Ventilation for Acceptable Indoor Air Quality.* American Society of Heating, Refrigerating and Air-Conditioning Engineers

ASHRAE Guideline 36-2021. *High-Performance Sequences of Operation for HVAC Systems.* American Society of Heating, Refrigerating and Air-Conditioning Engineers

Integral Group and Taylor Engineering. 2018. Codes and Standards Enhancement (CASE) Initiative *2019 California Building Energy Efficiency Standards: Proposals Based on ASHRAE 90.1-2016 – Results Report* http://title24stakeholders.com/wp-content/uploads/2019/01/T24-2019-CASEStudy-Results-Reports-Proposal-Based-on-ASHRAE-90.1-_Final_with_Attachments.pdf

LBNL. 2011. *A Meta-Analysis of Energy Savings from Lighting Controls in Commercial Buildings.* Lawrence Berkeley National Laboratory. LBNL-5095E https://eta-publications.lbl.gov/sites/default/files/a_meta-analysis_of_energy_savings_from_lighting_controls_in_commercial_buildings_lbnl-5095e.pdf

PNNL 2015 *"Cost-effectiveness Analysis of Occupant standby control for HVAC"* prepared by Reid Hart at Pacific Northwest National Laboratory

Texas A&M ARPA-E Projects (see two papers below) - https://hvac.engr.tamu.edu/arpa-e/

Pang, Z., Chen, Y., Zhang, J., O'Neill, Z., Cheng, H., & Dong, B. (2020). *Nationwide HVAC energy-saving potential quantification for office buildings with occupant-centric controls in various climates.* Applied Energy, 279, 115727. https://www.sciencedirect.com/science/article/abs/pii/S0306261920312186

Ye, Y., Chen, Y., Zhang, J., Pang, Z., O'Neill, Z., Dong, B., & Cheng, H. (2021). *Energy-saving potential evaluation for primary schools with occupant-centric controls.* Applied Energy, 293, 116854. https://www.sciencedirect.com/science/article/abs/pii/S0306261921003469

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: This proposal is a compilation of two ASHRAE documents plus addendum, with a needed clarification of intent.

CEPI-110-21

Proponents: Mike Kennedy, Mike D. Kennedy Inc., representing Northwest Energy Efficiency Alliance; Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Revise as follows:

C403.7.1 Demand control ventilation. Demand control ventilation (DCV) shall be provided for the following:

1. Spaces with ventilation provided by ~~all~~ single-zone systems where an air-side economizer is provided ~~required to comply~~ in accordance with Section~~s~~ C403.5~~ through C403.5.3 and~~
2. Spaces larger than ~~500~~ 250 square feet (~~46.5~~ 23.2 m^2) in climate zones 5A, 6, 7 and 8 and spaces larger than 500 square feet (46.5 m^2) in other climate zones ~~and~~ which have ~~with an average~~ a design occupant load of 15 people or greater per 1,000 square feet (93 m^2) of floor area, as established in Table 403.3.1.1 of the International Mechanical Code, and are served by systems with one or more of the following:
   - ~~1~~ 2.1. An air-side economizer.
   - ~~2~~ 2.2. Automatic modulating control of the outdoor air damper.
   - ~~3~~ 2.3. A design outdoor airflow greater than 3,000 cfm (1416 L/s).

Exceptions:

1. Spaces served by systems ~~Systems~~ with energy recovery ~~complying~~ in accordance with Section C403.7.4.2~~.~~ and that have floor area less than:
   - 1.1 6000 square feet (2600 m^2) in climate zone 3C.
   - 1.2 2000 square feet (190 m^2) in climate zones 1A, 3B, and 4B.
   - 1.3 1000 square feet (90 m^2) in climate zones 2A, 2B, 3A, 4A, 4C, 5 and 6.
   - 1.4 400 square feet (40 m^2) in climate zones 7 and 8.
2. Multiple-zone systems without direct digital control of individual zones communicating with a central control panel.
3. Spaces served by multiple- ~~Multiple-~~zone systems with a system design outdoor airflow less than 750 cfm (354 L/s).
4. Spaces where more than 75 percent of the space design outdoor airflow is required for makeup air that is exhausted from the space or transfer air that is required for makeup air that is exhausted from other spaces.
5. Spaces with one of the following occupancy classifications as defined in Table 403.3.1.1 of the *International Mechanical Code*: correctional cells, education laboratories, barber, beauty and nail salons, and bowling alley seating areas.

Reason: This proposal clarifies where DCV is required. All exceptions are edited to be space centric since the requirement is for spaces to have DCV. The only substantive change is to remove exception 2. During the Washington State Energy Code technical advisory group meetings several engineers felt this was unneeded: that most all multi-zone systems have DDC, and if not they should.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal is a restatement of the DCV language to clarify the intent and remove an exception that is no longer useful given the state of building controls. There is no cost impact as when and where DCV is required is not changed.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: This proposal clarifies where demand-controlled ventilation (DCV) is required. It also improves the exceptions related to energy recovery.

CEPI-112-21

Proponents: Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Add new definition as follows:

Energy recovery, series. A three-step process in which the first step is to remove energy from a single airstream without the use of mechanical cooling. In the second step the air stream is mechanically cooled for the purpose of dehumidification. In the third step the energy removed in step one is reintroduced to the air stream.

Revise as follows:

C403.7.3 Ventilation air heating control. Units that provide ventilation air to multiple zones and operate in conjunction with zone heating and cooling systems shall not use heating or heat recovery to warm supply air to a temperature greater than 60°F (16°C) when representative building loads or outdoor air temperatures indicate that the majority of zones require cooling.

> **Exception:** Units that heat the airstream using only series energy recovery when representative building loads or outdoor air temperature indicate that the majority of zones require cooling in Climate Zones 0A, 1A, 2A, 3A, and 4A.

Reason: Based on addendum n to 90.1-2019
This proposal

1. Adds a definition for series energy recovery.
2. Provides an exception for systems equipped with series energy recovery to the requirement.

Series energy recovery is a well-established method to provide both passive free cooling and reheating to an airstream. It is typically done with a wrap-around coil where heat is absorbed into the fluid upstream of a dehumidifying cooling and released downstream of the coil to provide reheat. A sensible-only plate heat exchanger can be employed as well. Unlike condenser heat recovery, which only provides free reheat, this process reduces the load on the dehumidifying cooling coil.

The requirement to provide cool air from a 100% outside air unit while the building needs cooling is so that the work done by the compressor to cool the air is not wasted. When air is provided at higher temperatures, the zone cooling systems must recool the air. The exception for series energy recovery is warranted because any excess reheat was provided by a reduction of the cooling load on the dehumidifying coil, so there is no net gain in compressor load. The exception is desirable because adding the capability to control the discharge temperature of a series energy recovery system is expensive.

Cost Impact: The code change proposal will decrease the cost of construction.
The proposal removes the need for costly controls that do not save energy.

Bibliography: ANSI/ASHRAE/IES Standard 90.1-2019 Energy Standard for Buildings Except Low-Rise Residential Buildings, Addendum n
https://www.ashrae.org/technical-resources/standards-and-guidelines/standards-addenda/addenda-to-standard-90-1-2019

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: Reason: Subcommittee referenced the reason statement from the proposal.

Based on addendum n to 90.1-2019

This proposal

1. Adds a definition for series energy recovery.

2. Provides an exception for systems equipped with series energy recovery to the requirement.

Series energy recovery is a well-established method to provide both passive free cooling and reheating to an airstream. It is typically done with a wrap-around coil where heat is absorbed into the fluid upstream of a dehumidifying cooling and released downstream of the coil to provide reheat. A sensible-only plate heat exchanger can be employed as well. Unlike condenser heat recovery, which only provides free reheat, this process

reduces the load on the dehumidifying cooling coil. The requirement to provide cool air from a 100% outside air unit while the building needs cooling is so that the work done by the compressor to cool the air is not wasted. When air is provided at higher temperatures, the zone cooling systems must recool the air. The exception for series energy recovery is warranted because any excess reheat was provided by a reduction of the cooling load on the dehumidifying coil, so there is no net gain in compressor load. The exception is desirable because adding the capability to control the discharge temperature of a series energy recovery system is expensive.

Proposal # 108

CEPI-113-21

Proponents: Mike Moore, Stator LLC, representing The Home Ventilating Institute (mmoore@statorllc.com)

2021 International Energy Conservation Code

Revise as follows:

C403.7.4.1 Nontransient dwelling units. Nontransient dwelling units shall be provided with balanced outdoor air heat or energy recovery ventilation systems with an *enthalpy recovery ratio* of not less than 50 percent at cooling design condition and not less than 60 percent at heating design condition.

Exceptions:

1. Nontransient dwelling units in Climate Zone 3C.
2. Nontransient dwelling units with not more than 500 square feet (46 m^2) of *conditioned floor area* in Climate Zones 0,~~–~~1, 2, 3, 4C, and 5C and either adjoin an open-ended corridor or do not adjoin a corridor.
3. Nontransient dwelling units with not more than 500 square feet (46 m^2) of conditioned floor area that are located in Climate Zones 1A, 2B, 3B, and 3C.
4. (~~3~~ 4.) *Enthalpy recovery ratio* requirements at heating design condition in Climate Zones 0, 1 and 2.
5. (~~4~~ 5.) *Enthalpy recovery ratio* requirements at cooling design condition in Climate Zones 4, 5, 6, 7 and 8.

Reason: This proposal expands the requirement for heat or energy recovery ventilators (i.e., an HRV or an ERV) for high-rise dwelling units in Group R-2 buildings based on a cost effectiveness analysis. The proposal expands the climate zones and dwelling unit sizes where an H/ERV is considered to be cost effective. Clarity is also provided that the system is expected to be a balanced ventilation system (now defined in the IMC and IRC) and that a heat or energy recovery ventilation system may be used, provided the system meets the minimum performance requirements of this section.

Cost Impact: The code change proposal will increase the cost of construction.
The cost effectiveness analysis was based on the ASHRAE 90.1 scalar method (values < 12.5 were considered cost effective) and also included considerations for the monetization of carbon emissions. The included table highlights cost-effective applications in green. Key assumptions:

- ASHRAE 62.2 ventilation rates (equivalent to 2021 IMC high-rise dwelling unit rates for the 1000 ft2 dwelling unit and slightly lower than the 2021 IMC high-rise dwelling unit rate for the 500 ft2 dwelling unit; tentatively approved for low-rise dwelling R-2 dwelling units in the 2024 IMC pending final approval through the OGCV of M19-21); these rates are ~30% lower than ASHRAE 62.1 and European rates (see additional rationale below). Note: HRVs and ERVs are more cost effective at higher ventilation rates.
- Balanced ventilation as the minimum code-compliant reference system (see additional rationale below)
- Fan efficacy compliant with the 2021 IECC
- 1000 ft2, 2-bed/2-bath and 500 ft2 1-bed/1-bath dwelling units
- Energy prices determined from 5-year national average of EIA data
- Effect of carbon price analyzed at four levels. This analysis was performed to permit the committee to identify the final climate zone exceptions that are appropriate in this section, based on the committee's final selection of a carbon price. See the following table for cost effectiveness under the four carbon pricing scenarios evaluated.
    - $0/metric ton
    - Cap and Trade: $29.63/metric ton[1] (used to justify cost effectiveness for this proposal)
    - IWG Social Cost of Carbon: $51/metric ton[2]
    - CEC Emissions Abatement Cost: $106/metric ton[1]
- Simulation and cost effectiveness analysis documents can be found at the following address: https://www.dropbox.com/sh/yuodjpuvkwrefwl/AADK5WsKTfh1VrlGSCGbqsPVa?dl=0

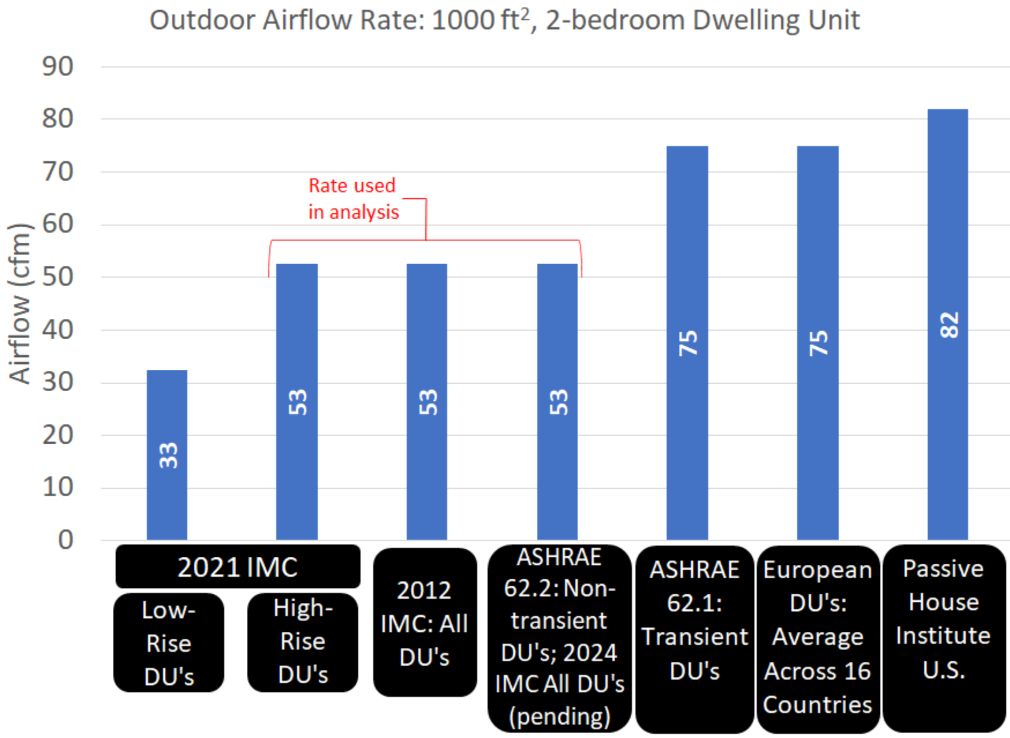
Climate Zone	Scalar Ratio Calculation							
	Carbon @ $0/metric ton		Carbon @ $29.63/metric ton		Carbon @ $51/metric ton		Carbon @ $106/metric ton	
	500 ft²	1000 ft²	500 ft²	1000 ft²	500 ft²	1000 ft²	500 ft²	1000 ft²
0A	4.4	1.5	4.0	1.4	3.7	1.3	3.2	1.2
0B	13.7	4.0	12.5	3.6	11.8	3.4	10.2	2.9
1A	44.7	8.0	40.8	7.3	38.4	6.8	33.3	5.9
1B	9.1	2.9	8.2	2.6	7.7	2.5	6.7	2.1
2A	13.7	3.9	12.4	3.6	11.6	3.4	10.0	2.9
2B	42.7	7.8	36.4	6.9	32.8	6.4	26.3	5.3
3A	10.6	3.3	9.1	2.8	8.3	2.6	6.7	2.1
3B	23.5	5.7	19.9	4.9	18.0	4.5	14.3	3.7
3C	No annual savings	No annual savings	No annual savings	No annual savings	No annual savings	No annual savings	No annual savings	No annual savings
4A	5.0	2.0	4.3	1.7	4.0	1.6	3.2	1.3
4B	9.5	3.4	8.2	3.0	7.4	2.7	5.9	2.2
4C	6.6	2.5	5.6	2.2	5.1	2.0	4.1	1.6
5A	4.0	1.6	3.4	1.4	3.1	1.3	2.5	1.1
5B	5.9	2.3	5.1	2.0	4.6	1.8	3.7	1.5
5C	4.8	1.9	4.2	1.7	3.8	1.5	3.1	1.3
6A	3.2	1.3	2.7	1.2	2.5	1.1	2.0	0.9
6B	3.9	1.6	3.3	1.4	3.0	1.3	2.5	1.0
7	2.5	1.0	2.1	0.9	1.9	0.8	1.6	0.7
8	1.9	0.8	1.6	0.7	1.5	0.6	1.2	0.5

Why choose balanced ventilation as the reference ventilation system?

Recent research has documented significant leakage pathways between the walls of newer, tight dwelling units and adjacent corridors in Group R-2 buildings, with approximately 40% of dwelling unit leakage area to the corridor.[3] Based on this finding, operating an unbalanced outdoor air ventilation system in a dwelling unit with a wall adjacent to a corridor is expected to establish a pressure differential with respect to the corridor. When a supply ventilation system is specified for the dwelling unit, this is expected to pressurize the dwelling unit, transferring air from the dwelling unit to the corridor. When an exhaust system is specified for the dwelling unit, this is expected to depressurize the dwelling unit, transferring air from the corridor to the dwelling unit. Transferring air to or from the corridor and an adjoining dwelling unit is a violation of IBC Section 1020.5 and IMC 601.2, which prohibit corridors from serving as "supply, return, exhaust, relief, or ventilation air ducts." Physically speaking, to comply with these requirements in the IBC and IMC, an outdoor air ventilation system must be balanced. Joe Lstiburek provides pages of rationale supporting this concept in his article, "Compartmentalization, Distribution and Balance" – which in 2019 laid out a game plan for energy efficient, construction and ventilation of multifamily dwelling units to achieve the building code's fire safety, IAQ, and energy efficiency objectives.[4] Perhaps for such reasons, prior to 2015, any dwelling unit having mechanical ventilation was required to provide mechanical ventilation "by a method of supply and return or exhaust air," where "the amount of supply air shall be approximately equal to the amount of return and exhaust air" (2012 IMC 403.1). As such, for the cost effectiveness analysis, this proposal assumes a balanced ventilation system for Group R-2 building dwelling units adjoining a corridor.

Why choose ASHRAE 62.2-2019 Ventilation Rates?

Within the cost effectiveness study supporting this proposal, ASHRAE 62.2-2019 ventilation rates were selected for dwelling units in low-rise Group R-2 buildings. ASHRAE 62.2-2019 ventilation rates are roughly equivalent to: the 2012 IMC ventilation rates for all dwelling units, the 2021 IMC ventilation rates for high-rise residential dwelling units in the 2021 IMC, and the pending 2024 IMC ventilation rates for all R-2 dwelling units (pending final action on M19-21). These rates are also more conservative (~30% lower) than European rates,[5] ASHRAE 62.1 rates, and Passive House rates. The 2015-2021 IMC rates for low-rise R-2 dwelling units are incredibly low – and are based on an old ASHRAE 62.2 formula for leaky, single-family, detached homes that is not relevant for tight, multifamily construction with higher occupant density and higher indoor air pollution concentration than single-family detached homes.



Additionally, the rates promulgated by ASHRAE 62.2-2019 and the IMC are recognized as rates needed to provide *minimum acceptable indoor air quality*. It is expected that members of the public seeking improved IAQ may elect to use higher rates to reduce pollutant concentration and support better productivity and health outcomes, which have also been linked to increases in wages. Studies that have shown better health outcomes or improved performance for building occupants as a function of higher ventilation rates include:

- Sundell[6]: Sick building syndrome declines as ventilation rate increases.
- Milton[7:] Sick leave decreases as ventilation rate increases.
- Bornehag[8]: Risk of asthma for children increases with decreasing ventilation rate in homes.
- Seppänen[9]: Productivity decreases with decreasing ventilation rate.
- Tejsen[10]: Productivity increases with increasing residential ventilation rate.

While some of these studies were conducted in commercial buildings, LBNL's[11] analysis of residential studies concluded that, "Just over half of (residential) studies report one or more statistically significant health benefits of increased ventilation rates." LBNL noted that, "The findings of research on how ventilation rates in homes affect health are mixed," but that "overall… the number of reported statistically significant improvements in health with increased ventilation rates far exceeded the anticipated chance improvements in health."

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3. Bohac D., and Sweeney L. 2020. Energy Code Field Studies: Low-Rise Multifamily Air Leakage Testing. Prepared by the Center for Energy and Environment, Ecotope, and The Energy Conservatory. Prepared for the U.S. Department of Energy Office of Energy Efficiency & Renewable Energy. https://www.energycodes.gov/sites/default/files/documents/LRMF_AirLeakageTesting_FinalReport_2020-07-06.pdf. [See Table 45, which shows average leakage to "common" area of 42%. The report also notes, "for buildings in this study, "common areas" are made up almost completely of corridors and a few small rooms such as mechanical closets and elevator rooms.]
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7. Milton et al. 2000. Risk of Sick Leave Associated with Outdoor Air Supply Rate, Humidification, and Occupant Complaints. Indoor Air, 10:212-221.
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10. Tejsen et al. 2016. The effects of bedroom air quality on sleep and next-day performance. Indoor Air, 26:679-686.
11. LBNL. Indoor Air Quality Scientific Findings Resource Bank. Building Ventilation. Accessed May 6, 2021. https://iaqscience.lbl.gov/ventsummary#:~:text=Just%20over%20half%20of%20studies,improve%20with%20increased%20ventilation%20rates.

Attached Files

- **HERV Cost Effectiveness Scalars.png**
  https://energy.cdpaccess.com/proposal/434/1113/files/download/121/
- **MF OA Rates.png**
  https://energy.cdpaccess.com/proposal/434/1113/files/download/120/

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Subcommittee referenced the reason statement from the proposal and proponent modifications.

Proposal # 434

CEPI-116-21

Proponents: Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Add new definition as follows:

Energy recovery, series. A three-step process in which the first step is to remove energy from a single airstream without the use of mechanical cooling. In the second step, the air stream is mechanically cooled for the purpose of dehumidification. In the third step, the energy removed in step one is reintroduced to the air stream.

Energy recovery ratio, series (SERR). The difference between the dry bulb air temperatures leaving the series energy recovery unit and leaving the dehumidifying coil divided by the difference between 75˚F (24˚C) and the dry bulb temperature of the air leaving the dehumidifying cooling coil.

Revise as follows:

C403.7.4.2 Spaces other than nontransient dwelling units. Where the supply airflow rate of a fan system serving a space other than a nontransient dwelling unit exceeds the values specified in Tables C403.7.4.2(1) and C403.7.4.2(2), the system shall include an energy recovery system. The energy recovery system shall provide an *enthalpy recovery ratio* of not less than 50 percent at design conditions. Where an air economizer is required, the energy recovery system shall include a bypass or controls that permit operation of the economizer as required by Section C403.5.

Exception: An energy recovery ventilation system shall not be required in any of the following conditions:

1. Where energy recovery systems are prohibited by the *International Mechanical Code*.
2. Laboratory fume hood systems that include not fewer than one of the following features:
    2.1. Variable-air-volume hood exhaust and room supply systems configured to reduce exhaust and makeup air volume to 50 percent or less of design values.
    2.2. Direct makeup (auxiliary) air supply equal to or greater than 75 percent of the exhaust rate, heated not warmer than 2°F (1.1°C) above room setpoint, cooled to not cooler than 3°F (1.7°C) below room setpoint, with no humidification added, and no simultaneous heating and cooling used for dehumidification control.
3. Systems serving spaces that are heated to less than 60°F (15.5°C) and that are not cooled.
4. Heating energy recovery where ~~Where~~ more than 60 percent of the outdoor heating energy is provided from site-recovered or site-solar energy in Climate Zones 5 through 8.
5. *Enthalpy recovery ratio* requirements at heating design condition in *Climate Zones* 0, 1 and 2.
6. *Enthalpy recovery ratio* requirements at cooling design condition in *Climate Zones* 3C, 4C, 5B, 5C, 6B, 7 and 8.
7. Systems in Climate Zones 0 through 4 requiring dehumidification that employ *series energy recovery* ~~in series with the cooling coil~~ and have a minimum SERR of 0.40.
8. Where the largest source of air exhausted at a single location at the building exterior is less than 75 percent of the design *outdoor air* flow rate.
9. Systems expected to operate less than 20 hours per week at the *outdoor air* percentage covered by Table C403.7.4.2(1).
10. Systems exhausting toxic, flammable, paint or corrosive fumes or dust.
11. Commercial kitchen hoods used for collecting and removing grease vapors and smoke.

Reason: This proposal revises two exceptions to the requirement to use energy recovery. One change limits the exception for solar heating to cooler climates.The second clarifies the exemption for the use of “energy recovery in series with the cooling coil” by creating a new definition for series energy recovery. This definition is required because some users of the standard have confused condenser heat recovery and site-recovered energy with series energy recovery. They are quite different.
There is also a new definition that defines the performance of series energy recovery. The purpose is to ensure that the series energy recovery system performs well enough to justify allowing it to be used in lieu of conventional energy recovery. The format of the code does not allow formulas to be used in a definition, so the series energy recovery ratio is described in the text. For clarity, the formula is shown here:

$SERR = (TL - TC)/(TE - TC)$

Where

SERR = Series energy recovery ratio

TL = Rated dry bulb temperature of the air leaving the device.

TC = Dry bulb temperature of the air leaving the dehumidifying cooling coil TE = Dry bulb temperature of the air entering the first step of 75º F In addition, the exemption for series energy recovery has been limited to warmer climate zones.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The changes only clarify the intent of the code.

Bibliography: ANSI/ASHRAE/IES Standard 90.1-2019 Energy Standard for Buildings Except Low-Rise Residential Buildings

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Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: This proposal revises two exceptions to the requirement to use energy recovery. One change limits the exception for solar heating to cooler climates. The second clarifies the exemption for the use of "energy recovery in series with the cooling coil" by creating a new definition for series energy recovery. This definition is required because some users of the standard have confused condenser heat recovery and site-recovered energy with series energy recovery. They are quite different. There is also a new definition that defines the performance of series energy recovery. The purpose is to ensure that the series energy recovery system performs well enough to justify allowing it to be used in lieu of conventional energy recovery.

Proposal # 47

CEPI-118-21

Proponents: Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Revise as follows:

C403.7.7 Shutoff dampers. Outdoor air intake and exhaust openings and stairway and shaft vents shall be provided with Class I motorized dampers. The dampers shall have an air leakage rate not greater than 4 cfm/ft^2 (20.3 L/s × m^2) of damper surface area at 1.0 inch water gauge (249 Pa) and shall be labeled by an *approved agency* when tested in accordance with AMCA 500D for such purpose.
Outdoor air intake and exhaust dampers shall be installed with automatic controls configured to close when the systems or spaces served are not in use or during unoccupied period warm-up and setback operation, unless the systems served require outdoor or exhaust air in accordance with the International Mechanical Code or the dampers are opened to provide intentional economizer cooling.

Stairway and elevator shaft vent dampers shall be installed with automatic controls configured to open upon the activation of any fire alarm initiating device of the building's fire alarm system , ~~or~~ the interruption of power to the damper , or by thermostatic control systems.

> **Exception:** Nonmotorized gravity dampers shall be an alternative to motorized dampers for exhaust and relief openings as follows:
>
> 1. In buildings less than three stories in height above grade plane.
> 2. In buildings of any height located in *Climate Zones* 0, 1, 2 or 3.
> 3. Where the design exhaust capacity is not greater than 300 cfm (142 L/s).

Nonmotorized gravity dampers shall have an air leakage rate not greater than 20 cfm/ft^2 (101.6 L/s × m^2) where not less than 24 inches (610 mm) in either dimension and 40 cfm/ft^2 (203.2 L/s × m^2) where less than 24 inches (610 mm) in either dimension. The rate of air leakage shall be determined at 1.0 inch water gauge (249 Pa) when tested in accordance with AMCA 500D for such purpose. The dampers shall be labeled by an *approved agency*.

Reason: Based on ASHRAE 90.1-2019 Addendum m.
Elevator shaft vents are no longer required by most model codes, but many machine-room-less elevator manufacturers insist on a vent to help maintain shaft temperatures that may rise due to heat produced by the cab-mounted elevator machinery. These vents are not likely necessary or even useful for temperature control in most applications due to the heat losses to the conditioned spaces adjacent to the elevator shaft that should result in acceptable shaft temperatures. However, they are being used nonetheless.

These vents are typically open year-round. This proposal requires that if such vents are installed, they are controlled to only open based on a thermostatic setting.

Cost Impact: The code change proposal will increase the cost of construction.
The cost of construction is increased in cases where elevator manufacturers require a vent in the elevator shaft.

Bibliography: ANSI/ASHRAE/IES Standard 90.1-2019 Energy Standard for Buildings Except Low-Rise Residential Buildings, Addendum m
https://www.ashrae.org/technical-resources/standards-and-guidelines/standards-addenda/addenda-to-standard-90-1-2019

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: Based on ASHRAE 90.1-2019 Addendum m.
Elevator shaft vents are no longer required by most model codes, but many machine-room-less elevator manufacturers insist on a vent to help maintain shaft temperatures that may rise due to heat produced by the cab-mounted elevator machinery. These vents are not likely necessary or even useful for temperature control in most applications due to the heat losses to the conditioned spaces adjacent to the elevator shaft that should result in acceptable shaft temperatures. However, they are being used nonetheless.
These vents are typically open year-round. This proposal requires that if such vents are installed, they are controlled to only open based on a thermostatic setting.

CEPI-119-21

Proponents: John Bade, representing California Investor Owned Utilities (johnbade@2050partners.com)

2021 International Energy Conservation Code

Revise as follows:

ENTHALPY RECOVERY RATIO (ERR). Change in the enthalpy of the *outdoor air* supply divided by the difference between the *outdoor air* and entering exhaust air enthalpy, expressed as a percentage.

FAN SYSTEM DESIGN CONDITIONS. Operating conditions that can be expected to occur during normal system operation that result in the highest supply fan airflow rate of ~~to conditioned spaces served by~~ the *fan system* ~~system~~, other than during air economizer operation.

Add new definition as follows:

FAN ELECTRICAL INPUT POWER. The electrical input power in kilowatts required to operate an individual fan or fan array at design conditions. It includes the power consumption of motor controllers, where present.

FAN NAMEPLATE ELECTRICAL INPUT POWER. Is the nominal electrical input power rating stamped on a fan assembly nameplate.

FAN SYSTEM. All the fans that contribute to the movement of air serving *spaces* that pass through a point of a common duct, plenum, or cabinet.

Add new definition as follows:

FAN SYSTEM, COMPLEX. A *fan system* that combines a *single-cabinet fan system* with other supply fans, exhaust fans, or both.

FAN SYSTEM, EXHAUST/RELIEF. A *fan system* dedicated to the removal of air from interior spaces to the outdoors.

FAN SYSTEM, RETURN. A *fan system* dedicated to removing air from the interior where some or all the air is to be recirculated except during economizer operation.

FAN SYSTEM, SINGLE-CABINET. A *fan system* where a single fan, single fan array, a single set of fans operating in parallel, or fans or fan arrays in series and embedded in the same cabinet that both supply air to a space and recirculate the air.

FAN SYSTEM, TRANSFER. A *fan system* that exclusively moves air from one occupied space to another.

2021 International Energy Conservation Code

Add new definition as follows:

FAN SYSTEM AIRFLOW. The sum of the airflow of all fans with *fan electrical input power* greater than 1 kW at *fan system design conditions*, excluding the airflow that passes through downstream fans with *fan electrical input power* less than 1 kW.

Revise as follows:

FAN SYSTEM ELECTRICAL INPUT POWER. The sum of the fan electrical input power of all fans that are required to operate at *fan system design conditions* ~~to supply air from the heating or cooling source to the conditioned spaces and/or return it to the source or exhaust it to the outdoors~~.

Delete and substitute as follows:

~~**C403.8.1 Allowable fan horsepower.** Each HVAC system having a total fan system motor nameplate horsepower exceeding 5 hp (3.7 kW) at fan system design conditions shall not exceed the allowable *fan system motor nameplate hp* (Option 1) or *fan system bhp* (Option 2) shown in Table C403.8.1(1). This includes supply fans, exhaust fans, return/relief fans, and fan-powered terminal units associated with systems providing heating or cooling capability. Single-zone variable air volume systems shall comply with the constant volume fan power limitation.~~

~~**Exceptions:**~~

1. ~~Hospital, vivarium and laboratory systems that utilize flow control devices on exhaust or return to maintain space pressure relationships necessary for occupant health and safety or environmental control shall be permitted to use variable volume fan power limitation.~~
2. ~~Individual exhaust fans with motor nameplate horsepower of 1 hp (0.746 kW) or less are exempt from the allowable fan horsepower requirement.~~

C403.8.1 Fan power. For each *fan system* serving an occupied space or other enclosed space that includes one or more fans or fan arrays with *fan electrical input power* greater than 1 kW, *fan system electrical input power* determined per Section C403.8.1.2 at the *fan system design airflow* shall not be greater than the limit is calculated in accordance with Section C403.8.1.1. This section does not apply to fans service heat rejection equipment.

Delete without substitution:

TABLE C403.8.1(1) FAN POWER LIMITATION

	LIMIT	CONSTANT VOLUME	VARIABLE VOLUME
Option 1: Fan system motor nameplate hp	Allowable nameplate motor hp	hp ≤ CFM_S × 0.0011	hp ≤ CFM_S × 0.0015
Option 2: Fan system bhp	Allowable fan system bhp	bhp ≤ CFM_S × 0.00094 + *A*	bhp ≤ CFM_S × 0.0013 + *A*

For SI: 1 bhp = 735.5 W, 1 hp = 745.5 W, 1 cfm = 0.4719 L/s.

where:

CFM_S = The maximum design supply airflow rate to conditioned spaces served by the system in cubic feet per minute.

hp = The maximum combined motor nameplate horsepower.

bhp = The maximum combined fan brake horsepower.

A = Sum of [*PD* × CFM_D / 4131].
where:

PD = Each applicable pressure drop adjustment from Table C403.8.1(2) in. w.c.

CFM_D = The design airflow through each applicable device from Table C403.8.1(2) in cubic feet per minute.

Add new text as follows:

TABLE C403.8.1(1)
SUPPLY FAN POWER ALLOWANCES (W/CFM)

Multi-Zone VAV Fan System Airflow (cfm)[a]				All Other Fan Systems Airflow (cfm)		
Air system Component	<5,000	5,000 to <10,000	>=10,000	<5,000	5,000 to <10,000	>=10,000
W/cfm						
Supply System Base Allowance for each fan system	0.413	0.472	0.480	0.243	0.267	0.248
Particle filtration (select all that apply)						
Filter not higher than MERV 12	0.094	0.079	0.073	0.097	0.084	0.075
MERV 13 to MERV 16 filter	0.210	0.177	0.165	0.217	0.185	0.168
HEPA filter	0.347	0.292	0.277	0.357	0.304	0.278
Heating (select all that apply)						
Hydronic heating coil (central)	0.047	0.050	0.055	0.049	0.053	0.057
Electric heat	0.047	0.040	0.037	0.049	0.042	0.038
Gas or oil furnace <90% Et or <90% AFUE	0.071	0.060	0.073	0.061	0.063	0.075
Gas or oil furnace >= 90% Et or >=90% AFUE	0.117	0.099	0.092	0.122	0.104	0.094
Cooling and dehumidification (select all that apply)						
Hydronic/DX cooling coil, or heat pump coil (wet) [Healthcare facilities can select twice]	0.141	0.118	0.110	0.146	0.125	0.112
Fluid economizer coil	0.141	0.118	0.110	0.146	0.125	0.112
Desiccant system-solid or liquid	0.164	0.138	0.128	0.170	0.145	0.131
Hot gas reheat coil	0.047	0.040	0.037	0.049	0.042	0.038
Series energy recovery	0.141	0.118	0.110	0.146	0.125	0.112
Evaporative humdifier/cooler in series with a cooling coil. Value shown is allowed W/cfm per 1.0 in. wg. Determine pressure loss (in. wg.) at the lesser of 400 fpm or maximum velocity allowed by the manufacturer. [Calculation required[b]]	0.233	0.196	0.184	0.241	0.205	0.186
Energy recovery						
Enthalpy Recovery Ratio >=0.50 and <0.55	0.141	0.118	0.110	0.146	0.125	0.112
Enthalpy Recovery Ratio >=0.55 and <0.60	0.166	0.140	0.130	0.172	0.147	0.133
Enthalpy Recovery Ratio >=0.60 and <0.65	0.191	0.161	0.151	0.198	0.169	0.153
Enthalpy Recovery Ratio >=0.65 and <0.70	0.217	0.182	0.171	0.224	0.191	0.173
Enthalpy Recovery Ratio >=0.70 and <0.75	0.242	0.204	0.191	0.250	0.213	0.193
Enthalpy Recovery Ratio >=0.75 and <0.80	0.267	0.225	0.212	0.276	0.235	0.213
Enthalpy Recovery Ratio >=0.80	0.292	0.246	0.232	0.301	0.257	0.234
Run-around liquid or refrigerant coils	0.141	0.118	0.110	0.146	0.125	0.112
Gas-phase filtration						
Gas-phase filtration	0.233	0.196	0.184	0.241	0.205	0.186
Other						
Economizer return damper	0.049	0.042	0.038	0.049	0.043	0.039
100% Outdoor air system[c]	0.000	0.000	0.000	0.073	0.104	0.112
Low-turndown single-zone VAV fan systemsd	0.000	0.000	0.000	0.073	0.104	0.094
Air blender	0.047	0.040	0.037	0.049	0.042	0.038
Sound attenuation section [fans serving spaces with design background noise goals below NC35]	0.035	0.030	0.027	0.036	0.032	0.029
Deducation for systems that feed a terminal unit or fan coil with a fan with electrical input power <1kWe	-0.500	-0.500	-0.500	-0.100	-0.100	-0.100

a. See section C408.3.1.1 for requirements for a Multi-Zone VAV system.

b. Power allowances require further calculation. Multiply the actual pressure drop of the device or component by the fan power allowance in Table C403.8.1(2).

c. The 100 percent outdoor air system must serve 3 or more HVAC zones.

d. A low-turndown single-zone VAV fan system must be capable of and configured to reduce airflow to 50 percent of design airflow and use no more than 30 percent of the design wattage at that airflow. No more than 10 percent of the design load served by the equipment shall have fixed loads.

e. The deduction of 0.500 W/cfm is a default value for multizone VAV fan systems. If the terminal unit or fan coil manufacturer can demonstrate that the share of the unit's fan power required to move the fan system's air is less than 0.500 W/cfm, that value may be used. The W/cfm shall be calculated by dividing the power required to operate the terminal unit's fan at fan system design conditions by the airflow of the terminal unit at those conditions.

Delete without substitution:

TABLE C403.8.1(2) FAN POWER LIMITATION PRESSURE DROP ADJUSTMENT

DEVICE	ADJUSTMENT
Credits	
Return air or exhaust systems required by code or accreditation standards to be fully ducted, or systems required to maintain air pressure differentials between adjacent rooms	0.5 inch w.c. (2.15 inches w.c. for laboratory and vivarium systems)
Return and exhaust airflow control devices	0.5 inch w.c.
Exhaust filters, scrubbers or other exhaust treatment	The pressure drop of device calculated at fan system design condition
Particulate filtration credit: MERV 9 thru 12	0.5 inch w.c.
Particulate filtration credit: MERV 13 thru 15	0.9 inch w.c.
Particulate filtration credit: MERV 16 and greater and electronically enhanced filters	Pressure drop calculated at 2 times the clean filter pressure drop at fan system design condition.
Carbon and other gas-phase air cleaners	Clean filter pressure drop at fan system design condition.
Biosafety cabinet	Pressure drop of device at fan system design condition.
Energy recovery device, other than coil runaround loop	For each airstream, (2.2 × energy recovery effectiveness - 0.5) inch w.c.
Coil runaround loop	0.6 inch w.c. for each airstream.
Evaporative humidifier/cooler in series with another cooling coil	Pressure drop of device at fan system design conditions.
Sound attenuation section (fans serving spaces with design background noise goals below NC35)	0.15 inch w.c.
Exhaust system serving fume hoods	0.35 inch w.c.
Laboratory and vivarium exhaust systems in high-rise buildings	0.25 inch w.c./100 feet of vertical duct exceeding 75 feet.
Deductions	
Systems without central cooling device	- 0.6 inch w.c.
Systems without central heating device	- 0.3 inch w.c.
Systems with central electric resistance heat	- 0.2 inch w.c.

For SI: 1 inch w.c. = 249 Pa, 1 inch = 25.4 mm, 1 foot = 304.8 mm.

w.c. = Water Column, NC = Noise Criterion.

Add new text as follows:

TABLE C403.8.1(4)
DEFAULT VALUES FOR FAN ELECTRICAL INPUT POWER BASED ON MOTOR NAMEPLATE HP[a,b]

Motor Nameplate Horsepower	Variable-Speed Drive (kW)	Without Variable-Speed Drive (kW)
<1	0.96	0.89
≥1 and <1.5	1.38	1.29
≥1.5 and <2	1.84	1.72
≥2 and <3	2.73	2.57
≥3 and <5	4.38	4.17
≥5 and <7.5	6.43	6.15
≥7.5 and <10	8.46	8.13
≥10 and <15	12.47	12.03
≥15 and <20	16.55	16.04
≥20 and <25	20.58	19.92
≥25 and <30	24.59	23.77
≥30 and <40	32.74	31.70
≥40 and <50	40.71	39.46
≥50 and <60	48.50	47.10
≥60 and <75	60.45	58.87
≥75 and ≤100	80.40	78.17

a. This table cannot be used for Motor Nameplate Horsepower values greater than 100.

b. This table is to be used only with motors with a service factor ≤1.15. If the service factor is not provided, this table may not be used.

C403.8.1.1 Determining Fan Power Limit. The maximum allowed *fan system electrical input power*, shall be determined in accordance with the following steps 1 through 5:

1. The *fan system's* classification shall be determined. A fan system is considered to be multizone VAV where it meets the following requirements; *fan systems* that do not meet the following requirements shall be classified as other fans:

   1.1. The fan system shall serve three or more HVAC zones and airflow to each shall be individually controlled based on heating, cooling and/or ventilation requirements.

   1.2. The sum of the minimum airflows for each HVAC zone shall be not greater than 40 percent of the *fan system design conditions*.

   Exception: Hospital, vivarium, and laboratory systems that use flow control devices on exhaust or return to maintain space pressure relationships necessary for occupant health and safety or environmental control shall use the multizone VAV fan power allowances.

2. Determine the fan system airflow and choose the applicable table(s) for fan power allowance.

   1. For *single-cabinet fan systems*, use the *fan system airflow* and the power allowances in both Table C403.8.1(1) and Table C403.8.1(2).
   2. For *supply-only fan systems*, use the fan system airflow and power allowances in Table C403.8.1(1).
   3. For *relief fan systems*, use the design relief airflow and the power allowances in Table C403.8.1(2).
   4. For exhaust, return and transfer *fan systems*, use the *fan system airflow* and the power allowances in Table C403.8.1(2).
   5. For *complex fan systems* and DOAS with energy recovery *fan systems*, separately calculate the fan power allowance for the supply and return/exhaust systems and sum them. For the supply airflow at the *fan system* design conditions, and the power allowances in Table C403.8.1(1). For the return/exhaust airflow, use return or exhaust airflow at the *fan system design conditions*, and the power allowances in Table C403.8.1(2).

3. For each *fan system* determine the components included in the *fan system* and sum the fan power allowances of those components. All *fan systems* shall include the System Base Allowance. If, for a given component, only a portion of the *fan system airflow* passes through the component, calculate the fan power allowance for the component per equation 4-9:

   $FPA_{adj} = (Q_{comp}/Q_{sys}) * FPA_{comp}$ **(Equation #)**
   where:

   FPA_{adj} = The corrected fan power allowance for the component in w/cfm

   Q_{comp} = The airflow through component in cfm

   Q_{sys} = The fan system airflow in cfm

   FPA_{comp} = The fan power allowance of the component from Table C403.8.1(1) or Table C403.8.1(2)

4. Multiply the fan system airflow by the sum of the fan power allowances for the fan system, then divide by 1000 to convert to KW.

   $FPL = (Q_{sys} * FPA_{sum})/1000$ **(Equation #)**
   where:

   FPL = The fan power limit in KW

   Q_{sys} = The fan system airflow in cflm (L/s)

   FPA_{sum} = The sum of the fan power allowance for the system in W/cfm

   1000 = The conversion from W to kW

5. For building sites at elevations greater than 3,000 feet (900 m), multiply the fan power limit by the correction factor from Table C408.3.1(3).

   $FPL_{alt} = FPL * C_{alt}$ **(Equation #)**
   where:

   FPL_{alt} = The adjusted fan power limit in KW.

   FPL = The fan power limit in KW calculated in step 4.

   C_{alt} = The altitude correction factor from Table C408.3.1(3)

C403.8.1.2 Determining *Fan System Electrical Input Power*. The *fan system electrical input power* is the sum of the *fan electrical input power* of each fan or fan array included in the fan system other than fans with *fan electrical input power* ≤ 1 kW. If variable speed drives are used their efficiency losses shall be included. *Fan system input power* shall be calculated with mid-life filter pressure drop, which is the mean of the clean filter pressure drop and design final filter pressure drop. The *fan electrical input power* for each fan or fan array shall be determined using one of the following methods. There is no requirement to use the same method for all fans in a *fan system*:

1. Use the default *fan electrical input power* in Table C408.3.1(4) for one or more of the fans. This method cannot be used for complex *fan systems*.
2. Use the *fan electrical input power* at *fan system design conditions* provided by the manufacturer of the fan, *fan array*, or equipment that includes the fan or *fan array*, calculated per a test procedure included in 10 CFR Part 430, 10 CFR Part 431, ANSI/AMCA Standard 210, ASHRAE 51 AHRI Standard 430, AHRI Standard 440, or ISO 5801.
3. Use the *fan electrical input power* provided by the manufacturer, calculated at *fan system design conditions* per one of the methods listed in section 5.3 of ANSI/AMCA 208.
4. Use the *fan nameplate electrical input power*.

C503.3 Heating and cooling systems. New heating, cooling and duct systems that are part of the *alteration* shall comply with Sections C403 and C408.

Add new text as follows:

C503.3.2 Additional fan power allowances. Additional Fan Power Allowances are available when determining the Fan Power Budget (Fan kW_{budget}) as specified in Table C503.4. These values can be added to the Fan Power Allowance values in Table C403.8.1(1) and Table C403.8.1(2) when calculating a new Fan kW_{budget} for the *fan system* being altered.

Add new standard(s) as follows:

AHRI

Air-Conditioning, Heating, & Refrigeration Institute
2111 Wilson Blvd, Suite 500
Arlington, VA 22201

AHRI 1060-2018	Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment
AHRI Standard 430-2020	Performance Rating of Central Station Air-Handling Units

Add new definition as follows:

FAN SYSTEM, COMPLEX. A *fan system* that combines a *single-cabinet fan system* with other supply fans, exhaust fans, or both.

FAN SYSTEM, EXHAUST or RELIEF. A *fan system* dedicated to the removal of air from interior spaces to the outdoors.

FAN SYSTEM, RETURN. A *fan system* dedicated to removing air from the interior where some or all the air is to be recirculated except during economizer operation.

FAN SYSTEM, SINGLE-CABINET. A *fan system* where a single fan, single fan array, a single set of fans operating in parrallel, or fans or fan arrays in series and embedded in the same cabinet that both supply air to a space and recirculate the air.

FAN SYSTEM, TRANSFER. A *fan system* that exclusively moves air from one occupied space to another.

Add new text as follows:

Table C403.8.1(2) EXHAUST, RETURN, RELIEF, TRANSFER FAN SYSTEM POWER ALLOWANCES (W/CFM)

Mult-Zone VAV Fan System airflow[a] (cfm)				All Other Fan Systems Airflow (cfm)		
Air System Component	<5,000	5,000 to <10,000	>=10,000	<5,000	5,000 to <10,000	>=10,000
W/cfm						
Exhaust, Return, Relief, and Transfer System Base Allowance for each *fan system*	0.231	0.256	0.248	0.194	0.192	0.200
Particle filtration						
Filter (any MERV value)[b]	0.049	0.042	0.038	0.049	0.043	0.039
Energy recovery						
Enthalpy Recovery Ratio >= 0.50 and <0.55	0.146	0.125	0.112	0.146	0.128	0.114
Enthalpy Recovery Ratio >=0.55 and <0.60	0.173	0.148	0.133	0.173	0.150	0.135
Enthalpy Recovery Ratio >=0.60 and <0.65	0.199	0.170	0.153	0.199	0.173	0.155
Enthalpy Recovery Ratio >=0.65 and <0.70	0.225	0.192	0.173	0.226	0.196	0.176
Enthalpy Recovery Ratio >=0.70 and <0.75	0.250	0.214	0.193	0.252	0.218	0.196
Enthalpy Recovery Ratio >=0.75 and <0.80	0.276	0.236	0.213	0.277	0.240	0.216
Enthalpy Recovery Ratio >=0.8	0.302	0.258	0.234	0.303	0.263	0.236
Run-around liquid or refrigerant coils	0.146	0.125	0.112	0.146	0.128	0.114
Special exhaust and return system requirements (select all that apply)						
Return or exhaust systems required to be fully ducted by code or accreditation standards	0.122	0.105	0.094	0.122	0.107	0.096
Return and/or exhaust airflow control devices required by code or accreditation standards to maintain pressure relationships between *spaces*	0.122	0.105	0.094	0.122	0.107	0.096
Laboratory and vivarium exhaust *systems* in high-rise buildings for vertical duct exceeding 75 feet. Value shown is allowed W/cfm per 0.25 inch wg for each 100 feet exceeding 75 feet. [Calculation requiredc]	0.061	0.053	0.047	0.061	0.054	0.048
Exhaust system serving fume hoods	0.085	0.074	0.066	0.085	0.075	0.067
Biosafety cabinet. Value shown is allowed W/cfm per 1.0 inch wg air pressure drop [Calculation required[c]]	0.241	0.206	0.186	0.242	0.210	0.188
Exhaust filters, scrubbers, or other exhaust treatment required by code or standard. Value shown is allowed W/cfm per 1.0 inch wg air pressure drop. [Calculation requiredc]	0.241	0.206	0.186	0.242	0.210	0.188
Other						
Sound attenuation section (fans serving spaces with design background noise goals below NC35)	0.036	0.032	0.029	0.036	0.032	0.029

a. See Section C408.3.1.1 for requirements for a Multi-Zone VAV System.

b. Particle filter pressure loss can only be counted once per *fan system*.

c. Power allowances require further calculation. Multiply the actual pressure drop of the device or component by the fan power allowance in Table C403.8.1(2).

TABLE C403.8.1(3) FAN POWER LIMIT ALTITUDE CORRECTION FACTOR

Altitude (ft)	Correction factor
<3,000	1.000
>=3,000 and <4,000	0.896
>=4,000 and <5,000	0.864
>=5,000 and <6,000	0.832
>=6,000	0.801

C503.3.2 Fan power limit. If a new *fan system* is installed and the existing duct system is not replaced, a fan power allowance as shown in Table C503.3 shall be added to that allowed in Section C403.8

TABLE C503.3 ADDITIONAL FAN POWER ALLOWANCES (W/CFM)

Multi-zone VAV Fan System Airflow[a] (cfm)			All Other Fan Systems Airflow (cfm)			
Air *System* Component	<5,000	5,000 to <10,000	>=10,000	<5,000	5,000 to <10,000	>=10,000
W/cfm						
Supply fan *system*	0.358	0.386	0.372	0.460	0.468	0.434
Exhaust, return, relief, transfer fan *system*	0.253	0.256	0.232	0.289	0.291	0.262
unit with adapter curb						
Exhaust, return, relief, transfer fan *system*	0.070	0.061	0.054	0.070	0.062	0.055
Additional allowance						
Exhaust, return, relief, transfer fan *system*	0.016	0.017	0.220	0.000	0.000	0.000

a. See definition of fan system, multi-zone variable air volume (VAV).

Reason: The fan power limits were one of the most successful energy savings addenda in the IECC. However, they have not been updated in a decade. This proposal provides some increase in stringency, but more importantly, it addresses flaws in the original to improve both enforceability and clarity.
The improvements include:

- The requirements are based on actual energy input rather than brake horsepower.
- Designs now get credit for using direct-drive transmissions vs. belt-drive.
- The scope has been expanded to include fan systems down to 1 kW of input power from the previous lower threshold of 5 brake horsepower.
- Fan systems to which the requirements apply have been clearly defined.
- Fan system components that were not included previously have been added (e.g., hot gas reheat coils)
- Equipment that does not include mechanical heating or cooling have been brought into scope.

A similar proposal was approved by the California Energy Commission for Title 24-2022. The measure was reviewed with stakeholders in several meetings and went through three stages of public review. The Codes and Standards Enhancement Report that includes an in=depth discussion of the proposal and energy savings analysis is available at this link: https://title24stakeholders.com/wp-content/uploads/2020/09/2022_T24-Final-CASE-Report_Air-Distribution.pdf.

This proposal is also soon to be voted on by SSPC 90.1. The draft of that addendum has been reviewed in two rounds of stakeholder meetings.

Cost Impact: The code change proposal will increase the cost of construction.
Cost-effectiveness for Proposal 510 – Fan Power Limits

The proposed values reduce the allowed fan system electrical input power by about 10% on average, the amount varies by system. A large multi-zone VAV system will see a reduction of about 13% if it includes MERV-13 filters. On the other hand with the new credit for single-zone VAV systems that are configured to turn down to 50% of airflow, there is no increase in stringency at all.

There are many ways to improve a system to achieve the goal. Though the improvements here are based on the cost difference between a belt-drive centrifugal fan and a direct-drive plenum fan, there are many options to reduce pressure drop in the fan system that will yield the same results for less money. In fact, the California Title 24 cost-effectiveness was based entirely on improving the design of the duct system while leaving the current minimum-efficiency air handler systems unchanged. Some of the options for improving fan system performance include:

- Reducing duct pressure drop through the selection of high-performance fittings.
- Using angle filters in place of flat filters.
- Locating equipment so that duct runs, and in particular vertical shafts, are straight.
- Careful consideration of design and the placement of the first turn in the duct system after leaving the air handler (this is often the highest pressure drop in the system).

However, for the purpose of this exercise, the cost of a belt-driven centrifugal fan with a variable-frequency drive was compared to a direct-drive plenum fan. The reduction in transmission losses alone make up for most of the required improvement in electrical input power. The two systems were run in the prototype buildings used by ASHRAE 90.1 in all climate zones. The majority of fans in the prototype buildings that are large enough to meet the threshold of 1 kW of input power in the proposal are variable-speed fans. Manufacture cost data was used to compare the cost per design cfm of the two different fans at two different sizes:

- 3,000 cfm - $0.346 per cfm
    - 10,000 cfm - $0.192 per cfm

The following tables show the annual energy cost savings for various buildings. The savings vary by climate, with warmer and wetter climates generally showing higher savings. The annual savings were multiplied by 12, which is the ASHRAE scalar limit for equipment with a 15-year lifespan. In nearly all cases, the cost per cfm of an improved fan is less than the scalar limit.

Primary school – these typically have fans that are about 3,000 cfm or a little more. In all cases, the savings are greater than the $0.346 additional cost:

	Elec Energy Savings (kWh)	Gas Energy Savings (Therm)	Elec Energy Cost Savings ($)	Gas Energy Cost Savings ($)	Total Energy Cost Savings ($)	Annual Savings X12	Modeled Airflow	$/cfm
Albuquerque	13085	-84	1438	-67	1371	$16,450	25169.5	$0.65
Atlanta	12935	-7	1422	-5	1416	$16,994	25169.5	$0.68
Buffalo	11531	-51	1267	-41	1226	$14,717	25169.5	$0.58
Denver	12004	-118	1319	-95	1224	$14,694	25169.5	$0.58
Dubai	18103	0	1990	0	1990	$23,875	25169.5	$0.95
ElPaso	13822	-50	1519	-40	1479	$17,744	25169.5	$0.70
Fairbanks	14078	-157	1547	-126	1422	$17,059	25169.5	$0.68
GreatFalls	11509	-40	1265	-32	1232	$14,790	25169.5	$0.59
HoChiMinh	14873	0	1635	0	1635	$19,615	25169.5	$0.78
InternationalFalls	12749	-95	1401	-76	1325	$15,904	25169.5	$0.63
Miami	15460	0	1699	0	1699	$20,384	25169.5	$0.81
NewDelhi	16277	1	1789	1	1790	$21,476	25169.5	$0.85
NewYork	11932	-12	1311	-10	1302	$15,622	25169.5	$0.62
PortAngeles	10436	-1	1147	-1	1146	$13,756	25169.5	$0.55
Rochester	12563	-72	1381	-58	1323	$15,872	25169.5	$0.63
SanDiego	11373	-10	1250	-8	1242	$14,903	25169.5	$0.59
Seattle	11632	-139	1278	-111	1167	$14,004	25169.5	$0.56
Tampa	16769	-1	1843	-1	1842	$22,108	25169.5	$0.88
Tucson	12771	0	1404	0	1404	$16,847	25169.5	$0.67

Large Hotel – These typically use large VAV fans. Again, in all cases, the additional cost of $0.192 per cfm is much less than the projected savings:

	Elec Energy Savings (kWh)	Gas Energy Savings (Therm)	Elec Energy Cost Savings ($)	Gas Energy Cost Savings ($)	Total Energy Cost Savings ($)	Annual Savings X12	Modeled Airflow	$/cfm
Albuquerque	24756	-20	2721	-16	2704	$32,451	40110.4	$0.81
Atlanta	20992	-24	2307	-19	2288	$27,453	40110.4	$0.68
Buffalo	19504	-60	2144	-49	2095	$25,140	40110.4	$0.63
Denver	24984	-45	2746	-36	2710	$32,520	40110.4	$0.81
Dubai	24856	-3	2732	-2	2729	$32,752	40110.4	$0.82
ElPaso	23902	-12	2627	-10	2617	$31,407	40110.4	$0.78
Fairbanks	16880	-72	1855	-58	1797	$21,565	40110.4	$0.54
GreatFalls	21103	-55	2319	-44	2275	$27,300	40110.4	$0.68
HoChiMinh	26707	-10	2935	-8	2927	$35,128	40110.4	$0.88
Honolulu	22710	-3	2496	-3	2493	$29,918	40110.4	$0.75
InternationalFalls	18937	-73	2081	-59	2022	$24,267	40110.4	$0.61
NewDelhi	24433	-8	2685	-7	2679	$32,143	40110.4	$0.80
NewYork	20083	-38	2207	-31	2177	$26,118	40110.4	$0.65
PortAngeles	19082	-24	2097	-19	2078	$24,937	40110.4	$0.62
Rochester	19824	-84	2179	-67	2112	$25,338	40110.4	$0.63
SanDiego	19085	-16	2097	-13	2084	$25,013	40110.4	$0.62
Seattle	19438	-27	2136	-22	2115	$25,375	40110.4	$0.63
Tampa	23725	-9	2607	-7	2600	$31,201	40110.4	$0.78
Tucson	23380	-11	2569	-9	2560	$30,726	40110.4	$0.77

Standalone Retail – These prototypes use a mix of small and large fans. However, the 12-year savings are much higher than the per cfm cost of both sizes.

	Elec Energy Savings (kWh)	Gas Energy Savings (Therm)	Elec Energy Cost Savings ($)	Gas Energy Cost Savings ($)	Total Energy Cost Savings ($)	Annual Savings X12	Modeled Airflow	$/cfm
Albuquerque	7589	-85	834	-68	766	$9,195	23371.2	$0.39
Atlanta	4501	-43	495	-35	460	$5,521	23371.2	$0.24
Buffalo	6972	-152	766	-122	645	$7,736	23371.2	$0.33
Denver	7759	-136	853	-109	744	$8,927	23371.2	$0.38
Dubai	10695	0	1175	0	1175	$14,103	23371.2	$0.60
ElPaso	10139	-66	1114	-53	1061	$12,736	23371.2	$0.54
Fairbanks	7159	-186	787	-149	638	$7,653	23371.2	$0.33
GreatFalls	7475	-171	822	-137	684	$8,210	23371.2	$0.35
HoChiMinh	10356	0	1138	0	1138	$13,657	23371.2	$0.58
InternationalFalls	6591	-140	724	-113	612	$7,341	23371.2	$0.31
Miami	9071	-1	997	-1	996	$11,956	23371.2	$0.51
NewDelhi	9863	-15	1084	-12	1072	$12,863	23371.2	$0.55
NewYork	6897	-121	758	-97	661	$7,927	23371.2	$0.34
PortAngeles	6750	-133	742	-106	635	$7,625	23371.2	$0.33
Rochester	7617	-179	837	-144	693	$8,320	23371.2	$0.36
SanDiego	6986	-11	768	-9	759	$9,109	23371.2	$0.39
Seattle	6975	-114	767	-92	675	$8,100	23371.2	$0.35
Tampa	7270	-12	799	-10	789	$9,472	23371.2	$0.41
Tucson	7817	-10	859	-8	851	$10,216	23371.2	$0.44

Large Office – These prototypes use large VAV fans. In this case, the additional cost of $0.192 per cfm meets the scalar for most climate zones. It does not meet the scalar for Climate Zone 8.

	Elec Energy Sa	Gas Energy Sa	Total Energy U	nergy Savings (	ergy Savings (	hergy Cost Savi	ergy Cost Savi	nergy Cost Savi	Annual Savings X12	Modeled Airflow	$/cfm
Albuquerque	222.89	-9.75	213.14	61963	-92	6810	-74	6736	$80,828	255854.8	$0.32
Atlanta	172.59	-0.7	171.89	47980	-7	5273	-5	5268	$63,212	255854.8	$0.25
Buffalo	152.66	-1.6	151.06	42439	-15	4664	-12	4652	$55,823	255854.8	$0.22
Denver	200.94	-15.33	185.61	55861	-145	6139	-117	6023	$72,271	255854.8	$0.28
Dubai	224.07	-0.08	223.99	62291	-1	6846	-1	6845	$82,143	255854.8	$0.32
ElPaso	231.17	-3.94	227.23	64265	-37	7063	-30	7033	$84,394	255854.8	$0.33
Fairbanks	52.95	-4.04	48.91	14720	-38	1618	-31	1587	$19,044	255854.8	$0.07
GreatFalls	148.99	-7.86	141.13	41419	-75	4552	-60	4492	$53,906	255854.8	$0.21
HoChiMinh	352.43	-0.45	351.98	97976	-4	10768	-3	10764	$129,169	255854.8	$0.50
InternationalFalls	189.47	-1.72	187.75	52673	-16	5789	-13	5776	$69,308	255854.8	$0.27
Miami	334.69	-0.31	334.38	93044	-3	10226	-2	10223	$122,678	255854.8	$0.48
NewDelhi	215.16	-1.05	214.11	59814	-10	6574	-8	6566	$78,788	255854.8	$0.31
NewYork	226.87	-0.49	226.38	63070	-5	6931	-4	6928	$83,132	255854.8	$0.32
PortAngeles	191.2	-16.32	174.88	53154	-155	5842	-124	5717	$68,610	255854.8	$0.27
Rochester	102.91	-0.29	102.62	28609	-3	3144	-2	3142	$37,703	255854.8	$0.15
SanDiego	158.62	-1.12	157.5	44096	-11	4846	-9	4838	$58,052	255854.8	$0.23
Seattle	240.28	-13.24	227.04	66798	-126	7341	-101	7240	$86,885	255854.8	$0.34
Tampa	222.8	-0.17	222.63	61938	-2	6807	-1	6806	$81,669	255854.8	$0.32
Tucson	219.17	-1.47	217.7	60929	-14	6696	-11	6685	$80,219	255854.8	$0.31

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: The fan power limits were one of the most successful energy savings addenda in the IECC. However, they have not been updated in a decade. This proposal provides some increase in stringency, but more importantly, it addresses flaws in the original to improve both enforceability and clarity

Proposal # 510

CEPI-120-21

Proponents: Mike Moore, Stator LLC, representing Broan-NuTone (mmoore@statorllc.com)

2021 International Energy Conservation Code

Revise as follows:

C403.8.4 Fractional hp fan motors. Motors for fans that are not less than $^{1}/_{12}$ hp (0.062 kW) and <u>are </u>less than 1 hp (0.746 kW) shall be electronically commutated motors or shall have a minimum motor efficiency of 70 percent, rated in accordance with DOE 10 CFR 431. These motors shall have the means to adjust motor speed for either balancing or remote control. The use of belt-driven fans to sheave adjustments for airflow balancing instead of a varying motor speed shall be permitted.

Exceptions: The following motors are not required to comply with this section

1. Motors in the airstream within fan coils and terminal units that only provide heating to the space served.
2. Motors in space-conditioning equipment that comply with Section C403.3.2 or Sections C403.8.1. through C403.8.3.
3. Motors that comply with Section C405.8.

Add new text as follows:

<u>**R403.7.8** **Dwelling unit ventilation system.** A fan that is the air mover for a heating or colling system that serves an individual *dwelling unit* shall not be used to provide outdoor air.</u>

<u>Exception: Where the fan efficacy is not less than 1.2 cfm of outdoor airflow per watt when there is no demand for heating or cooling.</u>

Reason: This proposal crosswalks the 2021 IECC-R Table R403.6.2 dwelling unit outdoor air fan efficacy requirements to the IECC-C (specifically as related to air handlers; other efficacy requirements are coordinated through other proposals). When space conditioning air handlers are used as the primary supply fan to provide outdoor air to dwelling units, the energy penalty can be significant. Such systems are commonly referred to as "central fan integrated" or CFI systems. The typical energy penalty associated with using a CFI system instead of a dedicated outdoor air supply fan is about 1148 kWh annually per dwelling unit[1] – an enormous penalty that is comparable to adding ~3 refrigerators[2] to a dwelling unit. This proposal would ensure that, where specified, a CFI system's outdoor air fan efficacy requirements would align with the 2021 IECC-R requirements and would comply with at least the minimum fan efficacy requirement of the alternatives provided in Table C403.8.5.

1. Annual central air handler energy use for a typical apartment was estimated at 1270 kWh, based on the following assumptions: 1000 sqft, 2-bedrooms, 53 cfm OA flow requirement, OA duct provides 1.5 x 53 cfm on an intermittent basis (i.e., 79 cfm; 67% annual duty cycle for ventilation), 25% annual duty cycle for central air handler run time to provide heating/cooling (source: Rudd, A., I. Walker 2007. “Whole House Ventilation System Options – Phase 1 Simulation Study.” ARTI Report No. 30090-01, Final Report, March. Air-Conditioning and Refrigeration Technology Institute, Arlington, VA), probability of coincidental operation of central air handler for heating/cooling and variable ventilation system for outdoor air: 67%*25%=17% (this is the % of “free” central air handler energy for distributing ventilation air), 0.58 W/cfm air handler fan efficacy (source: CEC Title 24 Section 150.1(c)10 prescriptive requirement for air handler efficacy that is not connected to a forced air furnace), 1.5-ton central cooling unit with airflow rate of 400 cfm/ton, air handler operates at design airflow rate when providing ventilation air (provides an upper bound for coincidental energy use). Result: 762 kWh/yr consumed by central air handler for heating and cooling, 2032 kWh/yr consumed by central air handler for heating, cooling, and distributing ventilation air, 1270 kWh/yr fan energy use for ventilation. If a dedicated outdoor air supply fan with an efficacy of 3.8 cfm/W were used instead, the dwelling unit would use 387 kWh instead (53 cfm / 3.8 cfm/W, continuous operation), a savings of 1148 kWh annually.

2 U.S. DOE’s Federal Energy Management Program estimates typical, new refrigerators to use 403 kWh annually: https://www.energy.gov/eere/femp/purchasing-energy-efficient-residential-refrigerators.

Motorized Damper for use with Air Handler

Manufacturer	Model	Price	Source
Honeywell	Y8150A1017	$202.39	Zoro.com
AirCycler	AC-G1D-06	$230.60	AirCycler website
Broan	FIN-6MD	$180.25	camperid.com
Aldes	FAK-II-MD-6	$187.50	HVACQuick.com
		$200.19	

Discrete Supply Fan

Manufacturer	Model	Price	Source
Broan	FIN-180B	$225.69	SupplyHouse.com
Broan	FIN-180P	$295.00	SupplyHouse.com
AirKing	QuFAM	$397.00	ACWholesalers.com
AprilAire	8142	$321.22	SupplyHouse.com
AprilAire	8145	$309.43	SupplyHouse.com
Panasonic	FV-15NLFS1	$537.50	SupplyHouse.com
Soler & Palau	RF8-120EC	$447.20	HVACQuick.com
		$361.86	

Cost Impact: The code change proposal will increase the cost of construction.
As noted in the reason statement for the proposal that introduced this requirement in the IECC-R (RE134-19), "For buildings that are already using an independent fan strategy (exhaust, supply, or balanced) or an integrated fan strategy that utilizes a small enough horsepower motor, this proposal will not increase or decrease the cost of construction. For buildings that are currently using (a motorized damper coupled with) a standard AHU/furnace fan motor (i.e., CFI system) as their mechanical ventilation fan, the cost of construction may increase as they will need to adjust their mechanical ventilation design strategy in order to comply." If designers elect to specify a dedicated in-line supply fan, the incremental first cost to the consumer is estimated to average ~$160 (with options as low as ~$45). See the included table for pricing information collected in September 2021. This incremental first cost can be recouped quickly based on energy savings of ~1148 kWh/year by using a dedicated in-line supply fan instead of a CFI system to deliver outdoor air.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: per the proponent’s reason statement submitted.

Proposal # 317

CEPI-121-21

Proponents: Mike Moore, Stator LLC, representing Broan-NuTone (mmoore@statorllc.com)

2021 International Energy Conservation Code

Revise as follows:

TABLE C403.8.5 LOW-CAPACITY VENTILATION FAN EFFICACY[a]

~~FAN LOCATION~~ SYSTEM TYPE	AIRFLOW RATE ~~MINIMUM~~ (CFM)	MINIMUM EFFICACY (CFM/WATT)	TEST PROCEDURE	~~AIRFLOW RATE MAXIMUM (CFM)~~
Balanced ventilation system without heat or energy recovery	Any	1.2[a]	ASHRAE Standard 51 (ANSI/AMCA Standard 210)	
HRV~~, or~~ ERV	Any	1.2~~ cfm/watt~~	CAN/CSA 439-18	~~Any~~
Range hood	Any	2.8	ASHRAE 51	
In-line supply or exhaust fan	Any	3.8~~ cfm/watt~~	ASHRAE 51	~~Any~~
~~Bathroom, utility room~~ Other exhaust fan	~~10~~ < 90	2.8~~ cfm/watt~~	ASHRAE 51	~~< 90~~
~~Bathroom, utility room~~ Other exhaust fan	>=90 and < 200	3.5~~ cfm/watt~~	ASHRAE 51	~~Any~~
~~Bathroom, utility room~~ Other exhaust fan	>= 200	4.0	ASHRAE 51	

For SI: 1 cfm/ft = ~~47.82 W~~ 0.47 L/s.

a. For balanced systems, HRVs, and ERVs determine the efficacy as the outdoor airflow divided by the total fan power.

~~Airflow shall be tested in accordance with HVI 916 and listed. Efficacy shall be listed or shall be derived from listed power and airflow. Fan efficacy for fully ducted HRV, ERV, balanced and in-line fans shall be determined at a static pressure not less than 0.2 inch w.c. Fan efficacy for ducted range hoods, bathroom and utility room fans shall be determined at a static pressure not less than 0.1 inch w.c.~~

C403.8.5 Low-capacity ventilation fans. Mechanical ventilation system fans with motors less than $^1/_{12}$ hp (0.062 kW) in capacity shall meet the efficacy requirements of Table C403.8.5 at one or more rating points. Airflow shall be tested in accordance with the test procedure referenced by Table C403.8.5 and listed. The airflow shall be reported in the product listing or on the label. Fan efficacy shall be reported in the product listing or shall be derived from the input power and airflow values reported in the product listing or on the label. Fan efficacy for fully ducted HRV, ERV, balanced, and in-line fans shall be determined at a static pressure not less than 0.2 inch w.c. (49.85 Pa). Fan efficacy for ducted range hoods, bathroom, and utility room fans shall be determined at a static pressure not less than 0.1 inch w.c. (24.91 Pa).

Exceptions:

1. Where ventilation fans are a component of a listed heating or cooling appliance.
2. Dryer exhaust duct power ventilators, domestic range hoods and domestic range booster fans that operate intermittently.
3. Fans in radon mitigation systems.
4. Fans not covered within the scope of the test methods referenced in Table C403.8.5.
5. Ceiling fans regulated under 10 CFR 430 Appendix U.

Add new standard(s) as follows:

CSA

CSA Group
8501 East Pleasant Valley Road
Cleveland, OH 44131-5516

CAN/CSA-C439-18 — Laboratory methods of test for rating the performance of heat/energy-recovery ventilators

ASHRAE

ASHRAE
180 Technology Parkway NW
Peachtree Corners, GA 30092

ASHRAE Standard 51-16 / ANSI/*AMCA* Standard 210-16. — Laboratory Methods Of Testing Fans For Certified Aerodynamic Performance Rating

Reason: This proposal improves alignment between the IECC-C fan efficacy table with ENERGY STAR specifications and ASHRAE 90.1 and IECC-R fan efficacy tables, providing better organization and clarity, establishing the minimum fan efficacy for balanced systems, establishing minimum fan efficacy for exhaust fans exceeding 200 cfm, and moving footnote information into the main body. Note that the change of the table header from "fan location" to "system type" and the additions of "balanced" and "range hood" system types were approved by ICC through approval of RE133-19, RE137-19, and RE178-19 and should show up in the 2021 version, pending ICC approval of submitted errata. The efficacy value introduced for range hoods is in the 2018 IECC-R table, is aligned with the ENERGY STAR Ventilating Spans v4.1 and is only applicable for range hoods operated continuously (as noted in the exceptions to the table's charging language. The new efficacy value introduced for exhaust fans exceeding 200 cfm is aligned with ENERGY STAR Ventilating Fans v4.1 and was found to be cost effective through the ASHRAE 90.1 process. All efficacy values track with ENERGY STAR values for the product type. The three exceptions were added to ensure that the section does not preempt federal regulations, does not apply to radon fans (which may operate at higher static pressures -- and lower efficacies -- than typical ventilation fans), and does not apply to fans that are not regulated by the test standards referenced (e.g., fans integrated with an appliance are exempt). Finally, the test methods referenced are those referenced by ASHRAE 90.1 and are those used by industry for testing and listing.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The only element of this proposal that may affect first costs is the introduction of a fan efficacy requirement for exhaust fans exceeding 200 cfm and a motor less than 1/12 horsepower. This requirement is aligned with ENERGY STAR Ventilating Fans v4.1 and has already been vetted by ASHRAE 90.1, which has cost effectiveness requirements. Additionally, a small sample of internet retail pricing for units that would be affected by this requirement showed that price was not heavily correlated with efficacy:

Compliant:

Model A: 300 cfm, 7.3 cfm/watt, $185

Model B: 200 cfm, 11.4 cfm/watt, $179

Not Compliant:

Model C 200 cfm, 3.5 cfm/watt, $159

Model D: 200 cfm, 3.6 cfm/watt, $212

Pricing gathered October 2021 from airxheat, ecomfort, homedepot, and amazon.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Clarifies the code and moves the footnote to show it applies to all the issues

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CEPI-123-21

Proponents: Glory O'Brien, representing Western Mechanical Solutions (glory.obrien@westernmechanicalsolutions.com)

2021 International Energy Conservation Code

Add new text as follows:

C403.8.6.2 Intermittent exhaust control for bathrooms and toilet rooms. Where an exhaust system serving a bathroom or toilet room is designed for intermittent operation, the exhaust system shall be provided with manual-on capability and one or more of the following controls:

1. A timer control that has a minimum setpoint not greater than 30 minutes.
2. An *occupant sensor control* that automatically turns off exhaust fans within 30 minutes after all occupants have left the space.
3. A humidity control capable of manual or automatic adjustment from a minimum setpoint not greater than 50% to a maximum setpoint not greater than 80% relative humidity.
4. A contaminant control that responds to a particle or gaseous concentration.

Exception: Bathroom and toilet room exhaust systems serving as an integral component of an outdoor air ventilation system in Group R-2, R-3, and R-4 occupancies shall not be required to provide controls other than manual on capability.

An off setpoint shall not be used to comply with a minimum setpoint requirement.

Reason: To reduce energy consumption and unnecessary infiltration in buildings.
Substantiation: Bin analysis was run on a 50 cfm bath exhaust fan in Denver. It was assumed the fan would run 2 hours a day with a manual switch vs. 5 minutes with a timer. Only heating energy and fan energy was reviewed, savings was $ 27 per year based on 10¢/KWH.

Assuming $ 100 installed cost, the payback is 4 years . Added benefit is that occupants no longer need to remember to go back and shutoff the bathroom exhaust fan.

Cost Impact: The code change proposal will increase the cost of construction.
A small increase in cost can significantly reduce the time a bathroom fan is on.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: this proposal will reduce energy consumption and unnecessary infiltration in buildings.

Proposal # 161

CEPI-124-21

Proponents: Amanda Hickman, representing Air Movement and Control Association (AMCA) (amanda@thehickmangroup.com); Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Revise as follows:

LARGE-DIAMETER CEILING FAN. A ceiling fan that is greater than or equal to 84.5 inches (2.15 meters)~~7 feet (2134 mm)~~ in diameter. These fans are sometimes referred to as High-Volume, Low-Speed (HVLS) fans.

C403.9 Large-diameter ceiling fans. Where provided, *large-diameter ceiling fans* shall be tested and labeled in accordance with AMCA 230 and shall meet the efficiency requirements of Table C403.9 and Section C403.9.1.

Add new text as follows:

TABLE C403.9
CEILING FAN EFFICIENCY REQUIREMENTS[a]

EQUIPMENT TYPE	MINIMUM EFFICIENCY[b,c]	TEST PROCEDURE
Large-diameter ceiling fan for applications outside the U.S.[c]	CFEI ≥ 1.00 at high (maximum) speed CFEI ≥ 1.31 at 40% of high speed or the nearest speed that is not less than 40% of high speed	10 CFR 430 Appendix U or AMCA Standard 230 and AMCA Standard 208 (for FEI calculations)
Large-diameter ceiling fan	CFEI ≥ 1.00 at high (maximum) speed; and CFEI ≥ 1.31 at 40% of high speed or the nearest speed that is not less than 40% of high speed	10 CFR 430 Appendix U

a. The minimum efficiency requirements at both high speed and 40% of maximum speed shall be met or exceeded to comply with this code.

b. Ceiling fans are regulated as consumer products by 10 CFR 430.

c. Chapter 6 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

C403.9.1 Ceiling Fan Energy Index (CFEI). The Ceiling Fan Energy Index shall be calculated as the ratio of the electric input power of a reference large-diameter ceiling fan to the electric input power of the actual large-diameter ceiling fan as calculated in accordance with AMCA 208 with the following modifications to the calculations for the reference fan: using an airflow constant (Q) of 26,500 cfm (12.507 m^3/s), a pressure constant (P) of 0.0027 in. of water (0.6719 Pa), and fan efficiency constant (η) of 42%.

Revise as follows:

AMCA

Air Movement and Control Association International
30 West University Drive
Arlington Heights, IL 60004-1806

230—15 with errata | Laboratory Methods of Testing Air Circulating Fans for Rating and Certification

Add new standard(s) as follows:

DOE

US Department of Energy
c/o Superintendent of Documents 1000 Independence Avenue SW
Washington, DC 20585

10 CFR, Part 430, App U | Uniform Test Method for Measuring the Energy Consumption of Ceiling Fans

Reason:
Large-diameter ceiling fans (LDCF) are used in many buildings covered by the International Energy Conservation Code. In recent years, the usage of this class of products has increased significantly. However, the 2021 IECC has no minimum energy efficiency requirements for this type of fan.

On January 19, 2017, the U.S. Department of Energy (DOE) completed a rulemaking and published a final rule establishing new federal minimum energy efficiency standards for ceiling fans. In doing so, it established the LDCF product class, which are ceiling fans with a blade span greater than 2.13 m (84 in.) and a corresponding efficiency metric of cubic feet per minute per Watt, or CFM/W.

The DOE test procedure's requirement is to round the measured blade span to the nearest inch, which does not appear in AMCA 230-15 or AMCA 208-18. Therefore, to provide equivalent requirements, the LDCF product class is all ceiling fans with blade spans greater than or equal to 84.5 in. (2.15m) when determined in accordance with the AMCA standards and 2.13 m (84 in.) when determined in accordance with 10 CFR 430.

On December 27, 2020, the U.S. House of Representatives Bill HR-133, aka the "Consolidated Appropriations Act, 2021," became Public Law No: 116-260. HR-133, Section 1008, entitled "Ceiling Fan Improvement Act," replaced the CFM/W efficiency metric with Ceiling Fan Energy Index (CFEI).

Specifically, Section 1008 of the Energy Act of 2020 (the "Act") amended section 325(ff)(6) of EPCA to specify that LDCF manufactured on or after January 21, 2020, are not required to meet minimum ceiling fan efficiency requirements in terms of the total airflow to the total power consumption, CFM/W, as established in the January 2017 Final Rule. Instead, LDCF are required to meet minimum efficiency requirements based on the CFEI metric. (42 U.S.C. 6295(ff)(6)(C)(i)(I), as codified). Small-diameter ceiling fans use a different test procedure, have a different efficiency metric, and were not impacted by the Energy Act of 2020.

The Act requires large-diameter ceiling fans to have a CFEI greater than or equal to 1.00 at high speed and greater than or equal to 1.31 at 40 percent speed or the nearest speed that is not less than 40 percent speed. (42 U.S.C. 6295(ff)(6)(C)(i)(II), as codified). Further, the Act specifies that CFEI is to be calculated in accordance with ANSI/AMCA Standard 208–18, with the following modifications to the constants used for the reference fan: (I) Using an Airflow Constant (Q_0) of 26,500 cubic feet per minute; (II) Using a Pressure Constant (P_0) of 0.0027 inches water gauge; and (III) Using a Fan Efficiency Constant (h_0) of 42 percent. (42 U.S.C. 6295(ff)(6)(C)(ii), as codified). The EPCA language did not provide metric equivalents for the replacement coefficients, however, the metric conversions are provided in the proposed addendum.

This proposal adds the minimum energy efficiency requirements from 42 U.S.C. 6295(ff)(6)(C)(ii) for large-diameter ceiling fans to the IECC and is consistent with the federal standards. DOE's analysis from the final rule indicates that the adopted energy conservation standards for all ceiling fan product classes would save a significant amount of energy. Relative to the case without amended standards (referred to as the "no-new-standards case"), the lifetime energy savings for ceiling fans purchased in the 30-year period amounts to 2.008 quadrillion British thermal units (Btu), or quads.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.

Building on the explanation above, additional details regarding the energy savings and economic calculations can be found in DOE's Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Ceiling Fans, published November 2016 which can be found at the link below. https://www.regulations.gov/document/EERE-2012-BT-STD-0045-0149

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: matches current federal regulations

Proposal # 197

CEPI-125-21

Proponents: Kimberly Cheslak, NBI, representing NBI (kim@newbuildings.org); Josh Keeling, representing Cadeo Group (jkeeling@cadeogroup.com); Ben Rabe, representing Fresh Energy (rabe@fresh-energy.org); Bryan Bomer, representing Department of Permitting Services (bryan.bomer@montgomerycountymd.gov); Lauren Urbanek, representing Natural Resources Defense Council (lurbanek@nrdc.org); Howard Wiig, representing Hawaii State Energy Office (howard.c.wiig@hawaii.gov); Kim Burke, representing Colorado Energy Office (kim.burke@state.co.us); Matt Tidwell, representing Portland General Electric (matthew.tidwell@pgn.com); Chris Castro, representing City of Orlando (chris.castro@orlando.gov); Brad Smith, representing City of Fort Collins (brsmith@fcgov.com); Amber Wood, representing ACEEE (awood@aceee.org)

2021 International Energy Conservation Code

Add new definition as follows:

DEMAND RESPONSE SIGNAL. A signal that indicates a price or a request to modify electricity consumption for a limited time period.

DEMAND RESPONSIVE CONTROL. A control capable of receiving and automatically responding to a demand response signal.

Add new text as follows:

C404.11 Demand responsive water heating. Electric storage water heaters with a rated water storage volume of 40 gallons (150L) to 120 gallons (450L) and a nameplate input rating equal to or less than 12kW shall be provided with *demand responsive controls* in accordance with Table C404.11 or another equivalent *approved* standard.

Exceptions:

1. Water heaters that provide a hot water delivery temperature of 180°F (82°C) or greater.
2. Water heaters that comply with Section IV, Part HLW or Section X of the ASME Boiler and Pressure Vessel Code.
3. Water heaters that use 3-phase electric power.

TABLE C404.11 DEMAND RESPONSIVE CONTROLS FOR WATER HEATING

Equipment Type	Controls	
	Manufactured before 7/1/2025	Manufactured on or after 7/1/2025
Electric storage water heaters	ANSI/CTA-2045-B Level 1 and also capable of initiating water heating to meet the temperature set point in response to a *demand response signal*.	ANSI/CTA-2045-B Level 2, except "Price Stream Communication" functionality as defined in the standard.

Add new standard(s) as follows:

ANSI

American National Standards Institute
25 West 43rd Street, 4th Floor
New York, NY 10036

ANSI/CTA 2045-B Modular Communications Interface for Energy Management

ASME

American Society of Mechanical Engineers
Two Park Avenue
New York, NY 10016-5990

BPVC Boiler and Pressure Vessel Code

Reason: With increasing penetrations of intermittent renewable energy, volatile wholesale power prices, and subsequent growth in dynamic rates/demand response programs, grid-interactive end uses present an opportunity to help homes manage their bills, participate in programs, and support efficient grid operations. Water heaters can provide many services to the grid, including generation, transmission, and distribution capacity, energy arbitrage, and ancillary services. In their assessment of the National Potential for Load Flexibility, Brattle estimated that across all measures these services could provide as much as $15 billion per year in value to the electric system.
As electricity systems transform to include more variable wind and solar energy, demand flexibility becomes increasingly critical to both grid operation and further transformation. Building systems that can use energy when it is abundant, clean, and low-cost not only help decarbonize the entire energy system, they also insulate their owners from future increases in demand charges and peak hour energy rates – a current and accelerating trend. Water heaters offer an unparalleled opportunity for load shifting: tanks full of hot water are inherently energy storage devices. Including the controls necessary to take advantage of this opportunity is relatively simple and affordable in new construction. Compared to other energy storage technologies such as batteries, smart, grid-integrated water heater controls can deliver substantial dispatchable (that is, reliable to the grid operator) energy flexibility. The controls specified by ANSI/CTA-2045-B ensure negligible risk of occupant disruption (that is, the hot water will not run out). Water heaters provide a particularly attractive option as they have inherent thermal storage that allows energy consumption to be shifted with little to no impact to the end user. This capability has been demonstrated in several contexts, most recently through regional demonstrations conducted by EPRI and BPA.

In their Grid-interactive and Efficient Buildings (GEBs) Roadmap, the US Department of Energy estimates that approximately 15 GW of additional load flexibility is expected to be added to the system under reference case assumptions. Combined with energy efficiency, this is expected to provide $13 billion/year of peak demand savings to the power system and its customers. Through a comprehensive literature review and interviewing dozens of national experts, the USDOE team found that one of the biggest barriers was the lack of interoperability. A key tool to solve this problem is building codes, which can help to ensure that interoperable devices and controls are installed at the time of construction. USDOE cited explicitly the use of codes and standards as one of its recommended pathways to enable greater adoption of GEBs technologies.

It is important to include the requirement for two-way communication (specifically, communication from the behind-the-meter control module back to the utility, grid operator, or other third party entity) because this communication ensures that the controls capability can be fully deployed when needed. With legacy demand response systems, a signal is sent out but the ability to track and quantify the impacts of that signal is effectively nonexistent. This one-way communication paradigm is a key reason that the "firmness" or reliability of many flexibility-related demand side management strategies, particularly demand response, is often considered to be very low. However, a two-way communication paradigm enables much more reliable impact tracking. Buildings whose controls include two-way communication capability, that is, those with grid-interactive controls as defined here, will be better able to participate in the demand response programs of the future, and their owners will have improved financial prospects through enhanced ability to participate in potentially lucrative utility demand response programs.

ANSI/CTA-2045-B standardizes the socket, and communications protocol, for electric water heaters so they can communicate with the grid, and with demand response signal providers. In addition, 2045-B adds control and communications requirements for mixing valves in water heaters, which enable them to provide greater storage capacity to support increased load shifting while eliminating scalding risk.

Versions of this standard are included in codes or other requirements in California, Oregon, and Washington and are referenced explicitly by ENERGY STAR.

Cost Impact: The code change proposal will increase the cost of construction.
To enable grid-interactive controls, there are two sources of costs: the incremental cost to ensure that equipment is interoperable with CTA-2045-B and the cost of the control module installed in that device. The incremental manufacturing cost is in the range of a few dollars, and negligible at higher volumes. The current incremental cost to include a CTA-2045-B compliant control module ranges from about $60 (direct current, hard-wired connection) to $160 (alternating current, wireless cellular connection); this is expected to decline as manufacturing lines are brought up to larger scale (source: Advanced Water Heating Initiative). The major determinant of cost if the chosen radio pathway as chipset costs vary considerably between different frequencies/standards.

In the BPA report, manufacturers stated a range of $2-$30 for regional deployment, but noted that there would be economies of scale for a national rollout. The main cost was development of firmware/hardware to accommodate the standard, but these costs have already been incurred to meet codes/standards in OR, WA, and CA.

Bibliography: Brattle, The National Potential for Load Flexibility (2019)
https://brattlefiles.blob.core.windows.net/files/16639_national_potential_for_load_flexibility_-_final.pdf
BPA, CTA-2045 Water Heater Demonstration Report (2018) https://www.bpa.gov/EE/Technology/demand-response/Documents/Demand%20Response%20-%20FINAL%20REPORT%20110918.pdf

EPRI, CEA-2045 Field Demonstrations Project Description (2014) https://www.epri.com/research/products/000000003002004009

USDOE, A National Roadmap for Grid-Interactive Efficient Buildings (2021)
https://gebroadmap.lbl.gov/A%20National%20Roadmap%20for%20GEBs%20-%20Final.pdf

Washington State Revised Code of Washington, Title 19, Chapter 19.260, Section 19.260.080, available at https://app.leg.wa.gov/RCW/default.aspx?cite=19.260.080

Oregon Department of Energy, Energy Efficiency Standards Rulemaking https://www.oregon.gov/energy/Get-Involved/Pages/EE-Standards-Rulemaking.aspx

U.S. EPA Energy Star Program, Connected Criteria for ENERGY STAR Products,
https://www.energystar.gov/products/spec/connected_criteria_energy_star_products_pd

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Grid-interactive end uses present an opportunity to help homes manage their bills, participate in programs, and support efficient grid operations. Water heaters can provide many services to the grid, including generation, transmission, and distribution capacity, energy arbitrage, and ancillary services.

CEPI-127-21

Proponents: Mike Kennedy, Mike D. Kennedy Inc., representing Northwest Energy Efficiency Alliance; Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Delete and substitute as follows:

TABLE C404.2 MINIMUM PERFORMANCE OF WATER-HEATING EQUIPMENT

EQUIPMENT TYPE	SIZE CATEGORY (input)	SUBCATEGORY OR RATING CONDITION	PERFORMANCE REQUIRED[a, b]	TEST PROCEDURE
Water heaters, electric	≤ 12 kW[d]	Tabletop[e], ≥ 20 gallons and ≤ 120 gallons	0.93 – 0.00132V, EF	DOE 10 CFR Part 430
		Resistance ≥ 20 gallons and ≤ 55 gallons	0.960 – 0.0003V, EF	
		Grid-enabled[f] > 75 gallons and ≤ 120 gallons	1.061 – 0.00168V, EF	
	> 12 kW	Resistance	$(0.3 + 27/V_m)$, %/h	ANSI Z21.10.3
	≤ 24 amps and ≤ 250 volts	Heat pump > 55 gallons and ≤ 120 gallons	2.057 – 0.00113V, EF	DOE 10 CFR Part 430
Storage water heaters, gas	≤ 75,000 Btu/h	≥ 20 gallons and > 55 gallons	0.675 – 0.0015V, EF	DOE 10 CFR Part 430
		> 55 gallons and ≤ 100 gallons	0.8012 – 0.00078V, EF	
	> 75,000 Btu/h and ≤ 155,000 Btu/h	< 4,000 Btu/h/gal	80% E_t $(Q/800 + 110\sqrt{V})$SL, Btu/h	ANSI Z21.10.3
	> 155,000 Btu/h	< 4,000 Btu/h/gal	80% E_t $(Q/800 + 110\sqrt{V})$SL, Btu/h	
Instantaneous water heaters, gas	> 50,000 Btu/h and < 200,000 Btu/h[c]	≥ 4,000 Btu/h/gal and < 2 gal	0.82 – 0.0019V, EF	DOE 10 CFR Part 430
	≥ 200,000 Btu/h	≥ 4,000 Btu/h/gal and < 10 gal	80% E_t	ANSI Z21.10.3
	≥ 200,000 Btu/h	≥ 4,000 Btu/h/gal and ≥ 10 gal	80% E_t $(Q/800 + 110\sqrt{V})$SL, Btu/h	
Storage water heaters, oil	≤ 105,000 Btu/h	≥ 20 gal and ≤ 50 gallons	0.68 – 0.0019V, EF	DOE 10 CFR Part 430
	≥ 105,000 Btu/h	< 4,000 Btu/h/gal	80% E_t $(Q/800 + 110\sqrt{V})$SL, Btu/h	ANSI Z21.10.3
Instantaneous water heaters, oil	≤ 210,000 Btu/h	≥ 4,000 Btu/h/gal and < 2 gal	0.59 – 0.0019V, EF	DOE 10 CFR Part 430
	> 210,000 Btu/h	≥ 4,000 Btu/h/gal and < 10 gal	80% E_t	ANSI Z21.10.3
	> 210,000 Btu/h	≥ 4,000 Btu/h/gal and ≥ 10 gal	78% E_t $(Q/800 + 110\sqrt{V})$SL, Btu/h	
Hot water supply boilers, gas and oil	≥ 300,000 Btu/h and < 12,500,000 Btu/h	≥ 4,000 Btu/h/gal and < 10 gal	80% E_t	ANSI Z21.10.3
Hot water supply boilers, gas	≥ 300,000 Btu/h and < 12,500,000 Btu/h	≥ 4,000 Btu/h/gal and ≥ 10 gal	80% E_t $(Q/800 + 110\sqrt{V})$SL, Btu/h	
Hot water supply boilers, oil	> 300,000 Btu/h and < 12,500,000 Btu/h	> 4,000 Btu/h/gal and > 10 gal	78% E_t $(Q/800 + 110\sqrt{V})$SL, Btu/h	
Pool heaters, gas and oil	All	—	82% E_t	ASHRAE 146
Heat pump pool heaters	All	—	4.0 COP	AHRI 1160
Unfired storage tanks	All	—	Minimum insulation requirement R-12.5 (h × ft² × °F)/Btu	(none)

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m², °C = [(°F) – 32]/1.8, 1 British thermal unit per hour = 0.2931 W, 1 gallon = 3.785 L, 1 British thermal unit per hour per gallon = 0.078 W/L.

a. Energy factor (EF) and thermal efficiency (E_t) are minimum requirements. In the EF equation, V is the rated volume in gallons.

b. Standby loss (SL) is the maximum Btu/h based on a nominal 70°F temperature difference between stored water and ambient requirements. In the SL equation, Q is the nameplate input rate in Btu/h. In the equations for electric water heaters, V is the rated volume in gallons and V_m is the measured volume in gallons. In the SL equation for oil and gas water heaters and boilers, V is the rated volume in gallons.

c. Instantaneous water heaters with input rates below 200,000 Btu/h shall comply with these requirements where the water heater is designed to heat water to temperatures 180°F or higher.

d. Electric water heaters with an input rating of 12 kW (40,950 Btu/h) or less that are designed to heat water to temperatures of 180°F or greater shall comply with the requirements for electric water heaters that have an input rating greater than 12 kW (40,950 Btu/h).

~~e A tabletop water heater is a water heater that is enclosed in a rectangular cabinet with a flat top surface not more than 3 feet in height.~~

~~f. A grid-enabled water heater is an electric-resistance water heater that meets all of the following:~~

~~1. Has a rated storage tank volume of more than 75 gallons.~~

~~2. Was manufactured on or after April 16, 2015.~~

~~3. Is equipped at the point of manufacture with an activation lock.~~

~~4. Bears a permanent label applied by the manufacturer that complies with all of the following:~~

~~4.1. Is made of material not adversely affected by water.~~

~~4.2. Is attached by means of nonwater-soluble adhesive.~~

~~4.3. Advises purchasers and end users of the intended and appropriate use of the product with the following notice printed in 16.5 point Arial Narrow Bold font: "IMPORTANT INFORMATION: This water heater is intended only for use as part of an electric thermal storage or demand response program. It will not provide adequate hot water unless enrolled in such a program and activated by your utility company or another program operator. Confirm the availability of a program in your local area before purchasing or installing this product."~~

TABLE C404.2 MINIMUM PERFORMANCE OF WATER-HEATING EQUIPMENT

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATING CONDITION	DRAW PATTERN	PERFORMANCE REQUIRED[a]	TEST PROCEDURE[b]
Electric Table-top water heaters[c]	≤12 kW	≥ 20 gal ≤ 120 gal [d]	Very small Low Medium High	UEF ≥ 0.6323 – (0.0058 × Vr) UEF ≥ 0.9188 – (0.0031 × Vr) UEF ≥ 0.9577 – (0.0023 × Vr) UEF ≥ 0.9884 – (0.0016 × Vr)	DOE 10 CFR Part 430 App. E
Electric Storage water heaters[e,f]: resistance and heat pump	≤12 kW	≥ 20 gal ≤ 55 gal [f]	Very small Low Medium High	UEF ≥ 0.8808 – (0.0008 × Vr) UEF ≥ 0.9254 – (0.0003 × Vr) UEF ≥ 0.9307 – (0.0002 × Vr) UEF ≥ 0.9349 – (0.0001 × Vr)	DOE 10 CFR Part 430 App. E
	≤12 kW	> 55 gal ≤120 gal [f]	Very small Low Medium High	UEF ≥ 1.9236 – (0.0011 × Vr) UEF ≥ 2.0440 – (0.0011 × Vr) UEF ≥ 2.1171 – (0.0011 × Vr) UEF ≥ 2.2418 – (0.0011 × Vr)	DOE 10 CFR Part 430 App. E
Electric Storage water heaters[e,f]	> 12 kW	–	–	(0.3 + 27/Vm), %h	DOE 10 CFR 431.106 App B.
Grid-enabled water heaters [g]	–	>75 gal [d]	Very small Low Medium High	UEF ≥ 1.0136 – (0.0028 × Vr) UEF ≥ 0.9984 – (0.0014 × Vr) UEF ≥ 0.9853 – (0.0010 × Vr) UEF ≥ 0.9720 – (0.0007 × Vr)	10 CFR 430 Appendix E
Electric Iinstantaneous water heaters[h]	≤12 kW	< 2 gal [d]	Very small Low Medium High	UEF ≥ 0.91 UEF ≥ 0.91 UEF ≥ 0.91 UEF ≥ 0.92	DOE 10 CFR Part 430

heaters	>12 kW & ≤ 58.6 kW [j]	≤ 2 gal & ≤180F	All	UEF ≥ 0.80	DOE 10 CFR Part 430
Gas Storage water heaters[e]	≤ 75,000 Btu/h	≥20 gal & ≤ 55 gal [d]	Very small Low Medium High	UEF ≥ 0.3456 – (0.0020 × Vr) UEF ≥ 0.5982 – (0.0019 × Vr) UEF ≥ 0.6483 – (0.0017 × Vr) UEF ≥ 0.6920 – (0.0013 × Vr)	DOE 10 CFR Part 430 App. E
	≤ 75,000 Btu/h	> 55 gal & ≤ 100 gal [d]	Very small Low Medium High	UEF ≥ 0.6470 – (0.0006 × Vr) UEF ≥ 0.7689 – (0.0005 × Vr) UEF ≥ 0.7897 – (0.0004 × Vr) UEF ≥ 0.8072 – (0.0003 × Vr)	DOE 10 CFR Part 430 App. E
	> 75,000 Btu/h and ≤ 105,000 Btu/h [j,k]	≤ 120 gal ≤ 180 F	Very small Low Medium High	UEF ≥ 0.2674-0.0009 x Vr UEF ≥ 0.5362-0.0012 x Vr UEF ≥ 0.6002-0.0011 x Vr UEF ≥ 0.6597-0.0009 x Vr	DOE 10 CFR Part 430 App. E
	> 105,000 Btu/h [k]	-	-	80% E_t SL ≤ (Q/800 +110√V), Btu/h	DOE 10 CFR 431.106
Gas Instantaneous water heaters[i]	> 50,000 Btu/h and < 200,000 Btu/h[k]	< 2 gal[d]	Very small Low Medium High	UEF ≥ 0.80 UEF ≥ 0.81 UEF ≥ 0.81 UEF ≥ 0.81	DOE 10 CFR Part 430 App. E
	≥ 200,000 Btu/h [k]	< 10 gal	-	80% *Et*	DOE 10 CFR 431.106
	≥ 200,000 Btu/h [k]	≥10 gal	-	80% E_t SL ≤ (Q/800 +110√V), Btu/h	
Oil Storage water heaters[e]	≤ 105,000 Btu/h	≤ 50 gal[d]	Very small Low Medium High	UEF = 0.2509 – (0.0012 × Vr) UEF = 0.5330 – (0.0016 × Vr) UEF = 0.6078 – (0.0016 × Vr) UEF = 0.6815 – (0.0014 × Vr)	DOE 10 CFR Part 430
	> 105,000 Btu/h and ≤ 140,000 Btu/h [l]	≤ 120 gal ≤ 180 F	Very small Low Medium High	UEF ≥ 0.2932-0.0015 x Vr UEF ≥ 0.5596-0.0018 x Vr UEF ≥ 0.6194-0.0016 x Vr UEF ≥ 0.6740-0.0013 x Vr	DOE 10 CFR Part 430 App. E
	>140,000 Btu/h	All	-	80% *Et* SL ≤ (Q/800 +110√V), Btu/h	DOE 10 CFR 431.106
Oil Instantaneous water heaters[h]	≤ 210,000 Btu/h	< 2 gal	-	80% Et EF ≥ 0.59 - 0.0005 x V	DOE 10 CFR Part 430 App. E
	> 210,000 Btu/h	< 10 gal	-	80% *Et*	DOE 10 CFR 431.106
	> 210,000 Btu/h	≥ 10 gal	-	78% E_t SL ≤ (Q/800 +110√V), Btu/h	DOE 10 CFR 431.106
Hot water supply boilers, gas and oil[h]	≥300,000 Btu/h and < 12,500,000 Btu/h	< 10 gal	-	80% *Et*	DOE 10 CFR 431.106
Hot water supply boilers, gas[i]	≥300,000 Btu/h and < 12,500,000 Btu/h	≥ 10 gal	-	80% E_t SL ≤ (Q/800 +110√V), Btu/h	DOE 10 CFR 431.106
Hot water supply boilers, oil[h]	≥300,000 Btu/h and < 12,500,000 Btu/h	≥ 10 gal	-	78% E_t SL ≤ (Q/800 +110√V), Btu/h	DOE 10 CFR 431.106
Pool heaters, gas[d]	All	—[f]	-	82% *Et*	DOE 10 CFR Part 430 App. P
Heat pump pool heaters	All	50°F db 44.2°F wb outdoor air 80.0°F entering water	-	4.0 COP	DOE 10 CFR Part 430 App. P
Unfired storage tanks	All	—	-	Minimum insulation requirement R-12.5 (h-ft[2]-°F)/Btu	(none)

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m^2, °C = [(°F) – 32]/1.8, 1 British thermal unit per hour = 0.2931 W, 1 gallon = 3.785 L, 1 British thermal unit per hour per gallon = 0.078 W/L.

a. Thermal efficiency (E_t) is a minimum requirement, while standby loss is a maximum requirement. In the standby loss equation, V is the rated volume in gallons and Q is the nameplate input rate in Btu/h. V_m is the measured volume in the tank in gallons. Standby loss for electric water heaters is in terms of %/h and denoted by the term "S," and standby loss for gas and oil water heaters is in terms of Btu/h and denoted by the term "SL" Draw pattern (DP) refers to the water draw profile in the Uniform Energy Factor (UEF) test. UEF and Energy Factor (EF) are minimum requirements. In the UEF standard equations, V_r refers to the rated volume in gallons.

b. Chapter 6 contains a complete specification, including the year version, of the referenced test procedure.

c. A tabletop water heater is a storage water heater that is enclosed in a rectangular cabinet with a flat top surface not more than three feet (0.91 m) in height and has a ratio of input capacity (Btu/h) to tank volume (gal) < 4000.

d. Water heaters or gas pool heaters in this category are regulated as consumer products by the USDOE as defined in 10 CFR 430.

e. Storage water heaters have a ratio of input capacity (Btu/h) to tank volume (gal)<4000.

f. Efficiency requirements for electric storage water heaters ≤ 12 kW apply to both electric resistance and heat pump water heaters. There are no minimum efficiency requirements for electric heat pump water heaters greater than 12kW or for gas heat pump water heaters.

g. A grid-enabled water heater is an electric resistance water heater that meets all of the following:

1. Has a rated storage tank volume of more than 75 gallons (284 L).
2. Is manufactured on or after April 16, 2015.
3. Is equipped at the point of manufacture with an activation lock.
4. Bears a permanent label applied by the manufacturer that complies with all of the following:
   - 4.1 Is made of material not adversely affected by water.
   - 4.2 Is attached by means of non-water soluble adhesive
   - 4.3 Advises purchasers and end-users of the intended and appropriate use of the product with the following notice printed in 16.5 point Arial Narrow Bold font: "IMPORTANT INFORMATION: This water heater is intended only for use as a part of an electric thermal storage or demand response program. It will not provide adequate hot water unless enrolled in such a program and activated by your utility company or another program operator. Confirm the availability of a program in your local area before purchasing or installing this product."

h. Instantaneous water heaters and hot water supply boilers have an input capacity (Btu/h) divided by storage volume (gal) ≥ 4000 Btu/h-gal.

i. Electric instantaneous water heaters with input capacity >12 kW and ≤58.6 kW that have either (1) a storage volume >2 gal; or (2) is designed to provide outlet hot water at temperatures greater than 180°F; or (3) uses three-phase power has no efficiency standard.

j. Gas storage water heaters with input capacity >75,000 Btu/h and ≤105,000 Btu/h must comply with the requirements for the >105,000 Btu/h if the water heater either (1) has a storage volume >120 gal; (2) is designed to provide outlet hot water at temperatures greater than 180°F; or (3) uses three-phase power.

k. Refer to Section C404.2.1 for additional requirements for gas storage and instantaneous water heaters and gas hot-water supply boilers.

l. Oil storage water heaters with input capacity>105,000 Btu/h and ≤140,000 Btu/h must comply with the requirements for the >140,000 Btu/h if the water heater either (1) has a storage volume > 120 gal; (2) is designed to provide outlet hot water at temperatures greater than 180ºF; or (3) uses three-phase power.

CEPI-126-21 proposes changes to Table C404.2 as well.

Reason: The current IECC Table C404.2 uses Energy Factor (EF) which DOE replaced with the Universal Energy Factor (UEF) in 2017. New equipment are ratings are published in UEF and EF is generally not published. As such this table needs to be changed.
The proposed table C404.2 updates the values to the current DOE standards requirements. It is taken from language proposed for the Washington State Energy Code. Alternate approaches would include deleting the table entirely or adopting a table similar to 90.1. Most of the values in Table C404.2 are based upon national standards of one sort and another. As such most equipment will comply whether the table is in the code or not. Simply eliminating the table is an option and would keep code officials from worrying about water heater efficiency. Or a table similar to that adopted by 90.1 could be used. It lists all the equipment categories but for standards equipment simply states that it's regulated by DOE standards.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal updates code to reflect current federal standards and therefore will not increase the cost.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: The current IECC Table C404.2 uses Energy Factor (EF) which DOE replaced with the Universal Energy Factor (UEF) in 2017. New equipment are ratings are published in UEF and EF is generally not published. As such this table needs to be changed. The proposed table C404.2 updates the values to the current DOE standards requirements. It is taken from language proposed for the Washington State Energy Code. Alternate approaches would include deleting the table entirely or adopting a table similar to 90.1. Most of the values in Table C404.2 are based upon national standards of one sort and another. As such most equipment will comply whether the table is in the code or not. Simply eliminating the table is an option and would keep code officials from worrying about water heater efficiency. Or a table similar to that adopted by 90.1 could be used. It lists all the equipment categories but for standards equipment simply states that it's regulated by DOE standards.

Proposal # 160

CEPI-128-21

Proponents: Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Revise as follows:

C404.2.1 High input service water-heating systems. Gas-fired service water-heating equipment in new buildings where the total input capacity provided by high-capacity service water-heating equipment is 1,000,000 Btu/h (293 W) or greater shall be in compliance with either or both of the following requirements:~~this section.~~

1. Where a singular piece of high-capacity gas-fired service water-heating equipment is installed ~~serves the entire building and the input rating of the equipment is 1,000,000 Btu/h (293 kW) or greater~~, such equipment shall have a thermal efficiency, E_t, of not less than 92 percent.
2. ~~Where multiple~~ Multiple pieces of high-capacity gas-fired servicewater-heating equipment connected to the same service water-heating system ~~serve the building and the combined input rating of the water-heating equipment is 1,000,000 Btu/h (293 kW) or greater~~, the combined input-capacity-weighted-average thermal efficiency, E_t, shall be not less than 90 percent and a minimum of 30% of the input to the gas-fired equipment in the service water-heating system shall have a thermal efficiency of not less than 92 percent.

High-capacity gas-fired service water-heating equipment is comprised of gas-fired instantaneous water heaters with a rated input both greater than 200,000 Btu/h (58.6 kW) and not less than 4,000 Btu/h per gallon (310 W per litre) of stored water, and gas-fired storage water heaters with a rated input both greater than 105,000 Btu/h (30.8 kW) and less than 4,000 Btu/h per gallon (310 W per litre) of stored water.

Exceptions:

~~1. Where not less than 25 percent of the annual service water-heating requirement is provided by *on-site renewable energy* or site-recovered energy, the minimum thermal efficiency requirements of this section shall not apply.~~

~~2~~ 1. The input rating of water heaters installed in individual dwelling units shall not be required to be included in the total input rating of service water-heating equipment for a building.

~~3~~ 2. The input rating of water heaters with an input rating of not greater than 105~~0~~,000 Btu/h (~~29.3~~ 30.8 kW) shall not be required to be included in the total input rating of service water-heating equipment for a building.

Reason: Addendum ah to 90.1-2019
This addendum makes a slight modification the to requirements for high-capacity water heaters.

- Currently, the 92% E_t requirement applies if there is just one water heater in the entire building. The change requires that the 92% E_t apply for any individual system that is high-capacity.
- Where multiple water heaters are connected to the same system, the average thermal efficiency is still 90%, but now at least 30% of the capacity must have a thermal efficiency of 92% or better.

Clear criteria have been established for high-capacity water heaters.

Commercial water heaters in the United States are regulated by the US Department of Energy (US DOE) under 10 CFR Part 431. These are the definitions of the products from the regulation:

- Gas-fired instantaneous water heaters with a rated input both greater than 200,000 Btu/h and not less than 4,000 Btu/h per gallon of stored water; or,
- Gas-fired storage water heaters with a rated input both greater than 105,000 Btu/h and less than 4,000 Btu/h per gallon of stored water.

These definitions are used to describe “high-capacity gas-fired service water heating equipment.” Service water heaters that are not included are consumer products regulated under 10 CFR Part 430 and “residential-duty commercial water heaters” as defined in 10 CFR Part 431. These products are rated using the Uniform Energy Factor, which cannot be readily compared to Et.

Other changes:

The exception for buildings that use site-solar or on-site recovered energy has been deleted since there are now general provisions covering renewables in other parts of the code.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Neither US DOE’s Compliance Certification Database nor AHRI’s Certification Database includes any commercial gas-fired storage water heaters rated in the range from 90% to <92% thermal efficiency (Et). There are only four model numbers of commercial gas-fired instantaneous water

heaters rated in the range from 90% to <92% Et. Three of these models are part of a product line with a range of Et from 87% to 90%, and the manufacturer's literature lists all models in that line at 87% Et, leaving only one model number from one manufacturer. That model has a maximum input of 250,000 Btu/h.

Bibliography: ANSI/ASHRAE/IES Standard 90.1-2019 Energy Standard for Buildings Except Low-Rise Residential Buildings, Addendum ah https://www.ashrae.org/technical-resources/standards-and-guidelines/standards-addenda/addenda-to-standard-90-1-2019

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: per the proponent's reason statement submitted.

CEPI-130-21

Proponents: Gary Klein, Gary Klein and Associates, Inc., representing Self (gary@garykleinassociates.com); Emily Toto, representing ASHRAE (etoto@ashrae.org); John Bade, representing California Investor Owned Utilities (johnbade@2050partners.com)

2021 International Energy Conservation Code

Revise as follows:

C404.4 ~~Insulation of piping~~ Service water heating system piping insulation. ~~Piping from a water heater to the termination of the heated water fixture supply pipe shall be insulated in accordance with Table C403.12.3. On both the inlet and outlet piping of a storage water heater or heated water storage tank, the piping to a heat trap or the first 8 feet (2438 mm) of piping, whichever is less, shall be insulated. Piping that is heat traced shall be insulated in accordance with Table C403.12.3 or the heat trace manufacturer's instructions. Tubular pipe insulation shall be installed in accordance with the insulation manufacturer's instructions. Pipe insulation shall be continuous except where the piping passes through a framing member. The minimum insulation thickness requirements of this section shall not supersede any greater insulation thickness requirements necessary for the protection of piping from freezing temperatures or the protection of personnel against external surface temperatures on the insulation.~~

Service water heating system piping shall be surrounded by uncompressed insulation. The wall thickness of the insulation shall be not less than the thickness shown in Table C404.4.1. Where the insulation thermal conductivity is not within the range in the table, the following equation shall be used to calculate the minimum insulation thickness:

$$t_{alt} = r\cdot[(1 + t_{table}/r)k_{alt}/k_{upper} - 1]$$

Where:

t_{alt} = minimum insulation thickness of the alternate material (in.) (mm)

r = actual outside radius of pipe (in.) (mm)

t_{table} = insulation thickness listed in this table for applicable fluid temperature and pipesize

k_{alt} = thermal conductivity of the alternate material at mean rating temperature indicatedfor the applicable fluid temperature [Btu·in/h·ft2·°F] [W (m·°C)]

k_{upper} = the upper value of the thermal conductivity range listed in this table for the applicable fluid temperature [Btu·in/h·ft2·°F] [W (m·°C)]

For nonmetallic piping thicker than Schedule 80 and having thermal resistance greater than that of steel pipe, reduced insulation thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot (meter) than a steel pipe of the same size with the insulation thickness shown in the table.

Exception: Tubular pipe insulation shall not be required on the following:

1. ~~The tubing from the connection at the termination of the fixture supply piping to a plumbing fixture or plumbing appliance.~~ Factory-installed piping within water heaters and hot water storage tanks
2. Valves, pumps, and strainers ~~and threaded unions~~ in piping that is not greater than 1 inch (25 mm) ~~or less~~ in nominal diameter.
3. Piping that conveys hot water that has not been heated through the use of fossil fuels or electricity

~~3.~~ 4. Piping from user-controlled shower and bath mixing valves to the water outlets.

~~4.~~ 5. Cold-water piping of a demand recirculation water system. .

~~5. Tubing from a hot drinking-water heating unit to the water outlet.~~

6. Piping in existing buildings where alterations are made to existing service water heating systems where there is insufficient space or access to meet the requirements.

~~6.~~ 7. Piping at locations where a vertical support of the piping is installed.

~~7. Piping surrounded by building insulation with a thermal resistance (*R*-value) of not less than R-3.~~

8. Where piping passes through a framing member if it requires increasing the size of the framing member

Add new text as follows:

C404.4.1 Installation Requirements. The following piping shall be insulated per the requirements of this section:

1. Recirculating system piping, including the supply and return piping
2. The first 8 feet (2.4m) of outlet piping from:
   - 2.1. Storage water heaters
   - 2.2. Hot water storage tanks
   - 2.3. Any water heater and hot water supply boiler containing not less than 10 gallons (37.9 L) of water heated by a direct heat source, an indirect heat source, or both a direct heat source and an indirect heat source.
3. The first 8 feet (2.4m) of branch piping connecting to recirculated, heat traced, or impedance heated piping.
4. The make-up water inlet piping between heat traps and the storage water heaters and the storage tanks they are serving, nonrecirculating service water heating storage-system.
5. Hot water piping between multiple water heaters, between multiple hot water storage tanks, and between water heaters and hot water storage tanks.
6. Piping that is externally heated (such as heat trace or impedance heating).
7. For direct-buried service water heating system piping, reduction of these thicknesses by 1.5 inches (38.1 mm) shall be permitted (before thickness adjustment required in T C404.4) but not to thicknesses less than 1 in (25.4 mm).

TABLE C404.4.1 MINIMUM PIPING INSULATION THICKNESS FOR SERVICE WATER HEAING SYSTEMS[a]

Service Hot-Water Temperature Range	Insulation Thermal Conductivity		Nominal Pipe or Tube Size, in.				
	Conductivity, Btu·in/h·ft2·°F	Mean Rating Temperature, °F	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
			Insulation Thickness, in.				
105°F to 140°F	0.22 to 0.28	100	1.0	1.0	1.5	1.5	1.5
>140°F to 200°F	0.25 to 0.29	125	1.0	1.0	2.0	2.0	2.0
>200°F	0.27 to 0.30	150	1.5	1.5	2.5	3.0	3.0

a. These thicknesses are based on energy efficiency considerations only. Additional insulation may be necessary for safety.

Reason: This proposal has been submitted to create a placeholder for the IECC to incorporate changes that are being considered for inclusion in the 2022 update to ASHRAE Standard 90.1.

The existing pipe insulation thickness requirements for service water heating piping come from Table C403.12.3, which was developed primarily for space heating. The major change in this proposal is to include a pipe insulation wall thickness table in the service water heating section of the IECC. Having a separate table will allow requirements for service water heating piping insulation to be based on typical service water heating operation and operating temperatures, which may be very different from those for mechanical systems.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The revisions proposed to this section will not change construction costs.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: The existing pipe insulation thickness requirements for service water heating piping come from Table C403.12.3, which was developed primarily for space heating. The major change in this proposal is to include a pipe insulation wall thickness table in the service water heating section of the IECC. Having a separate table will allow requirements for service water heating piping insulation to be based on typical service water heating operation and operating temperatures, which may be very different from those for mechanical systems.

Proposal # 498

CEPI-131-21

Proponents: Lisa Rosenow, representing Self (lrosenow@evergreen-tech.net); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Revise as follows:

C404.6.1 Circulation systems. Heated-water circulation systems shall be provided with a circulation pump. Gravity and thermo-syphon circulation systems are prohibited. The system return pipe shall be a dedicated return pipe . ~~or a cold water supply pipe. Gravity and thermo-syphon circulation systems shall be prohibited. Controls for circulating hot water system pumps~~ Controls shall be configured to automatically turn off the pump when the water in the circulation loop is at the desired temperature and when there is not a demand for hot water. ~~The controls shall limit the temperature of the water entering the cold water piping to not greater than 104°F (40°C).~~ Where a circulation pump serves multiple risers or piping zones, controls shall include self-actuating thermostatic balancing valves or another means of flow control to automatically balance the flow rate through each riser or piping zone.

Reason: In service water heating systems, circulation pumps with electronically commutated motors (ECM) offer energy savings compared to circulation pumps with standard induction motors by providing the ability to balance system flow based on demand. The use of thermostatic balancing valves optimizes hot water flow to each zone in multiple zone or multiple riser systems. Both of these strategies reduce waste of heated water.
As a clarification, language regarding the use of a cold water supply pipe as the return has been removed. This language is covered under Section C404.6.1.1 for demand recirculation systems.

Cost Impact: The code change proposal will increase the cost of construction.
Cost Increase Information

Cost comparison is between a circulation pump with a standard A/C induction motor and a circulation pump with an electronically commutated motor.

Circulation pump size used for cost analysis - 2.5 - 5 gpm at 15 ft/hd, 145 psi

Installed cost for circulation pump with A/C induction motor - $750

Installed cost for circulation pump with ECM - $1,000

$250 incremental cost increase per pump based on manufacturer data from Bell and Gossett. Refer to manufacturer literature attached.

Projected Energy Savings

Assumptions - 4,000 hrs/yr pump operation; Circulation pump w/ECM ~ 30% more efficient

Circulation pump with standard motor - 70 watts

Circulation pump with ECM - 100 watts

30 watt savings x 4,000 hours/yr/1,000 = 120 kWh/yr

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: The use of thermostatic balancing valves optimizes hot water flow to each zone in multiple zone or multiple riser systems and reduces waste of heated water.

Proposal # 547

CEPI-133-21

Proponents: Jack Bailey, representing International Association of Lighting Designers (jbailey@oneluxstudio.com)

2021 International Energy Conservation Code

Revise as follows:

C405.1 General. Electrical power and lLighting system s ~~controls, the maximum lighting power for interior and exterior applications, and electrical energy consumption~~ shall comply with this section. *Sleeping units* shall comply with Section C405.2.5 and with ~~either~~ Section C405.1.1~~ or C405.3~~. *General lighting* shall consist of all lighting included when calculating the total connected interior lighting power in accordance with Section C405.3.1 and which does not require specific application controls in accordance with Section C405.2.5.
Transformers, uninterruptable power supplies, motors and electrical power processing equipment in data center systems shall comply with Section 8 of ASHRAE 90.4 in addition to this code.

Reason: The description of the scope of this section has not kept pace with the actual content of the section. This should be updated to more accurately represent the current scope.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The change is editorial.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Provides clarity to scope of C405.

Proposal # 379

CEPI-134-21

Proponents: Jack Bailey, representing International Association of Lighting Designers (jbailey@oneluxstudio.com)

2021 International Energy Conservation Code

Revise as follows:

C405.1 General. Lighting system controls, the maximum lighting power for interior and exterior applications, and electrical energy consumption shall comply with this section. *Sleeping units* shall comply with Section C405.2.5 and with either Section C405.1.1 or C405.3. *General lighting* shall consist of all lighting included when calculating the total connected interior lighting power in accordance with Section C405.3.1 and which does not require specific application controls in accordance with Section C405.2.5.
~~Transformers, uninterruptable power supplies, motors and electrical power processing equipment in data center systems shall comply with Section 8 of ASHRAE 90.4 in addition to this code.~~

Add new text as follows:

C405.9 Data Center Systems. Transformers, uninterruptable power supplies, motors and electrical power processing equipment in data center systems shall comply with Section 8 of ASHRAE 90.4 in addition to this code.

Reason: This technical content does not belong in C405.1. It should be in a new subsection C405.9 (between motor efficiencies and vertical and horizontal transportation systems).

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This change is entirely editorial in nature.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: It makes sense to remove from current location under general, to a new section. This will also make it easier for searching in digital codes.

Proposal # 220

CEPI-135-21

Proponents: Glenn Heinmiller, representing International Association of Lighting Designers (glenn@lampartners.com)

2021 International Energy Conservation Code

Revise as follows:

C405.1 General. Lighting system controls, the maximum lighting power for interior and exterior applications, and electrical energy consumption shall comply with this section. *Sleeping units* shall comply with Section C405.2.5 and with ~~either~~ Section C405.1.1 ~~or C405.3~~. *General lighting* shall consist of all lighting included when calculating the total connected interior lighting power in accordance with Section C405.3.1 and which does not require specific application controls in accordance with Section C405.2.5.
Transformers, uninterruptable power supplies, motors and electrical power processing equipment in data center systems shall comply with Section 8 of ASHRAE 90.4 in addition to this code.

C405.1.1 Lighting power for sleeping units and dwelling units. No less than 90 percent of the permanently installed lighting serving sleeping units and dwelling units, excluding kitchen appliance lighting, shall be provided by lamps with an efficacy of not less than 65 lm/W or luminaires with an efficacy of not less than 45 lm/W~~, or shall comply with Sections C405.2.4 and C405.3.~~

TABLE C405.3.2(2) INTERIOR LIGHTING POWER ALLOWANCES: SPACE-BY-SPACE METHOD

COMMON SPACE TYPES[a]	LPD (watts/ft²)
Atrium	
Less than 40 feet in height	0.48
Greater than 40 feet in height	0.60
Audience seating area	
In an auditorium	0.61
In a gymnasium	0.23
In a motion picture theater	0.27
In a penitentiary	0.67
In a performing arts theater	1.16
In a religious building	0.72
In a sports arena	0.33
Otherwise	0.33
Banking activity area	0.61
Breakroom (See Lounge/breakroom)	
Classroom/lecture hall/training room	
In a penitentiary	0.89
Otherwise	0.71
Computer room, data center	0.94
Conference/meeting/multipurpose room	0.97
Copy/print room	0.31
Corridor	
In a facility for the visually impaired (and not used primarily by the staff)[b]	0.71
In a hospital	0.71
Otherwise	0.41
Courtroom	1.20
Dining area	
In bar/lounge or leisure dining	0.86
In cafeteria or fast food dining	0.40
In a facility for the visually impaired (and not used primarily by the staff)[b]	1.27
In family dining	0.60
In a penitentiary	0.42
Otherwise	0.43
Electrical/mechanical room	0.43
Emergency vehicle garage	0.52
Food preparation area	1.09
~~Guestroom[c, d]~~	~~0.41~~
Laboratory	
In or as a classroom	1.11
Otherwise	1.33
Laundry/washing area	0.53
Loading dock, interior	0.88
Lobby	
For an elevator	0.65
In a facility for the visually impaired (and not used primarily by the staff)[b]	1.69

COMMON SPACE TYPES	LPD (watts/ft²)
In a hotel	0.51
In a motion picture theater	0.23
In a performing arts theater	1.25
Otherwise	0.84
Locker room	0.52
Lounge/breakroom	
In a healthcare facility	0.42
Otherwise	0.59
Office	
Enclosed	0.74
Open plan	0.61
Parking area, interior	0.15
Pharmacy area	1.66
Restroom	
In a facility for the visually impaired (and not used primarily by the staff[b]	1.26
Otherwise	0.63
Sales area	1.05
Seating area, general	0.23
Stairwell	0.49
Storage room	0.38
Vehicular maintenance area	0.60
Workshop	1.26
BUILDING TYPE SPECIFIC SPACE TYPES[a]	**LPD (watts/ft²)**
Automotive (see Vehicular maintenance area)	
Convention Center—exhibit space	0.61
~~Dormitory—living quarters[c, d]~~	~~0.50~~
Facility for the visually impaired[b]	
In a chapel (and not used primarily by the staff)	0.70
In a recreation room (and not used primarily by the staff)	1.77
~~Fire Station—sleeping quarters[c]~~	~~0.23~~
Gymnasium/fitness center	
In an exercise area	0.90
In a playing area	0.85
Healthcare facility	
In an exam/treatment room	1.40
In an imaging room	0.94
In a medical supply room	0.62
In a nursery	0.92
In a nurse's station	1.17
In an operating room	2.26
~~In a patient room[c]~~	~~0.68~~
In a physical therapy room	0.91
In a recovery room	1.25
Library	
In a reading area	0.96
In the stacks	1.18
Manufacturing facility	
[illegible]	[illegible]

COMMON SPACE TYPES	LPD (watts/ft²)
In a detailed manufacturing area	0.80
In an equipment room	0.76
In an extra-high-bay area (greater than 50 feet floor-to-ceiling height)	1.42
In a high-bay area (25–50 feet floor-to-ceiling height)	1.24
In a low-bay area (less than 25 feet floor-to-ceiling height)	0.86
Museum	
In a general exhibition area	0.31
In a restoration room	1.10
Performing arts theater—dressing room	0.41
Post office—sorting area	0.76
Religious buildings	
In a fellowship hall	0.54
In a worship/pulpit/choir area	0.85
Retail facilities	
In a dressing/fitting room	0.51
In a mall concourse	0.82
Sports arena—playing area	
For a Class I facility~~[e]~~[c]	2.94
For a Class II facility~~[f]~~[d]	2.01
For a Class III facility~~[g]~~[e]	1.30
For a Class IV facility~~[h]~~[f]	0.86
Transportation facility	
At a terminal ticket counter	0.51
In a baggage/carousel area	0.39
In an airport concourse	0.25
Warehouse—storage area	
For medium to bulky, palletized items	0.33
For smaller, hand-carried items	0.69

For SI: 1 foot = 304.8 mm, 1 watt per square foot = 10.76 w/m^2.

a. In cases where both a common space type and a building area specific space type are listed, the building area specific space type shall apply.

b. A ‘Facility for the Visually Impaired’ is a facility that is licensed or will be licensed by local or state authorities for senior long-term care, adult daycare, senior support or people with special visual needs.

~~c. Where sleeping units are excluded from lighting power calculations by application of Section R404.1, neither the area of the sleeping units nor the wattage of lighting in the sleeping units is counted.~~

~~d. Where dwelling units are excluded from lighting power calculations by application of Section R404.1, neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.~~

~~e~~ c. Class I facilities consist of professional facilities; and semiprofessional, collegiate, or club facilities with seating for 5,000 or more spectators.

~~f.~~ d. Class II facilities consist of collegiate and semiprofessional facilities with seating for fewer than 5,000 spectators; club facilities with seating for between 2,000 and 5,000 spectators; and amateur league and high school facilities with seating for more than 2,000 spectators.

~~g.~~ e. Class III facilities consist of club, amateur league and high school facilities with seating for 2,000 or fewer spectators.

~~h.~~ f. Class IV facilities consist of elementary school and recreational facilities; and amateur league and high school facilities without provision for spectators.

TABLE C405.3.2(1) INTERIOR LIGHTING POWER ALLOWANCES: BUILDING AREA METHOD

BUILDING AREA TYPE	LPD (w/ft^2)
Automotive facility	0.75
Convention center	0.64
Courthouse	0.79
Dining: bar lounge/leisure	0.80
Dining: cafeteria/fast food	0.76
Dining: family	0.71
Dormitory~~[a, b]~~	0.53
Exercise center	0.72
Fire station~~[a]~~	0.56
Gymnasium	0.76
Health care clinic	0.81
Hospital~~[a]~~	0.96
Hotel/Motel~~[a, b]~~	0.56
Library	0.83
Manufacturing facility	0.82
Motion picture theater	0.44
Multiple-family~~[c]~~	0.45
Museum	0.55
Office	0.64
Parking garage	0.18
Penitentiary	0.69
Performing arts theater	0.84
Police station	0.66
Post office	0.65
Religious building	0.67
Retail	0.84
School/university	0.72
Sports arena	0.76
Town hall	0.69
Transportation	0.50
Warehouse	0.45
Workshop	0.91

For SI: 1 watt per square foot = 10.76 w/m^2.

~~a. Where sleeping units are excluded from lighting power calculations by application of Section R404.1, neither the area of the sleeping units nor the wattage of lighting in the sleeping units is counted.~~

~~b. Where dwelling units are excluded from lighting power calculations by application of Section R404.1, neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.~~

~~c. Dwelling units are excluded. Neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.~~

C405.3.2.1 Building Area Method. For the Building Area Method, the interior lighting power allowance is calculated as follows:

1. For each building area type inside the building, determine the applicable building area type and the allowed lighting power density for that type from Table C405.3.2(1). For building area types not listed, select the building area type that most closely represents the use of that area. For the purposes of this method, an "area" shall be defined as all contiguous spaces that accommodate or are associated with a single building area type.

2. Determine the floor area for each building area type listed in Table C405.3.2(1) and multiply this area by the applicable value from Table C405.3.2(1) to determine the allowed lighting power (watts) for each building area type. *Sleeping units* and *dwelling units* are excluded from lighting power allowance calculations by application of Section C405.1.1. The area of *sleeping units* and *dwelling units* is not included in the calculation.
3. The total interior lighting power allowance (watts) for the entire building is the sum of the lighting power from each building area type.

C405.3.2.2 Space-by-Space Method. Where a building has unfinished spaces, the lighting power allowance for the unfinished spaces shall be the total connected lighting power for those spaces, or 0.2 watts per square foot (10.76 w/m^2), whichever is less. For the Space-by-Space Method, the interior lighting power allowance is calculated as follows:

1. For each space enclosed by partitions that are not less than 80 percent of the ceiling height, determine the applicable space type from Table C405.3.2(2). For space types not listed, select the space type that most closely represents the proposed use of the space. Where a space has multiple functions, that space may be divided into separate spaces.
2. Determine the total floor area of all the spaces of each space type and multiply by the value for the space type in Table C405.3.2(2) to determine the allowed lighting power (watts) for each space type. *Sleeping units* and *dwelling units* are excluded from lighting power allowance calculations by application of Section C405.1.1. The area of *sleeping units* and *dwelling units* is not included in the calculation.
3. The total interior lighting power allowance (watts) shall be the sum of the lighting power allowances for all space types.

C405.3.1 Total connected interior lighting power. The total connected interior lighting power shall be determined in accordance with Equation 4-10.

$$TCLP = [LVL + BLL + LED + TRK + \text{Other}] \qquad \textbf{(Equation 4-10)}$$

where:

TCLP = Total connected lighting power (watts).

LVL = For luminaires with lamps connected directly to building power, such as line voltage lamps, the rated wattage of the lamp.

BLL = For luminaires incorporating a ballast or transformer, the rated input wattage of the ballast or transformer when operating that lamp.

LED = For light-emitting diode luminaires with either integral or remote drivers, the rated wattage of the luminaire.

TRK = For lighting track, cable conductor, rail conductor, and plug-in busway systems that allow the addition and relocation of luminaires without rewiring, the wattage shall be one of the following:

1. The specified wattage of the luminaires, but not less than 8 W per linear foot (25 W/lin m).
2. The wattage limit of the permanent current-limiting devices protecting the system.
3. The wattage limit of the transformer supplying the system.

Other = The wattage of all other luminaires and lighting sources not covered previously and associated with interior lighting verified by data supplied by the manufacturer or other *approved* sources.

The connected power associated with the following lighting equipment and applications is not included in calculating total connected lighting power.

1. Television broadcast lighting for playing areas in sports arenas.
2. Emergency lighting automatically off during normal building operation.
3. Lighting in spaces specifically designed for use by occupants with special lighting needs, including those with visual impairment and other medical and age-related issues.
4. Casino gaming areas.
5. Mirror lighting in dressing rooms.
6. Task lighting for medical and dental purposes that is in addition to general lighting.
7. Display lighting for exhibits in galleries, museums and monuments that is in addition to general lighting.
8. Lighting for theatrical purposes, including performance, stage, film production and video production.
9. Lighting for photographic processes.
10. Lighting integral to equipment or instrumentation and installed by the manufacturer.
11. Task lighting for plant growth or maintenance.

12. Advertising signage or directional signage.
13. Lighting for food warming.
14. Lighting equipment that is for sale.
15. Lighting demonstration equipment in lighting education facilities.
16. Lighting approved because of safety considerations.
17. Lighting in retail display windows, provided that the display area is enclosed by ceiling-height partitions.
18. Furniture-mounted supplemental task lighting that is controlled by automatic shutoff.
19. Exit signs.
20. Antimicrobial lighting used for the sole purpose of disinfecting a space.
21. Lighting in *sleeping units* and *dwelling units*

C405.2.5 Specific application controls. Specific application controls shall be provided for the following:

1. The following lighting shall be controlled by an occupant sensor complying with Section C405.2.1.1 or a time-switch control complying with Section C405.2.2.1. In addition, a manual control shall be provided to control such lighting separately from the general lighting in the space:

    1.1. Luminaires for which additional lighting power is claimed in accordance with Section C405.3.2.2.1.

    1.2. Display and accent.

    1.3. Lighting in display cases.

    1.4. Supplemental task lighting, including permanently installed under-shelf or under-cabinet lighting.

    1.5. Lighting equipment that is for sale or demonstration in lighting education.

    1.6. Display lighting for exhibits in galleries, museums and monuments that is in addition to *general lighting*.

2. *Sleeping units* shall have control devices or systems that are configured to automatically switch off all permanently installed luminaires and switched receptacles within 20 minutes after all occupants have left the unit.

    Exceptions:

    1. Lighting and switched receptacles controlled by card key controls.
    2. Spaces where patient care is directly provided.

~~3. Permanently installed luminaires within *dwelling units* shall be provided with controls complying with Section C405.2.1.1 or C405.2.3.1.~~

~~4.~~ 3. Lighting for nonvisual applications, such as plant growth and food warming, shall be controlled by a time switch control complying with Section C405.2.2.1 that is independent of the controls for other lighting within the room or space.

~~5.~~ 4. Task lighting for medical and dental purposes that is in addition to *general lighting* shall be provided with a *manual control*.

Reason: For *sleeping units* the code currently allows the use of either the luminaire efficacy requirement (C405.1.1), **or** lighting power density (C405.3) to limit lighting power, and requires specific controls for *sleeping units* (C405.2.5 #2). The option to use lighting power density to comply with lighting power requirements is not needed, does nothing to improve energy efficiency, and adds unnecessary complexity. Designers and Engineers are always going to choose the luminaire efficacy requirement because it is simple and does not require any calculations.

For *dwelling units* the code currently allows the use of either the luminaire efficacy requirement (C405.1.1), **or** lighting power density (C405.3) and C405.2.5 #3 which requires occupancy sensors and light reduction controls (although it is not clear how this is to be applied to *dwelling units*). Designers/engineers/building owners will always choose the luminaire efficacy option because it is simple and does not require installation of lighting controls in the *dwelling unit*. The option is not necessary because it will never be used.
When the lighting power density option is removed, then the lighting power allowances for "Guestroom", "Dormitory -- living quarters", "Fire Station -- sleeping quarters" and "healthcare facility -- patient room" can be removed from Table C405.3.2 (2). All of these space types are by defintion either *sleeping units*, *dwelling units*, or both.

Five complicated footnotes to Tables C405.3.2(1) and C405.3.2(2) can also be removed and incorporated into C405.3.2.1 #2 and C405.3.2.2 #2 by adding one sentence. For clarity, "Lighting in *sleeping units* and *dwelling units*" is added to the list of lighting that is not included in lighting power calculations.

The clarifying word "allowed" is added to C405.3.2.1 #2 and C405.3.2.2 #2. You are calculating the lighting power allowance, not the lighting power.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This simplification of a the code will not require the use of more expensive equipment and does not eliminate a lower cost option

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Improves code language to more accurately depict dwelling and sleeping unit use.

CEPI-137-21

Proponents: Mike Moore, Stator LLC, representing Broan-NuTone (mmoore@statorllc.com)

2021 International Energy Conservation Code

Revise as follows:

C405.1.1 Lighting for dwelling units. No less than 90 percent of the permanently installed lighting serving dwelling units~~, excluding kitchen appliance lighting, ~~shall be provided by lamps with an efficacy of not less than 65 lm/W or luminaires with an efficacy of not less than 45 lm/W, or shall comply with Sections C405.2.4 and C405.3.

Exceptions:

1. Lighting integral to a kitchen appliance or exhaust hood.
2. Antimicrobial lighting used for the sole purpose of disinfecting.

C405.3.1 Total connected interior lighting power. The total connected interior lighting power shall be determined in accordance with Equation 4-10.

$$TCLP = [LVL + BLL + LED + TRK + \text{Other}]$$ **(Equation 4-10)**

where:

TCLP = Total connected lighting power (watts).

LVL = For luminaires with lamps connected directly to building power, such as line voltage lamps, the rated wattage of the lamp.

BLL = For luminaires incorporating a ballast or transformer, the rated input wattage of the ballast or transformer when operating that lamp.

LED = For light-emitting diode luminaires with either integral or remote drivers, the rated wattage of the luminaire.

TRK = For lighting track, cable conductor, rail conductor, and plug-in busway systems that allow the addition and relocation of luminaires without rewiring, the wattage shall be one of the following:

1. The specified wattage of the luminaires, but not less than 8 W per linear foot (25 W/lin m).
2. The wattage limit of the permanent current-limiting devices protecting the system.
3. The wattage limit of the transformer supplying the system.

Other = The wattage of all other luminaires and lighting sources not covered previously and associated with interior lighting verified by data supplied by the manufacturer or other *approved* sources.

~~The connected power associated with the following lighting equipment and applications is not in in calculating total connected lighting power.~~

1. ~~Television broadcast lighting for playing areas in sports arenas.~~
2. ~~Emergency lighting automatically off during normal building operation.~~
3. ~~Lighting in spaces specifically designed for use by occupants with special lighting needs, including those with visual impairment and other medical and age-related issues.~~
4. ~~Casino gaming areas.~~
5. ~~Mirror lighting in dressing rooms.~~
6. ~~Task lighting for medical and dental purposes that is in addition to general lighting.~~
7. ~~Display lighting for exhibits in galleries, museums and monuments that is in addition to general lighting.~~
8. ~~Lighting for theatrical purposes, including performance, stage, film production and video production.~~
9. ~~Lighting for photographic processes.~~
10. ~~Lighting integral to equipment, appliances, or instrumentation and installed by the manufacturer.~~
11. ~~Task lighting for plant growth or maintenance.~~
12. ~~Advertising signage or directional signage.~~
13. ~~Lighting for food warming.~~

14. ~~Lighting equipment that is for sale.~~
15. ~~Lighting demonstration equipment in lighting education facilities.~~
16. ~~Lighting approved because of safety considerations.~~
17. ~~Lighting in retail display windows, provided that the display area is enclosed by ceiling-height partitions.~~
18. ~~Furniture-mounted supplemental task lighting that is controlled by automatic shutoff.~~
19. ~~Exit signs.~~
20. ~~Antimicrobial lighting used for the sole purpose of disinfecting a space.~~

Add new text as follows:

C405.3.1.1 **Interior lighting power exclusions .** The connected power associated with the following lighting equipment and applications is excluded in calculating total connected lighting power.

1. Television broadcast lighting for playing areas in sports arenas.
2. Emergency lighting automatically off during normal building operation.
3. Lighting in spaces specifically designed for use by occupants with special lighting needs, including those with visual impairment and other medical and age-related issues.
4. Casino gaming areas.
5. Mirror lighting in dressing rooms.
6. Task lighting for medical and dental purposes that is in addition to general lighting.
7. Display lighting for exhibits in galleries, museums and monuments that is in addition to general lighting.
8. Lighting for theatrical purposes, including performance, stage, film production and video production.
9. Lighting for photographic processes.
10. Lighting integral to equipment, appliances, or instrumentation and installed by the manufacturer.
11. Task lighting for plant growth or maintenance.
12. Advertising signage or directional signage.
13. Lighting for food warming.
14. Lighting equipment that is for sale.
15. Lighting demonstration equipment in lighting education facilities.
16. Lighting approved because of safety considerations.
17. Lighting in retail display windows, provided that the display area is enclosed by ceiling-height partitions.
18. Furniture-mounted supplemental task lighting that is controlled by automatic shutoff.
19. Exit signs.
20. Antimicrobial lighting used for the sole purpose of disinfecting a space.

Reason: The efficacy requirements of Section C405.1.1 were developed to apply to lighting used for illumination. There are multiple exceptions to the requirements that should be recognized for dwelling units, similar to other spaces in other occupancies. Instead of continuing to expand the list of exceptions in C405.1.1 (which should include kitchen appliance lighting equipment and antimicrobial/germicidal lighting at a minimum), it is more reasonable to reference exceptions that are already itemized in Section C405.3.1. This proposal also improves organization of Section C405.3.1 by moving the exceptions to a subsection for clarity and ease of reference.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal clarifies the intent of this section, resulting in no increase or decrease in the cost of construction.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: This proposal clarifies exceptions to high-efficacy lighting requirements.

CEPI-138-21

Proponents: Kim Cheslak, NBI, representing NBI (kim@newbuildings.org)

2021 International Energy Conservation Code

Add new definition as follows:

COMMON AREA. All portions of Group R occupancies that are not dwelling units or sleeping units.

Revise as follows:

C405.12 Energy monitoring. ~~New buildings~~ Buildings ~~with a gross *conditioned floor area* of 25,000 square feet (2322 m^2) or larger~~ shall be equipped to measure, monitor, record and report energy consumption data in compliance with Sections C405.12.1 through C405.12.5.

~~**Exception**~~ **Exceptions:**

1. Buildings less than 10,000 square feet (929 m^2).
2. Existing buildings.
3. R-2 occupancies with less than 10,000 square feet (929 m^2) of *common area.*
4. ~~and individual~~ Individual tenant spaces ~~are not required to comply with this section provided that the space has its own utility services and meters and has~~ less than 5,000 square feet (464.5 m^2) ~~of *conditioned floor area*~~ with their own utility service and meter.

Reason: There are currently over 40 benchmarking regulations across the US (38 local jurisdictions and four states) – with size thresholds as low as 10,000 sf. These regulations require the reporting of energy use, and are being used as a steppingstone toward regulation of building performance – either through audit and retro-commissioning requirements or building performance standards. Ensuring that buildings are equipped to comply with these policies is a critical function of the code.
This change amends the structure of the code language slightly, but its primary focus is to drop the size threshold for compliance to 10,000 sqft – adding additional exceptions that align with similar language in ASHRAE 90.1-2019 under Section 8.4.3.

Cost Impact: The code change proposal will increase the cost of construction.
A similar measure has proven cost effective in 90.1.

Bibliography: Benchmarking policy data: https://www.buildingrating.org/

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Based on the reason statement provided by the proponent, it improves the use of energy for buildings with a smaller overall size.

CEPI-140-21

Proponents: Sean Denniston, representing New Buildings Institute (sean@newbuildings.org)

2021 International Energy Conservation Code

Add new definition as follows:

ELECTRIC VEHICLE (EV). An automotive-type vehicle for on-road use, such as passenger automobiles, buses, trucks, vans, neighborhood electric vehicles, electric motorcycles, and the like, primarily powered by an electric motor that draws current from a rechargeable storage battery, a fuel cell, a photovoltaic array, or another source of electric current. Plug-in hybrid electric vehicles are electric vehicles having a second source of motive power. Off-road, self-propelled electric mobile equipment, such as industrial trucks, hoists, lifts, transports, golf carts, airline ground support equipment, tractors, boats and the like, are not considered electric vehicles.

Revise as follows:

TABLE C405.12.2 ENERGY USE CATEGORIES

LOAD CATEGORY	DESCRIPTION OF ENERGY USE
Total HVAC system	Heating, cooling and ventilation, including but not limited to fans, pumps, boilers, chillers and water heating. Energy used by 120-volt equipment, or by 208/120-volt equipment that is located in a building where the main service is 480/277-volt power, is permitted to be excluded from total HVAC system energy use.
Interior lighting	Lighting systems located within the building.
Exterior lighting	Lighting systems located on the building site but not within the building.
Plug loads	Devices, appliances and equipment connected to convenience receptacle outlets.
Process load	Any single load that is not included in an HVAC, lighting or plug load category and that exceeds 5 percent of the peak connected load of the whole building, including but not limited to data centers, manufacturing equipment and commercial kitchens.
Electric vehicle charging	*Electric vehicle* charging loads.
Building operations and other miscellaneous loads	The remaining loads not included elsewhere in this table, including but not limited to vertical transportation systems, automatic doors, motorized shading systems, ornamental fountains, ornamental fireplaces, swimming pools, in-ground spas and snow-melt systems.

Reason:
As electric vehicles become more common place, even if not required by code, the electricity supplied to these chargers will increase the overall energy use when compared to the same building without EV charging. Combined with the increasing regulations from jurisdictions on benchmarking and building performance, it will be important that owners know and understand the EV charging use separate from the base building uses. It is far more cost-effective to sub-meter these loads during new construction than to try to isolate them and add additional sub-meters as part of a retrofit. “Electrical Vehicle Supply Equipment is separately metered” is a requirement to deduct your EV electricity from Boston’s recent update to BERDO. Currently ENERGY STAR Portfolio Manager and most other BPS and benchmarking policies do not give explicit instructions on how to account for EV charging in reporting. By getting these loads sub-metered upfront, building owners will be better able to meet needs of local policies and their own energy planning.

Cost Impact: The code change proposal will increase the cost of construction.

Because electrical submetering is already required for many building systems in the code, the incremental cost for submetering an additional system is nominal. NBI and partners estimate based on cost-data from RS Means, estimated labor costs and indirect markups that separately metering Electric Vehicle equipment increases construction costs on the order of $0.02 per square foot for a 53,000 square foot office building.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Definition as no longer needed and electrical vehicle charging monitoring is needed separate from other monitored loads.

Proposal # 275

CEPI-142-21

Proponents: Kimberly Cheslak, NBI, representing NBI (kim@newbuildings.org); Josh Keeling, representing Cadeo Group (jkeeling@cadeogroup.com); Matt Tidwell, representing Portland General Electric (matthew.tidwell@pgn.com)

2021 International Energy Conservation Code

Add new text as follows:

C405.13 Inverters. Direct-current-to-alternating-current inverters serving on-site renewable energy systems or on-site electrical energy storage systems shall be compliant with IEEE 1547-2018a and UL 1741-2021.

Add new standard(s) as follows:

IEEE

Institute of Electrical and Electronic Engineers
3 Park Avenue, 17th Floor
New York, NY 10016

1547-2018a	IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces

UL

UL LLC
333 Pfingsten Road
Northbrook, IL 60062

1741-2021	UL Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources

Reason: IEEE 1547-2018a governs requirements for the interconnection of distributed energy resources that operate in parallel to the electric grid. This standard (and its implementation at the device level through (UL 1741) ensure that these resources can support and potentially enhance grid stability, thereby improving reliability, reducing curtailments, stabilizing voltage, and maintaining power quality. Requirements to implement IEEE 1547-2018 are being explored in several states and the standard is already required as a part of California's Rule 21 interconnection requirements. The National Association of Regulatory Utilities Commissioners (NARUC) has already recommended that state utility commissions require implementation of IEEE1547-2018a as a part of their interconnection requirements.
While commission rulemaking will help to accelerate adoption, codifying the requirement within building code will provide further clarity to DER installers and provide consistency across unregulated (consumer-owned/public) utility service areas. This will help to avoid inconsistency and requirements and/or potentially future retrofit costs if a non-compliant unit must be retrofitted later at interconnection.

Smart inverter functionality can provide several benefits, with potentially significant cost advantage over traditional solutions. While the primary purpose of smart inverter functionality is grid stability, there are several additional benefits to the grid and its stakeholders. When operating in volt-VAR mode supporting reactive power, these inverters can actually provide energy savings, particularly when operating within distribution networks already operating conservation voltage reduction schemes. Additionally, smart inverters can help to increase DER hosting capacity of distribution networks, enabling greater access to renewable energy systems while maintaining safety and reliability.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
In an economic assessment of 1547-2018 functionality, EPRI found that an increase of 25% in distribution hosting capacity for solar could be achieved at a savings of $20,000/year per feeder in the reference case and could reach as high as $100,000/year. In its assessment of smart inverter benefits in high DER areas, NREL found an additional energy savings of up to 1% from smart inverters when coupled with traditional conservation voltage regulation (baseline savings of 1.5%-3%) while also improving power quality scores by up to 0.26. A study by PG&E of a set of representative feeders found deferred distribution upgrade costs of up to $200,000 per feeder at the highest levels of DER penetration and that smart inverter functionality was cost-effective across a wide range of scenarios.

Given the growing prevalence of smart inverter requirements, this is likely to have a low to no incremental cost. While communication with utility and/or third-party systems is enabled by IEEE 1547-2018a, it is not required and smart inverters can provide much of their value autonomously based on their operating setpoint. Individual utilities or jurisdictions may dictate specific setpoints and/or communications integration with utility/third-party systems as they see fit based on the specific grid context, like how loads might be integrated for demand response programs. The physical communication pathway for smart inverters is typically wi-fi, which is standard for inverters already for the purposes of system monitoring and commissioning.

Bibliography: [1]IEEE 1547-2018 Status of Adoption across the U.S. (2021) https://sagroups.ieee.org/scc21/wp-

content/uploads/sites/285/2021/09/IEEE-1547-2018_States-and-ISOs-RTOs-Adoption_IEEE-Format.pdf
[2] CPUC, Rule 21 Rulemaking, https://www.cpuc.ca.gov/Rule21/

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Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Based on the reason statement to make sure that inverters are in compliance with applicable standards.

Proposal # 184

CEPI-147-21

Proponents: Glenn Heinmiller, representing International Association of Lighting Designers (glenn@lampartners.com)

2021 International Energy Conservation Code

Revise as follows:

C405.2 Lighting controls. Lighting systems shall be provided with controls that comply with ~~one of the following.~~

1. ~~Lighting controls as specified in~~ Sections C405.2.1 through C405.2.8.
2. ~~Luminaire level lighting controls (LLLC) and lighting controls as specified in Sections C405.2.1, C405.2.5 and C405.2.6. The LLLC luminaire shall be independently capable of:~~
   - ~~2.1. Monitoring occupant activity to brighten or dim lighting when occupied or unoccupied, respectively.~~
   - ~~2.2. Monitoring ambient light, both electric light and daylight, and brighten or dim artificial light to maintain desired light level.~~
   - ~~2.3. For each control strategy, configuration and reconfiguration of performance parameters including; bright and dim setpoints, timeouts, dimming fade rates, sensor sensitivity adjustments, and wireless zoning configurations.~~

Exceptions: Lighting controls are not required for the following:

1. Areas designated as security or emergency areas that are required to be continuously lighted.
2. Interior exit stairways, interior exit ramps and exit passageways.
3. Emergency egress lighting that is normally off.

Reason: The language that we propose to delete is completely unnecessary and does nothing to improve the energy efficiency of buildings. It just causes confusion and increases complexity with no benefit.

- LLLC's, as defined, are allowed by the code without this language. There is no regulatory hurdle that needs to be overcome for these products to be more widely used in the marketplace.
- There is no requirement in this proposal for LLLC's to be used. When this language was introduced in IECC 2018, it did not add a new requirement, or modify an existing requirement, so why is it in the code?
- This language does not provide clarification on the controls requirements in the code. It does the opposite -- it makes the code more complicated and confusing.

LLLC is not a term that is in widespread use in the lighting industry, and there is no clear definition or rating or qualification for what an LLLC would be. Under these circumstances it would be easier for these systems to comply with the code without this language rather than getting into a debate over whether a particular manufacturer's system (which may be called an LLLC by the manufacturer, and which may be considered an LLLC by DLC or some other trade group) actually meets the requirement for being an LLLC as defined in the IECC.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal removes unnecessary language and does not modify a code requirement

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Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: Removes an unnecessary compliance pathway.

CEPI-148-21

Proponents: Jack Bailey, representing International Association of Lighting Designers (jbailey@oneluxstudio.com)

2021 International Energy Conservation Code

Revise as follows:

C405.2 Lighting controls. Lighting systems shall be provided with controls that comply with one of the following.

1. Lighting controls as specified in Sections C405.2.1 through C405.2.8.
2. Luminaire level lighting controls (LLLC) and lighting controls as specified in Sections C405.2.1, C405.2.5 and C405.2.6. The LLLC luminaire shall be independently capable of:

   2.1. Monitoring occupant activity to brighten or dim lighting when occupied or unoccupied, respectively.

   2.2. Monitoring ambient light, both electric light and daylight, and brighten or dim artificial light to maintain desired light level.

   2.3. For each control strategy, configuration and reconfiguration of performance parameters including; bright and dim setpoints, timeouts, dimming fade rates, sensor sensitivity adjustments, and wireless zoning configurations.

Exceptions: Lighting controls are not required for the following:

1. Areas designated as security or emergency areas that are required to be continuously lighted.
2. Interior exit stairways, interior exit ramps and exit passageways.
3. Emergency ~~egress~~ lighting that is normally off.
4. Emergency lighting required by the *International Building Code* in exit access components which are not provided with fire alarm systems.
5. Up to 0.02 watts per square foot (0.06 W/m^2)of lighting in exit access components which are provided with fire alarm systems.

Reason: A lot of energy is wasted in buildings by operating emergency lights as 24-hour "night lights" when buildings are unoccupied. There are a variety of reasons why this is done, but the most important is to prevent shared exit access components from being completely dark when spaces they serve may be occupied. A good example of this is an elevator lobby in a multi-story, multi-tenant building, where it may be desired to keep a light burning at all times so that the elevator lobby will never be completely dark when an elevator arrives at the floor.
Over the years, the lighting industry has developed a convention of leaving emergency lights operating continuously in commercial buildings, even though this is not currently permitted by the IECC. This proposal would call attention to the fact that this practice is not currently permitted by code, by adding exceptions allowing more limited night lighting than is common practice today.

But in doing this, we need to make sure that we are not creating unsafe conditions or violating requirements of the IBC/IFC, specifically the requirement that egress lighting be maintained in exit access components while the spaces they serve are occupied. This implies that occupant sensors could not be used to control minimum egress lighting in exit access components, and in fact it would be unsafe to use occupant sensors alone to turn off egress lighting in common exit access components since occupant sensors are not tested in smoke.

The solution for this is to provide a tie-in to fire alarm system, so that egress lighting can be automatically turned on when the premises fire alarm system is activated, ensuring that egress lighting is present during an emergency. This proposal therefore establishes a separate set of requirements for buildings provided with fire alarm systems, compared to those not provided with fire alarm systems.

The 0.02 watt/sf number is copied from other codes, and this is likely to be sufficient for emergency lighting that complies with the IBC, but not sufficient for egress lighting that complies with the IBC.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
One the one hand, this proposal creates exceptions which don't currently exist in the code, so that compliance with the code will be easier and less expensive.

On the other hand, this limits the use of 24 hour night lighting in buildings, which will create additional costs for the vast majority of projects which are not currently complying with code.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Clarifies energy efficiency requirements for egress and emergency lighting.

Proposal # 241

CEPI-150-21

Proponents: Jack Bailey, representing INTERNATIONAL ASSOCIATION OF LIGHTING DESIGNERS (jbailey@oneluxstudio.com)

2021 International Energy Conservation Code

Revise as follows:

C405.2 Lighting controls. Lighting systems <u>powered through the energy service for the building</u> shall be provided with controls that comply with one of the following.

1. Lighting controls as specified in Sections C405.2.1 through C405.2.8.
2. Luminaire level lighting controls (LLLC) and lighting controls as specified in Sections C405.2.1, C405.2.5 and C405.2.6. The LLLC luminaire shall be independently capable of:

   2.1. Monitoring occupant activity to brighten or dim lighting when occupied or unoccupied, respectively.

   2.2. Monitoring ambient light, both electric light and daylight, and brighten or dim artificial light to maintain desired light level.

   2.3. For each control strategy, configuration and reconfiguration of performance parameters including; bright and dim setpoints, timeouts, dimming fade rates, sensor sensitivity adjustments, and wireless zoning configurations.

Exceptions: Lighting controls are not required for the following:

1. Areas designated as security or emergency areas that are required to be continuously lighted.
2. Interior exit stairways, interior exit ramps and exit passageways.
3. Emergency egress lighting that is normally off.

Reason: The code is clear in C405.5.1 that the scope of exterior lighting power requirements is "all lighting that is powered through the energy service for the building". But the code is not clear about the scope of exterior lighting controls requirements. This proposal will clarify the scope of exterior lighting controls.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Mot users assume that the scope of lighting controls requirements matches the scope of lighting power requirements, so this proposal will not be likely to change the scope of the code in practice.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: This change clarifies when lighting controls are required and is consistent with other provisions with the IECC

Proposal # 383

CEPI-152-21

Proponents: Glenn Heinmiller, representing International Association of Lighting Designers (glenn@lampartners.com)

2021 International Energy Conservation Code

Revise as follows:

C405.2 Lighting controls. Lighting systems shall be provided with controls that comply with one of the following.

1. Lighting controls as specified in Sections C405.2.1 through C405.2.8.
2. Luminaire level lighting controls (LLLC) and lighting controls as specified in Sections C405.2.1, C405.2.5 and C405.2.6. The LLLC luminaire shall be independently capable of:

    2.1. Monitoring occupant activity to brighten or dim lighting when occupied or unoccupied, respectively.

    2.2. Monitoring ambient light, both electric light and daylight, and brighten or dim artificial light to maintain desired light level.

    2.3. For each control strategy, configuration and reconfiguration of performance parameters including; bright and dim setpoints, timeouts, dimming fade rates, sensor sensitivity adjustments, and wireless zoning configurations.

Exceptions: Lighting controls are not required for the following:

1. ~~Areas designated as security or emergency areas that are required to be continuously lighted.~~ <u>Spaces where an automatic shutoff could endanger occupant safety or security</u>
2. Interior exit stairways, interior exit ramps and exit passageways.
3. Emergency egress lighting that is normally off.

C405.2.2 Time-switch controls. Each area of the building that is not provided with *occupant sensor controls* complying with Section C405.2.1.1 shall be provided with *time-switch controls* complying with Section C405.2.2.1.

Exceptions:

1. Luminaires that are required to have specific application controls in accordance with Section C405.2.4.
2. Spaces where patient care is directly provided.
3. ~~Spaces where an automatic shutoff would endanger occupant safety or security.~~
4. ~~Lighting intended for continuous operation.~~
5. ~~Shop and laboratory classrooms.~~

Reason: The "safety" exception in C405.2 is quite important. If written too narrowly, it can compromise safety. But if written too broadly, it can become a loophole that creates unnecessary exceptions from the lighting controls requirements in the code. Let's examine the current language. Areas "designated as security or emergency areas". Designated by whom? Such designations are shown on floor plans? Is this meant to be limited to 911 call centers and prisons? Or is this meant to include bank branches and fire stations?Refuge areas? Muster points?

"That are required to be continuously lighted". Required by whom? What jurisdiction requires that lights operate continuously in buildings that are unoccupied? Jurisdictional lighting requirements are common – for bank ATM areas,Hospitals, swimming pools, kitchens, parking lots, etc. as well as for egress lighting required by IBC. But these requirements are almost always limited in duration – either while the space or building is occupied, while a certain activity is occurring, or after dark for exterior areas. There is almost never a requirement that lights operate continuously. So if this "requirement" that the space be continuously lighted does not come from the jurisdiction, does it come from the building owner?

It is also possible that the current exception does not cover all spaces where lighting controls could endanger occupants. For example, dangerous work is performed in some (but not all) laboratories and workshops.

The proposed language, "Spaces where an automatic shutoff would endanger occupant safety or security" is already an exception from the time-switch controls requirements in section C405.2.2, and it makes sense to apply this language more broadly as the exception from occupant sensor and daylight responsive controls requirements as well.

An "automatic shutoff" could be planned or unplanned, and could be the result of a malfunctioning control system (e.g. occupant sensors shut off lights in an occupied space).

“Would” endanger is strong language. There is no guarantee that any shutoff would endanger occupants, but this is better than the permissive language alternates "could", "may" etc.

And finally, it is the “occupants” who would need to be endangered. We are not using this as an excuse to leave lights burning continuously for “security” lighting to secure an empty room. In the 21st century we have better ways to secure spaces than leaving the lights on all the time and having a guard walk by occasionally to look in.

Once we have made this change in C405.2 then we can eliminate some additional exceptions in C405.2.2.

- “Lighting intended for continuous operation” has always been problematic. “Intended” by whom? Since it is quite rare for an authority to have such a requirement, this is usually interpreted to mean that a building owner “requires” (i.e.“wants”) the lighting to be operated continuously. If an authority has such a requirement, then that requirement would supercede this code (per C101.3). But even if this is an owner “requirement” at the time the space is built, requirements change over time. A store which is intended to be 24-hour operation may well change to 18-hour operation during an economic downturn, or close and be re-opened by someone else who runs a 12-hour operation.

- “Shop and laboratory classrooms” – if there is a safety concern then the proposed Exception 1 to C405.2 would provide an exemption. It should be noted, however, that in practice many spaces of this type are currently provided with occupant sensors.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This is a clarification and simplification that does not change code requirements

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Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: This clarifies the exceptions to automatic control requirements related to safety and security.

Proposal # 78

CEPI-154-21

Proponents: Harold Jepsen, representing Legrand (harold.jepsen@legrand.us)

2021 International Energy Conservation Code

Revise as follows:

C405.2.3 Light-reduction controls. Where not provided with occupant sensor controls complying with Section C405.2.1.1, general lighting shall be provided with light-reduction controls complying with Section C405.2.3.1.

Exceptions:

~~1. Luminaires controlled by daylight responsive controls complying with Section C405.2.4.~~

1~~2~~. Luminaires controlled by special application controls complying with Section C405.2.5.

2~~3~~. Where provided with manual control, the following areas are not required to have light-reduction control:

2.1.~~3.1.~~ Spaces that have only one luminaire with a rated power of less than 60 watts.

2.2 ~~3.2.~~ Spaces that use less than 0.45 watts per square foot (4.9 W/m²).

2.3.~~3.3.~~ Corridors, lobbies, electrical rooms and/or mechanical rooms.

Reason: This exception for daylight responsive controls is a hold over from the florescent lighting era. During that time, it was difficult and costly to have lighting controls properly coordinate both manual light reduction control devices with daylight responsive controls (manual or automatic). With the prevalence of LED light source and driver dimming capability as the default commercial lighting technology today, this exception no longer serves its intended purpose from when it was introduced into the code in 2012.
Removal of this exception aligns today's design practice and lighting controls that already coordinate the operation of light reduction control with daylight responsive controls. By removing the exception it further acknowledges the ability of users to have light reduction control across the entire space, inclusive of the daylight responsive zones. This makes far better design sense and promotes further energy efficiency when the user preference is to adjust space lighting down below the daylight responsive control setpoint.

There is no cost adder to construction since LED lighting is already controllable and the controls used for daylight responsive continuous dimming control in C405.2.4, already provide manual light reduction control dimming capability.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
As presented in the reason statement, today's LED lighting technology dimmability and accompanying controls already provide this capability at not added cost.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: Deleted unnecessary exception based on current state of technology.

Proposal # 433

CEPI-156-21

Proponents: Jack Bailey, representing International Association of Lighting Designers (jbailey@oneluxstudio.com)

2021 International Energy Conservation Code

Revise as follows:

C405.2.3 ~~Light-reduction controls~~ Dimming controls. ~~Where not provided with occupant sensor controls complying with Section C405.2.1.1, general lighting shall be provided with light-reduction controls complying with Section C405.2.3.1.~~ Dimming controls complying with Section C405.2.3.1 are required for general lighting in the following space types:

1. Classroom / lecture hall / training room.
2. Conference / multipurpose / meeting room.
3. In a dining area for bar/lounge or leisure, family dining.
4. Laboratory.
5. Lobby.
6. Lounge / Break Room.
7. Offices.
8. Gymnasium / fitness center.
9. Library reading room.
10. In a health care facility for imaging rooms, exam rooms, nursery, and nurses' station.
11. Spaces not provided with occupant sensor controls complying with Section C405.2.1.1.

Exceptions:

1. Luminaires controlled by daylight responsive controls complying with Section C405.2.4.
2. Luminaires controlled by special application controls complying with Section C405.2.5.
3. ~~Where provided with manual control, the following areas are not required to have light-reduction control:~~
   - ~~3.1. Spaces that have only one luminaire with a rated power of less than 60 watts.~~
   - ~~3.2. Spaces that use less than 0.45 watts per square foot (4.9 W/m²).~~
   - ~~3.3. Corridors, lobbies, electrical rooms and/or mechanical rooms.~~

C405.2.3.1 ~~Light-reduction~~ Dimming control function. Spaces required to have ~~light-reduction controls shall have a *manual control* that allows the occupant to reduce the connected lighting load by not less than 50 percent in a reasonably uniform illumination pattern with an intermediate step in addition to full on or off, or with continuous dimming control, using one of the following or another *approved* method~~ dimming control shall be provided with *manual* controls that allow lights to be dimmed from full output to 10 percent of full power or lower with continuous dimming, as well as turning lights off. *Manual* control shall be provided within each room to dim lights. *Exception*: *Manual* dimming control is not required where lighting controls have a high-end trim setting and have undergone functional testing in accordance with C408.3.1.4.

1. ~~Continuous dimming of all luminaires from full output to less than 20 percent of full power.~~
2. ~~Switching all luminaires to a reduced output of not less than 30 percent and not more than 70 percent of full power.~~
3. ~~Switching alternate luminaires or alternate rows of luminaires to achieve a reduced output of not less than 30 percent and not more than 70 percent of full power.~~

Add new definition as follows:

HIGH-END TRIM. A lighting control setting which limits the maximum power to individual luminaires or groups of luminaires in a space.

Add new text as follows:

C408.3.1.4 High-end trim. Where lighting controls are configured for *high-end trims*, verify the following:

1. That *high-end trim* has been set.
2. That the calibration adjustment equipment is located for *ready access* only by authorized personnel.

3. That lighting controls with *ready access* for users cannot increase the lighting power above the maximum level established by the *high-end trim* controls.

Reason: 1. Dimming lights saves energy, whether is done through dimmer switches that are accessible to users, or through central "task tuning" systems. California T24 has required dimming of most lights in commercial buildings for years.
2. Almost all LED luminaires sold today are inherently dimmable at no additional cost. The daylight responsive controls section of the code already requires diming for lights in daylight zones, so this is not new, unfamiliar, or controversial.

3. Realistically in 2025 no one will be switching alternate rows of luminaires or lamps because it will be less expensive to dim the lights. It is probably less expensive to dim lights today.

From an editorial standpoint this proposal streamlines a very clunky section of the code.

From an energy efficiency standpoint, this is one of the only remaining lighting controls strategies which can save meaningful amounts of energy.

From a practical standpoint, this is proven technology which is familiar to almost all designers, builders, and owners.

Cost Impact: The code change proposal will increase the cost of construction.
The changes in Section C405.2.3.1 will not increase the cost of construction.

The additional scope in Section C405.2.3 (items 1 through 9) will expand the scope of dimming controls and will therefore increase the cost of construction.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: To match current technology by providing dimming controls giving additional energy efficiency and controllability to general lighting.

Proposal # 243

CEPI-161-21

Proponents: Glenn Heinmiller, representing International Association of Lighting Designers (glenn@lampartners.com); Michael Jouaneh, representing Lutron Electronics Co., Inc. (mjouaneh@lutron.com)

2021 International Energy Conservation Code

Revise as follows:

C405.2.4 Daylight-responsive controls. *Daylight-responsive controls* complying with Section C405.2.4.1 shall be provided to control the general lighting within *daylight zones* in the following spaces:

1. Spaces with a total of more than 150 watts of *gen eral lighting* within primary sidelit daylight zones complying with Section C405.2.4.2.
2. Spaces with a total of more than 300 watts of *general lighting* within sidelit daylight zones complying with Section C405.2.4.2.
3. Spaces with a total of more than 150 watts of *general lighting* within toplit daylight zones complying with Section C405.2.4.3.

Exceptions: Daylight responsive controls are not required for the following:

1. Spaces in health care facilities where patient care is directly provided.
2. Sidelit daylight zones on the first floor above grade in Group A-2 and Group M occupancies.
3. ~~New buildings where the total connected lighting power calculated in accordance with Section C405.3.1 is not greater than the adjusted interior lighting power allowance (LPA_{adj}) calculated in accordance with Equation 4-9.~~

$$LPA_{adj} = [LPA_{norm} \times (1.0 - 0.4 \times UDZFA / TBFA)]$$ ~~**(Equation 4-9)**~~

~~where:~~

~~LPA_{adj} = Adjusted building interior lighting power allowance in watts.~~

~~LPA_{norm} = Normal building lighting power allowance in watts calculated in accordance with Section C405.3.2 and reduced in accordance with Section C406.3 where Option 2 of Section C406.1 is used to comply with the requirements of Section C406.~~

~~*UDZFA* = Uncontrolled daylight zone floor area is the sum of all sidelit and toplit zones, calculated in accordance with Sections C405.2.4.2 and C405.2.4.3, that do not have daylight responsive controls.~~

~~*TBFA* = Total building floor area is the sum of all floor areas included in the lighting power allowance calculation in Section C405.3.2.~~

Reason: Heinmiller: Exception #3 was added to IECC 2018. It created unnecessary complexity with no benefit. It does not improve energy efficiency or the usability of the code -- and actually does the opposite. Exception #4 attempts to solve a problem that does not exist. The “problem” is assumed to be that the installation of daylight responsive controls is an unreasonable burden. This was not the case three years ago, and is not the case today. Designers have not, and are not, asking for this exception. We believe that this exception will hurt energy efficiency in the long run by discouraging the use of daylight responsive controls. While designers welcome alternate paths around unreasonable requirements, we do not welcome alternate paths that provide no benefit and only make the code more complex and confusing.

Jouaneh: This proposal strikes an unnecessary and complicated exception to daylight responsive controls. The requirement to use daylight responsive controls already has a built-in wattage exception (i.e., spaces where lighting power less than 150 watts in all the daylight zones are already exempt from daylight responsive control). So, there is no need for this additional lighting power exception. What’s more is that this exception not likely get used as projects can simply with the wattage exception in the requirement. Thus, this proposal will simplify the language by eliminating these extra words.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Heinmiller: Because this proposal eliminates an option to avoid the small cost of installing daylight responsive controls (if certain power density limits are met), it could conceivably increase the cost of construction slightly. But this assumes that the option would commonly be taken. We believe that the option currently in the code is unlikely to be used. Daylight responsive controls are standard practice today and we believe will likely be installed anyhow, regardless of whether or not this option is available. Therefore a possible small increase in construction cost is only a hypothetical and not a given.

Jouaneh: Proposal is editorial. The exception is not needed since there already is a wattage exception in the requirement.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: Removes an unneeded exception that is no longer needed due to lighting advances.

CEPI-164-21

Proponents: Megan Hayes, representing NEMA (Megan.Hayes@nema.org)

2021 International Energy Conservation Code

Revise as follows:

C405.2.4 Daylight-responsive controls. *Daylight-responsive controls* complying with Section C405.2.4.1 shall be provided to control the general lighting within *daylight zones* in the following spaces:

1. Spaces with a total of more than 75 ~~150~~ watts of *gen eral lighting* within primary sidelit daylight zones complying with Section C405.2.4.2.
2. Spaces with a total of more than 150 ~~300~~ watts of *general lighting* within sidelit daylight zones complying with Section C405.2.4.2.
3. Spaces with a total of more than 75 ~~150~~ watts of *general lighting* within toplit daylight zones complying with Section C405.2.4.3.

Exceptions: Daylight responsive controls are not required for the following:

1. Spaces in health care facilities where patient care is directly provided.
2. Sidelit daylight zones on the first floor above grade in Group A-2 and Group M occupancies.
3. Enclosed office spaces less than 250 square feet(23.2 m^2).

~~3.~~ 4. New buildings where the total connected lighting power calculated in accordance with Section C405.3.1 is not greater than the adjusted interior lighting power allowance (LPA_{adj}) calculated in accordance with Equation 4-9.

$$LPA_{adj} = [LPA_{norm} \times (1.0 - 0.4 \times UDZFA / TBFA)]$$ **(Equation 4-9)**

where:

LPA_{adj} = Adjusted building interior lighting power allowance in watts.

LPA_{norm} = Normal building lighting power allowance in watts calculated in accordance with Section C405.3.2 and reduced in accordance with Section C406.3 where Option 2 of Section C406.1 is used to comply with the requirements of Section C406.

UDZFA = Uncontrolled daylight zone floor area is the sum of all sidelit and toplit zones, calculated in accordance with Sections C405.2.4.2 and C405.2.4.3, that do not have daylight responsive controls.

TBFA = Total building floor area is the sum of all floor areas included in the lighting power allowance calculation in Section C405.3.2.

Reason: This proposal reduces the daylight responsive control wattage threshold from 150W to 75W in primary toplight and sidelight daylight areas and 150 Watts of combined wattage for primary and secondary daylighting areas for sidelit areas. This will qualify more daylight areas for the energy efficiency and energy savings opportunity of daylight responsive controls. This proposal will:
1. Increase energy efficiency by expanding the number daylight responsive controlled areas2. Rely on the efficiency of readily available dimming technology

3. Maintain the same level of enforceability with the code

4. Coincide with amendments happening to current IECC versions and align with wattage threshold reduction of other standards: ASHRAE 90.1, CA Title 24.

The IECC daylighting threshold requirement was established and adopted in the 2015 IECC. It was based on the high cost of controlling and dimming fluorescent technology. The conversion to LED lighting technology has substantially reduced the cost for luminaire dimming controllability. LED luminaires now typically come standard with dimmable drivers without an added cost, where this was not the case with fluorescent lighting technology. As LED technology is a much more efficacious lighting source, maintaining a 150W threshold for daylight responsive control is now reducing the number of spaces where the requirement should apply and save energy.

Recognizing these facts, certain jurisdictions have amended the 2018 IECC daylight responsive control wattage threshold and other standards have or are changing to lower wattage thresholds as follows:

New York City – 100 Watts

Massachusetts – 100 Watts

Washington State – more than two luminaires in the daylight area

Washington DC – toplight 105 Watts, sidelight 150 Watts

Lower wattage thresholds in other standards:

California Title 24 Part 6 versions 2013, 2016, 2019, 2022 – 120 Watts

ASHRAE 90.1 – 2019 Addendum O – 75 Watts

ASHRAE 90.1 Addendum O forward stated:

"Costs have shifted since 2013. In 2013, the fluorescent system needed either a dimming ballast or multiple ballasts adding between ($30 - $100 per fixture adder). Dimming drivers are a standard no-cost feature of LED equipment. Other costs have changed between 2013 and now because of the advent of sensors that are integral to the fixtures."

Overall, the cost of construction will not increase as these spaces would have already qualified for daylight responsive controls with prior lighting technologies which consumed more power. As the efficacy of lighting has dropped considerably with LED lighting technology, this proposal adapts the code to this shift in more efficient and more controllable lighting.

We highly recommend the committee accept and adopt this shift to LED lighting efficacy and its effect on daylight responsive control in order to maintain the energy savings intended by the IECC.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
With the cost effective dimmability of LED sources, LED drivers, and widespread availability of daylight responsive controls, greater daylight areas and energy savings can be realized by reducing the daylight responsive control threshold from 150W to 120W.

Bibliography: *Daylighting Analysis for ASHRAE 90.1 Code Development – Final Results, March 29, 2012*, PNNL: Athalye, Xie, Rosenberg, Liu and Heschong Mahone Group: Saxena, Perry, Chappell.
"Daylighting Control Wattage Threshold", ASHRAE 90.1-2019 Motion 9, Addendum O, First Public Review, June 2020
California Title 24 Part 6 versions 2013, 2016, 2019, 2022

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: The revised proposal more closely matches the daylighting requirements in ANSI/ASHRAE/IES Standard 90.1 and leads to more energy savings in IECC.

Proposal # 153

CEPI-166-21

Proponents: Jack Bailey, representing INTERNATIONAL ASSOCIATION OF LIGHTING DESIGNERS (jbailey@oneluxstudio.com)

2021 International Energy Conservation Code

Revise as follows:

C405.2.4.2 Sidelit daylight zone. The sidelit daylight zone is the floor area adjacent to vertical *fenestration* that complies with all of the following:

1. Where the fenestration is located in a wall, the primary sidelit daylight zone shall extend laterally to the nearest full-height wall, or up to 1.0 times the height from the floor to the top of the fenestration, and longitudinally from the edge of the fenestration to the nearest full-height wall, or up to 0.5 times the height from the floor to the top of the fenestration, whichever is less, as indicated in Figure C405.2.4.2(1).
2. Where the fenestration is located in a rooftop monitor, the primary sidelit daylight zone shall extend laterally to the nearest obstruction that is taller than 0.7 times the ceiling height, or up to 1.0 times the height from the floor to the bottom of the fenestration, whichever is less, and longitudinally from the edge of the fenestration to the nearest obstruction that is taller than 0.7 times the ceiling height, or up to 0.25 times the height from the floor to the bottom of the fenestration, whichever is less, as indicated in Figures C405.2.4.2(2) and C405.2.4.2(3).
3. Where the fenestration is located in a wall, the secondary sidelit daylight zone is directly adjacent to the primary sidelit daylight zone and shall extend laterally to 2.0 times the height from the floor to the top of the fenestration or to the nearest full height wall, whichever is less, and longitudinally from the edge of the fenestration to the nearest full height wall, or up to 0.5 times the height from the floor to the top of the fenestration, whichever is less, as indicated in Figure C405.2.4.2(1). The area of secondary sidelit zones shall not be considered in the calculation of the daylight zones in Section C402.4.1.1.
4. The area of the fenestration is not less than 24 square feet (2.23 m^2).
5. The distance from the fenestration to any building or geological formation that would block *access to* daylight is greater than one-half of the height from the bottom of the fenestration to the top of the building or geologic formation.
6. The visible transmittance of the fenestration is not less than 0.20.
7. The projection factor (determined in accordance with Equation 4-5) for any overhanging projection that is shading the fenestration is not greater than 1.0 for fenestration oriented 45 degrees or less from true north and not greater than 1.5 for all other orientations.

Reason: The change clarifies the language describing the secondary daylight zone, which was added in the last code cycle.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
There is no change to the technical content of the code.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: Makes necessary editorial corrections in this section.

Proposal # 381

CEPI-167-21

Proponents: Jack Bailey, representing INTERNATIONAL ASSOCIATION OF LIGHTING DESIGNERS (jbailey@oneluxstudio.com)

2021 International Energy Conservation Code

Revise as follows:

C405.2.4.2 Sidelit daylight zone. The sidelit daylight zone is the floor area adjacent to vertical *fenestration* that complies with all of the following:

1. Where the fenestration is located in a wall, the sidelit daylight zone shall extend laterally to the nearest full-height wall, or up to 1.0 times the height from the floor to the top of the fenestration, and longitudinally from the edge of the fenestration to the nearest full-height wall, or up to 0.5 times the height from the floor to the top of the fenestration, whichever is less, as indicated in Figure C405.2.4.2(1).
2. Where the fenestration is located in a rooftop monitor, the sidelit daylight zone shall extend laterally to the nearest obstruction that is taller than 0.7 times the ceiling height, or up to 1.0 times the height from the floor to the bottom of the fenestration, whichever is less, and longitudinally from the edge of the fenestration to the nearest obstruction that is taller than 0.7 times the ceiling height, or up to 0.25 times the height from the floor to the bottom of the fenestration, whichever is less, as indicated in Figures C405.2.4.2(2) and C405.2.4.2(3).
3. The secondary sidelit daylight zone is directly adjacent to the primary sidelit daylight zone and shall extend laterally to 2.0 times the height from the floor to the top of the fenestration or to the nearest full height wall, whichever is less, and longitudinally from the edge of the fenestration to the nearest full height wall, or up to 0.5 times the height from the floor to the top of the fenestration, whichever is less, as indicated in Figure C405.2.4.2(1). ~~The area of secondary sidelit zones shall not be considered in the calculation of the daylight zones in Section C402.4.1.1.~~
4. The area of the fenestration is not less than 24 square feet (2.23 m^2).
5. The distance from the fenestration to any building or geological formation that would block *access to* daylight is greater than one-half of the height from the bottom of the fenestration to the top of the building or geologic formation.
6. The visible transmittance of the fenestration is not less than 0.20.
7. The projection factor (determined in accordance with Equation 4-5) for any overhanging projection that is shading the fenestration is not greater than 1.0 for fenestration oriented 45 degrees or less from true north and not greater than 1.5 for all other orientations.

C402.4.1.1 Increased vertical fenestration area with daylight responsive controls. In *Climate Zones* 0 through 6, not more than 40 percent of the gross above-grade wall area shall be vertical fenestration, provided that all of the following requirements are met:

1. In buildings not greater than two stories above grade, not less than 50 percent of the net floor area is within a primary sidelit *daylight zone* or a toplit *daylight zone*.
2. In buildings three or more stories above grade, not less than 25 percent of the net floor area is within a primary sidelit *daylight zone* or a toplight *daylight zone*.
3. *Daylight responsive controls* are installed in *daylight zones.*
4. Visible transmittance (VT) of vertical fenestration is not less than 1.1 times solar heat gain coefficient (SHGC).

    Exception: Fenestration that is outside the scope of NFRC 200 is not required to comply with Item 4.

Reason: The description of how C402.4.1.1 counts daylight zones belongs in C402.4.1.1 not in C405.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The change is entirely editorial in nature.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: Makes necessary editorial corrections in this section.

CEPI-168-21

Proponents: Glenn Heinmiller, representing International Association of Lighting Designers (glenn@lampartners.com)

2021 International Energy Conservation Code

Revise as follows:

C405.2.5 Specific application controls. Specific application controls shall be provided for the following:

1. The following lighting shall be controlled by an occupant sensor complying with Section C405.2.1.1 or a time-switch control complying with Section C405.2.2.1. In addition, a manual control shall be provided to control such lighting separately from the general lighting in the space:
   - 1.1. Luminaires for which additional lighting power is claimed in accordance with Section C405.3.2.2.1.
   - 1.2. Display and accent~~.~~ lighting, including lighting in display cases.
   - ~~1.3. Lighting in display cases.~~
   - ~~1.4~~ 1.3. Supplemental task lighting, including permanently installed under-shelf or under-cabinet lighting.
   - ~~1.5~~ 1.4. Lighting equipment that is for sale or demonstration in lighting education.
   - ~~1.6. Display lighting for exhibits in galleries, museums and monuments that is in addition to *general lighting*.~~
2. *Sleeping units* shall have control devices or systems that are configured to automatically switch off all permanently installed luminaires and switched receptacles within 20 minutes after all occupants have left the unit.

   Exceptions:

   1. Lighting and switched receptacles controlled by card key controls.
   2. Spaces where patient care is directly provided.

3. Permanently installed luminaires within *dwelling units* shall be provided with controls complying with Section C405.2.1.1 or C405.2.3.1.
4. Lighting for nonvisual applications, such as plant growth and food warming, shall be controlled by a time switch control complying with Section C405.2.2.1 that is independent of the controls for other lighting within the room or space.
5. Task lighting for medical and dental purposes that is in addition to *general lighting* shall be provided with a *manual control*.

Reason: This proposal simplifies and clarifies the requirements by eliminating redundancy and unclear terminology. Three related types of lighting are consolidated under one type: "Display lighting"

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This is a simplification for clarity and does not change code requirements.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: This proposal simplifies and clarifies requirements by eliminating redundancy.

Proposal # 84

CEPI-169-21

Proponents: Michael Jouaneh, representing Lutron Electronics Co., Inc. (mjouaneh@lutron.com)

2021 International Energy Conservation Code

Revise as follows:

C403.7.6 Automatic control of HVAC systems serving guestrooms. In Group R-1 buildings containing more than 50 guestrooms, each guestroom shall be provided with controls complying with the provisions of Sections C403.7.6.1 and C403.7.6.2. ~~Card key controls comply with these requirements.~~

C405.2.5 Specific application controls. Specific application controls shall be provided for the following:

1. The following lighting shall be controlled by an occupant sensor complying with Section C405.2.1.1 or a time-switch control complying with Section C405.2.2.1. In addition, a manual control shall be provided to control such lighting separately from the general lighting in the space:
   - 1.1. Luminaires for which additional lighting power is claimed in accordance with Section C405.3.2.2.1.
   - 1.2. Display and accent.
   - 1.3. Lighting in display cases.
   - 1.4. Supplemental task lighting, including permanently installed under-shelf or under-cabinet lighting.
   - 1.5. Lighting equipment that is for sale or demonstration in lighting education.
   - 1.6. Display lighting for exhibits in galleries, museums and monuments that is in addition to *general lighting*.
2. *Sleeping units* shall have control devices or systems that are configured to automatically switch off all ~~permanently~~ installed luminaires and switched receptacles within 20 minutes after all occupants have left the unit.

   ~~**Exceptions**~~ <u>**Exception**</u>:

   1. Lighting and switched receptacles controlled by card key controls <u>in buildings containing fewer than 50 *sleeping units*</u>.
   2<u>.</u> Spaces where patient care is directly provided.

3. Permanently installed luminaires within *dwelling units* shall be provided with controls complying with Section C405.2.1.1 or C405.2.3.1.
4. Lighting for nonvisual applications, such as plant growth and food warming, shall be controlled by a time switch control complying with Section C405.2.2.1 that is independent of the controls for other lighting within the room or space.
5. Task lighting for medical and dental purposes that is in addition to *general lighting* shall be provided with a *manual control*.

Reason: Captive card key controls should not be considered an equivalent compliance option to occupant sensing or automatic controls in hotel guestrooms. Captive card key controls are a manual control (not automatic) that are easily and often bypassed thereby negating any potential energy savings. If they are to remain as an option, then only permit them to comply in the smaller hotels/motels. The larger hotels should be required to use automatic guestroom controls that will guarantee the energy savings and provide guests with a more satisfactory experience.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Will not increase cost of construction. The removal of captive card option plus installation/wiring is roughly equivalent to if not more than the cost of guest room systems with occupancy detection.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Proposal will increase the energy savings from guest rooms

CEPI-172-21

Proponents: Glenn Heinmiller, representing International Association of Lighting Designers (glenn@lampartners.com)

2021 International Energy Conservation Code

Revise as follows:

C405.2.7.2 Building facade and landscape lighting. *Building* facade and landscape lighting shall automatically shut off from not later than 1 hour after *building* or business closing to not earlier than 1 hour before *building* or business opening.

C405.2.7.3 Lighting setback. Lighting that is not controlled in accordance with Section C405.2.7.2 shall comply with the following:

1. Be controlled so that the total wattage of such lighting is automatically reduced by not less than 50 percent by selectively switching off or dimming luminaires at one of the following times:
   1.1. From not later than midnight to not earlier than 6 a.m.
   1.2. From not later than one hour after *building* or business closing to not earlier than one hour before *building* or business opening.
   1.3. During any time where activity has not been detected for 15 minutes or more.
2. Luminaires serving outdoor parking areas and having a rated input wattage of greater than 78 watts and a mounting height of 24 feet (7315 mm) or less above the ground shall be controlled so that the total wattage of such lighting is automatically reduced by not less than 50 percent during any time where activity has not been detected for 15 minutes or more. Not more than 1,500 watts of lighting power shall be controlled together.

Reason:
- As currently written, the code exempts any *buildings* that do not contain "businesses" such as schools, community centers, houses of worship, public/government buildings, university campuses, etc. We do not believe that this is the intent of this code provision.
- All of the "businesses" in an office building might be "closed" to visitors but the *building* would still be open so that workers could access the offices after the business is "closed". The C405.2.7.3 setback should not apply because the *building* is still open, even though the businesses are closed.
- The important criteria is whether the *building* is closed or open. This makes sense because the code is applicable to commercial *buildings* and their *building sites* (C405.1). *Building* is a defined term in the code.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal is only a clarification of code requirements

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: Adds clarification to the requirement that it applies to all occupancies (businesses and non-business [e.g., school or church, etc.]).

Proposal # 89

CEPI-173-21

Proponents: Mike Kennedy, Mike D Kennedy Inc, representing Northwest Energy Efficiency Alliance; Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Revise as follows:

C405.2.7.3 Lighting setback. Lighting that is not controlled in accordance with Section C405.2.7.2 shall comply with the following:

1. Be controlled so that the total wattage of such lighting is automatically reduced by not less than 50 percent by selectively switching off or dimming luminaires at one of the following times:

   1.1. From not later than midnight to not earlier than 6 a.m.

   1.2. From not later than one hour after business closing to not earlier than one hour before business opening.

   1.3. During any time where activity has not been detected for 15 minutes or more.

2. Luminaires serving outdoor parking areas and having a rated input wattage of greater than 40~~78~~ watts and a mounting height of 24 feet (7315 mm) or less above the ground shall be controlled so that the total wattage of such lighting is automatically reduced by not less than 50 percent during any time where activity has not been detected for 15 minutes or more. Not more than 1,500 watts of lighting power shall be controlled together.

Reason: Current language has little impact as most luminaires mounted under 24 feet use less than 78 watts. This proposal, by lowering the fixture wattage threshold to 40 watts, will result in greater applicability of this measure that has shown good energy savings potential.
Parking lot activity sensors were evaluated for California Title 24 with estimated costs and savings detailed in Nonresidential Outdoor Lighting Controls - Final Report from the California Codes and Standards Enhancement (CASE) Initiative (see Cost Impact).

The 2021 IECC base case control is a time clock reducing light from midnight to 6 am by 50%. The full load hours for this control are estimated to be 3285 full load hours. (6pm to midnight at 100%, midnight to 6 - 50% reduction). Table 16 of the California Title 24 CASE report determined the equivalent full load hours of various control strategies. For fixtures with activity sensors and no time clock they estimated full load hours at 2,874. This results in an estimated 40 watts / fixture * 411 full load hours / 1000 = 16 kWh / year savings for the lowest savings case of the current proposal.

In Californian and Washington the minimum wattage threshold was established based upon the limit of cost effectiveness. In California there is not minimum wattage. Looking at the distribution of light sources they determined to apply it to all parking lot lights. They also require time clock control with 75% turn down for the same fixtures. Washington applied a minimum wattage of 40 watts as proposed here. The cost effectiveness of this measure could warrant a lower minimum threshold or even eliminating the threshold.

Cost Impact: The code change proposal will increase the cost of construction.
Parking lot activity sensors were evaluated for California Title 24 with estimated costs and savings detailed in Nonresidential Outdoor Lighting Controls - Final Report from the California Codes and Standards Enhancement (CASE) Initiative. Section 5.3.2 of the report found the cost of an integral activity sensor control of $59. Section 5.3.1 of the same report found an cost of wiring a control signal from a time clock, the baseline control, to each pole to be $53. Therefore the incremental cost for the proposed control is $7 per fixture. This cost data is from 2017. An 11.4% inflation factor was used to adjust the cost to year end 2021 for a cost of $7.80. Sales tax was not included in this because many states also tax commercial electricity consumption or utilities bills but if that is accounted for in the electric cost then tax should be added to this cost.

Bibliography: Nonresidential Outdoor Lighting Controls - Final Report from the California Codes and Standards Enhancement (CASE) Initiative. Available online at: https://t24stakeholder.wpengine.com/wp-content/uploads/2017/09/2019-T24-CASE-Report_Outdoor-Ltg-Controls_Final_September-2017.pdf.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: Proposal aligns the code with efficacy improvements with LED lighting and is cost effective with simple payback under 5 years.

CEPI-176-21

Proponents: Michael Jouaneh, representing Lutron Electronics Co., Inc. (mjouaneh@lutron.com)

2021 International Energy Conservation Code

Add new text as follows:

C405.2.9 Demand responsive lighting controls. Buildings shall have controls that are capable of automatically reducing general lighting power not less than 15% in response to a demand response signal.

Exceptions:

1. Buildings with less than 4,000 watts of combined installed general lighting power in spaces that have more than 0.5 W/ft^2 of general lighting power.
2. Buildings where demand response programs are not available.
3. I-2 and I-3 occupancies.

Revise as follows:

C406.1 Additional energy efficiency credit requirements. New buildings shall achieve a total of 10 credits from Tables C406.1(1) through C406.1(5) where the table is selected based on the use group of the building and from credit calculations as specified in relevant subsections of Section C406. Where a building contains multiple-use groups, credits from each use group shall be weighted by floor area of each group to determine the weighted average building credit. Credits from the tables or calculation shall be achieved where a building complies with one or more of the following:

1. More efficient HVAC performance in accordance with Section C406.2.
2. Reduced lighting power in accordance with Section C406.3.
3. Enhanced lighting controls in accordance with Section C406.4.
4. On-site supply of renewable energy in accordance with Section C406.5.
5. Provision of a dedicated outdoor air system for certain HVAC equipment in accordance with Section C406.6.
6. High-efficiency service water heating in accordance with Section C406.7.
7. Enhanced envelope performance in accordance with Section C406.8.
8. Reduced air infiltration in accordance with Section C406.9
9. Where not required by Section C405.12, include an energy monitoring system in accordance with Section C406.10.
10. Where not required by Section C403.2.3, include a fault detection and diagnostics (FDD) system in accordance with Section C406.11.
11. Efficient kitchen equipment in accordance with Section C406.12.
12. Where not required by Section C405.2.9, include demand responsive lighting controls complaint with C405.2.9.

Reason: Demand responsive systems help projects savings on energy costs, especially peak demand charges, by helping to curtail/shift loads during times of peak electricity pricing or demand. Lighting is particularly well suited for demand response as lighting can often be adjusted without any disruption to the occupants (unlike cooling). Lights can gradually dim during a demand response event so that occupants don't notice the change in lighting (note that the first 20-25% of lighting dimming is undetectable by the human eye, yet that saves 20-25% in lighting energy). And after the DR event lighting can be brought back to previous levels quickly (unlike cooling loads which can take time for the space to be brought back to previous temperature).
What's more is that most networked lighting control (NLC) systems have native automated demand response capability. So, no new equipment is required.

Studies show that demand responsive lighting can save 30–50% of lighting power during peak periods (Newsham GR & Birt B. 2010. Demand-responsive lighting: a field study).

Lastly, demand responsive lighting has been in CA Title 24 since 2008 and in the ASHRAE 189.1 energy chapter since 2014. Plus, demand response is worth optional points in LEED v4 and demand response will be in the upcoming ASHRAE 90.1-2022 energy efficiency credits. Thus, the addition of demand responsive lighting will help bring the IECC inline with the other major building standards and rating systems.

Cost Impact: The code change proposal will increase the cost of construction.
The code change proposal may increase the cost of construction. However, savings from peak demand charges more than offsets any increased costs. Plus, most projects with over 4000 watts of lighting power will be using a networked lighting control system to comply with the mandatory lighting control provisions. And since most networked lighting control provisions have demand response built-in, no additional cost is incurred.

Bibliography: Newsham GR & Birt B. 2010. Demand-responsive lighting: a field study. Leukos. 6(3) pg 203–225
Title 24 Stakeholders CASE report on demand response: https://title24stakeholders.com/wp-content/uploads/2020/08/NR-Grid-Integration_Final-CASE-Report_Statewide-CASE-Team.pdf

https://lightingcontrolsassociation.org/2014/05/20/lighting-control-and-demand-response/

https://www.energy.gov/sites/prod/files/2020/02/f71/ssl-rd2020-ghosh-market.pdf

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Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Provides a means to effectively reduce lighting during demand response requests or other signals and improve the effective use of energy.

Proposal # 500

CEPI-177-21

Proponents: Glenn Heinmiller, representing International Association of Lighting Designers (glenn@lampartners.com)

2021 International Energy Conservation Code

Revise as follows:

C405.3.1 Total connected interior lighting power. The total connected interior lighting power shall be determined in accordance with Equation 4-10.

$$TCLP = [LVL + BLL + LED + TRK + \text{Other}]$$ **(Equation 4-10)**

where:

TCLP = Total connected lighting power (watts).

LVL = For luminaires with lamps connected directly to building power, such as line voltage lamps, the rated wattage of the lamp.

BLL = For luminaires incorporating a ballast or transformer, the rated input wattage of the ballast or transformer when operating that lamp.

LED = For light-emitting diode luminaires with either integral or remote drivers, the rated wattage of the luminaire.

TRK = For lighting track, cable conductor, rail conductor, and plug-in busway systems that allow the addition and relocation of luminaires without rewiring, the wattage shall be one of the following:

1. The specified wattage of the luminaires, but not less than 8 W per linear foot (25 W/lin m).
2. The wattage limit of the permanent current-limiting devices protecting the system.
3. The wattage limit of the transformer supplying the system.

Other = The wattage of all other luminaires and lighting sources not covered previously and associated with interior lighting verified by data supplied by the manufacturer or other *approved* sources.

The connected power associated with the following lighting equipment and applications is not included in calculating total connected lighting power.

~~1.~~ ~~Television broadcast lighting for playing areas in sports arenas.~~

~~2~~ 1. Emergency lighting automatically off during normal building operation.

~~3~~ 2. Lighting in spaces specifically designed for use by occupants with special lighting needs, including those with visual impairment and other medical and age-related issues.

~~4~~ 3. Casino gaming areas.

~~5~~ 4. Mirror lighting in makeup or dressing ~~rooms.~~ areas used for video broadcasting, video or film recording, or live theatrical and music performance.

~~6~~ 5. Task lighting for medical and dental purposes that is in addition to general lighting.

~~7~~ 6. Display lighting for exhibits in galleries, museums and monuments that is in addition to general lighting.

~~8~~ 7. ~~Lighting for theatrical purposes, including performance, stage, film production and video production.~~ Lighting in any location that is specifically used for video broadcasting, video or film recording, or live theatrical and music performance

~~9~~ 8. Lighting for photographic processes.

~~10~~ 9. Lighting integral to equipment or instrumentation and installed by the manufacturer.

~~11~~ 10. Task lighting for plant growth or maintenance.

~~12~~ 11. Advertising signage or directional signage.

~~13~~ 12. Lighting for food warming.

~~14~~ 13. Lighting equipment that is for sale.

~~15~~ 14. Lighting demonstration equipment in lighting education facilities.

~~16~~ 15. Lighting approved because of safety considerations.

~~17~~ 16. Lighting in retail display windows, provided that the display area is enclosed by ceiling-height partitions.

~~18~~ 17. Furniture-mounted supplemental task lighting that is controlled by automatic shutoff.

~~19~~ <u>18</u>. Exit signs.

~~20~~ <u>19</u>. Antimicrobial lighting used for the sole purpose of disinfecting a space.

C405.5.1 Total connected exterior building exterior lighting power. The total exterior connected lighting power shall be the total maximum rated wattage of all lighting that is powered through the energy service for the building.

Exception: Lighting used for the following applications shall not be included.

1. Lighting *approved* because of safety considerations.
2. Emergency lighting automatically off during normal business operation.
3. Exit signs.
4. Specialized signal, directional and marker lighting associated with transportation.
5. Advertising signage or directional signage.
6. Integral to equipment or instrumentation and installed by its manufacturer.
7. ~~Theatrical purposes, including performance, stage, film production and video production~~. <u>Lighting in any location that is specifically used for video broadcasting, video or film recording, or live theatrical and music performance</u>
8. Athletic playing areas.
9. Temporary lighting.
10. Industrial production, material handling, transportation sites and associated storage areas.
11. Theme elements in theme/amusement parks.
12. Used to highlight features of art, public monuments and the national flag.
13. Lighting for water features and swimming pools.
14. Lighting controlled from within dwelling units, where the lighting complies with Section R404.1.
15. <u>Lighting of the exterior means of egress as required by the *International Building Code*.</u>

Reason: This proposal clarifies the exemption from interior and exterior lighting power requirements for the lighting for dressing room mirrors and for video production and live performance.

- C405.3.1 #1 is consolidated into revised #8
- C405.3.1 #5 is revised to clarify that this only applies to mirror lighting in dressing areas used for video and performance, not mirrors in retail dressing/fitting rooms. Retail dressing room mirror lighting is covered by the lighting power allowance in Table C405.3.2(2)
- C405.3.1 #8 is revised to clarify the exemption by using more accurate terms and clear language
- C405.5.1 #7 is revised to clarify the exemption by using more accurate terms and clear language

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This is a clarification of code requirements and does not change intent or stringency

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Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Aligns language with 90.1 and adds new language consistent with the International Building Code.

Proposal # 90

CEPI-181-21

Proponents: Lisa Rosenow, representing Self (lrosenow@evergreen-tech.net); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Revise as follows:

C405.3.2.2 Space-by-Space Method. Where a building has unfinished spaces, the lighting power allowance for the unfinished spaces shall be the total connected lighting power for those spaces, or 0.1~~0.2~~ watts per square foot (~~10.76 w/m2~~ 1.08 w/m^2), whichever is less. For the Space-by-Space Method, the interior lighting power allowance is calculated as follows:

1. For each space enclosed by partitions that are not less than 80 percent of the ceiling height, determine the applicable space type from Table C405.3.2(2). For space types not listed, select the space type that most closely represents the proposed use of the space. Where a space has multiple functions, that space may be divided into separate spaces.
2. Determine the total floor area of all the spaces of each space type and multiply by the value for the space type in Table C405.3.2(2) to determine the lighting power (watts) for each space type.
3. The total interior lighting power allowance (watts) shall be the sum of the lighting power allowances for all space types.

Reason: Clarifies that the lighting power allowance and the total connected lighting power within an unfinished space cannot be included in the Space-by-space calculation for finished spaces. Prevents trading of lighting power between finished and unfinished areas.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal clarifies code intent. It does not increase code stringency.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Prevents the trading of lighting power between finished and unfinished areas of the building.

Proposal # 527

CEPI-185-21

Proponents: Diana Burk, New Buildings Institute, representing New Buildings Institute (diana@newbuildings.org)

2021 International Energy Conservation Code

Revise as follows:

GREENHOUSE. A structure or a thermally isolated area of a building that maintains a specialized sunlit environment with a skylight roof ratio of 50% or more above the growing area exclusively used for, and essential to, the cultivation, protection or maintenance of plants.*Greenhouses* are those that are erected for a period of 180 days or more.

Add new definition as follows:

HORTICULTURAL LIGHTING. Electric lighting used for horticultural production, cultivation or maintenance.

PHOTOSYNTHETIC PHOTON EFFICACY (PPE). Photosynthetic photon flux emitted by a light source divided by its electrical input power in units of micromoles per second per watt, or micromoles per joule (µmol/J) between 400-700nm as defined by ANSI/ASABE S640.

Revise as follows:

C405.4 ~~Lighting for plant growth and maintenance~~ Horticultural Lighting. ~~Not less than 95 percent of the p~~ Permanently installed luminaires ~~used for plant growth and maintenance~~ shall have a ~~photon efficiency~~ *photosynthetic photon efficacy* of not less than ~~1.6~~ 1.7 µmol/J for *horticultural lighting* in *greenhouses* and not less than 1.9 µmol/J for all other *horticultural lighting.* Luminaires for *horticultural lighting* in *greenhouses* shall be controlled by a device that automatically turns off the luminaire when sufficient daylight is available. Luminaires for *horticultural lighting* shall be controlled by a device that automatically turns off the luminaire at specific programmed times. ~~µmol/J as defined in accordance with ANSI/ASABE S640.~~

Reason: Indoor agriculture energy usage is projected to grow substantially nationwide over the next several years, driven in large part (but not entirely) by the legalization of medical and recreational marijuana across the country. A total of 46 million square feet of grow area in the U.S. is lit by electric horticultural lighting, 58% of which was in supplemental greenhouses, 41% in non-stacked indoor farms, and 1% in vertical farms. Lighting in greenhouses operate on average 2,120 hours per year or 6 hours per day and lighting in non-stacked indoor operations were on 5,475 hours per year or 15 hours per day. Because of these long operating hours, lighting can account for 50 to 80% of a facilities energy use in indoor operations and 30% of energy use in greenhouses. Because sales of both recreational and medical marijuana are becoming legal across the country, it is critical to ensure these facilities are as efficient as possible.
Because of the large opportunity for energy savings, the 2021 IECC has already adopted requirements for lighting in these applications using the efficiency metric of µmol/J (micromoles per Joule) which was developed in collaboration with the American Society of Agricultural and Biological Engineers to measure the efficacy of lighting used for plant growth. A double-ended High Pressure Sodium (HPS) luminaire can meet the existing 2021 IECC standard of1.6 µmol/J.The proposed requirement increases the efficacy level required to 1.9 µmol/J. This new efficacy standard does not require a technology shift within indoor horticulture because slightly more efficient double-ended HPS lamps that meet the existing standard can also meet the proposed standard. Because a technology shift is not required, the additional energy savings from increasing the standard from 1.6 µmol/J to 1.9 µmol/J for indoor operations is very cost-effective. This proposed amendment also institutes a lower efficacy requirement of 1.7 µmol/J for greenhouses due to lower operating hours and thus longer payback periods in these applications.

This amendment also introduces requirements for lighting controls that are able to turn off the luminaire at specific times during the day and a lighting control requirement for greenhouses to ensure lights are off when sufficient daylight is available. Finally, the amendment clarifies these requirements by introducing horticultural lighting and photosynthetic photon efficacy as new definitions and by amending the definition for greenhouse.

These requirements are consistent with proposed Addendum ar-2019 recently released for public review to ASHRAE Standard 90.1 and with code requirements proposed for inclusion in Section 120.6(h)2 of California's Title 24-2022. The Technical Advisory Groups in Minnesota, Washington State, and Washington D.C. are also recommending these efficacy requirements as amendments to their local commercial energy codes.

Cost Impact: The code change proposal will increase the cost of construction.
This proposal will result in no additional cost for growers using greenhouses because there is little to no cost difference between luminaires meeting the current 2021 IECC requirement of 1.6 µmol/J and the proposed requirement of 1.7 µmol/J and because lighting control requirements are already common practice for these applications. For indoor grow operations, the cost of purchasing a luminaire that meets a 1.9 µmol/J requirement vs a 1.6 µmol/J would result in increased costs of approximately $13/square foot. Assuming an electricity rate of 11.09 cents/kWh, annual energy cost savings from this code proposal is approximately $4.55/square foot resulting in a three-year simple payback period.

Bibliography: *Energy Savings Potential of SSL in Horticultural Applications*. U.S. Department of Energy, Dec. 2017, https://www.energy.gov/sites/prod/files/2017/12/f46/ssl_horticulture_dec2017.pdf.
Schimelpfenig, Gretchen. *Energy Efficiency for Massachusetts Marijuana Cultivators*, Resource Innovation Institute, Sept. 2020, resourceinnovationinstitute.wildapricot.org/RII-REPORTS/.

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Proposed Addendum ar to Standard 90.1-2019, Energy Standard for Buildings Except Low-Rise Residential Buildings

, ASHRAE, Aug. 2021, http://osr.ashrae.org/Online-Comment-Database/ShowDoc2/Table/DocumentAttachments/FileName/3689-90.1(2019)ar%20PPR1%20Draft.pdf/download/false.

Morlino, Lauren, Emerging Technologies & Services Manager at Vermont Energy Investment Corporation . Re: Cost Information for VT Luminaires, 21 June 2021.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: Cost effective increase in energy efficiency.

Proposal # 192

CEPI-187-21

Proponents: Jack Bailey, representing INTERNATIONAL ASSOCIATION OF LIGHTING DESIGNERS (jbailey@oneluxstudio.com)

2021 International Energy Conservation Code

Revise as follows:

C405.5.1 Total connected exterior building exterior lighting power. The total exterior connected lighting power shall be the total maximum rated wattage of all lighting that is powered through the energy service for the building.

Exception: Lighting used for the following applications shall not be included.

1. Lighting *approved* because of safety considerations.
2. Emergency lighting that is automatically off during normal operations~~automatically off during normal business operation~~.
3. Exit signs.
4. Specialized signal, directional and marker lighting associated with transportation.
5. Advertising signage or directional signage.
6. Integral to equipment or instrumentation and installed by its manufacturer.
7. Theatrical purposes, including performance, stage, film production and video production.
8. Athletic playing areas.
9. Temporary lighting.
10. Industrial production, material handling, transportation sites and associated storage areas.
11. Theme elements in theme/amusement parks.
12. Used to highlight features of art, public monuments and the national flag.
13. Lighting for water features and swimming pools.
14. Lighting controlled from within dwelling units, where the lighting complies with Section R404.1.

C405.3.1 Total connected interior lighting power. The total connected interior lighting power shall be determined in accordance with Equation 4-10.

$$TCLP = [LVL + BLL + LED + TRK + \text{Other}]$$ **(Equation 4-10)**

where:

TCLP = Total connected lighting power (watts).

LVL = For luminaires with lamps connected directly to building power, such as line voltage lamps, the rated wattage of the lamp.

BLL = For luminaires incorporating a ballast or transformer, the rated input wattage of the ballast or transformer when operating that lamp.

LED = For light-emitting diode luminaires with either integral or remote drivers, the rated wattage of the luminaire.

TRK = For lighting track, cable conductor, rail conductor, and plug-in busway systems that allow the addition and relocation of luminaires without rewiring, the wattage shall be one of the following:

1. The specified wattage of the luminaires, but not less than 8 W per linear foot (25 W/lin m).
2. The wattage limit of the permanent current-limiting devices protecting the system.
3. The wattage limit of the transformer supplying the system.

Other = The wattage of all other luminaires and lighting sources not covered previously and associated with interior lighting verified by data supplied by the manufacturer or other *approved* sources.

The connected power associated with the following lighting equipment and applications is not included in calculating total connected lighting power.

1. Television broadcast lighting for playing areas in sports arenas.
2. Emergency lighting that is automatically off during normal operations~~automatically off during normal building operation~~.

3. Lighting in spaces specifically designed for use by occupants with special lighting needs, including those with visual impairment and other medical and age-related issues.
4. Casino gaming areas.
5. Mirror lighting in dressing rooms.
6. Task lighting for medical and dental purposes that is in addition to general lighting.
7. Display lighting for exhibits in galleries, museums and monuments that is in addition to general lighting.
8. Lighting for theatrical purposes, including performance, stage, film production and video production.
9. Lighting for photographic processes.
10. Lighting integral to equipment or instrumentation and installed by the manufacturer.
11. Task lighting for plant growth or maintenance.
12. Advertising signage or directional signage.
13. Lighting for food warming.
14. Lighting equipment that is for sale.
15. Lighting demonstration equipment in lighting education facilities.
16. Lighting approved because of safety considerations.
17. Lighting in retail display windows, provided that the display area is enclosed by ceiling-height partitions.
18. Furniture-mounted supplemental task lighting that is controlled by automatic shutoff.
19. Exit signs.
20. Antimicrobial lighting used for the sole purpose of disinfecting a space.

C405.2 Lighting controls. Lighting systems shall be provided with controls that comply with one of the following.

1. Lighting controls as specified in Sections C405.2.1 through C405.2.8.
2. Luminaire level lighting controls (LLLC) and lighting controls as specified in Sections C405.2.1, C405.2.5 and C405.2.6. The LLLC luminaire shall be independently capable of:

   2.1. Monitoring occupant activity to brighten or dim lighting when occupied or unoccupied, respectively.

   2.2. Monitoring ambient light, both electric light and daylight, and brighten or dim artificial light to maintain desired light level.

   2.3. For each control strategy, configuration and reconfiguration of performance parameters including; bright and dim setpoints, timeouts, dimming fade rates, sensor sensitivity adjustments, and wireless zoning configurations.

Exceptions: Lighting controls are not required for the following:

1. Areas designated as security or emergency areas that are required to be continuously lighted.
2. Interior exit stairways, interior exit ramps and exit passageways.
3. Emergency ~~egress~~ lighting that is ~~normally~~ automatically off during normal operations.

Reason: All three of these sections are trying to describe the same lighting, but each section uses different terminology.
The language proposed here clarifies that this is emergency lighting, not egress lighting, and leaves out the language about "business operation".

Per IBC, emergency lighting can be off at all times when there is no emergency, but egress lighting must be on whenever the space it is serving is occupied.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The proposed change is entirely editorial.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: provides clarification

CEPI-188-21

Proponents: Jack Bailey, representing INTERNATIONAL ASSOCIATION OF LIGHTING DESIGNERS (jbailey@oneluxstudio.com)

2021 International Energy Conservation Code

Revise as follows:

C405.5.1 Total connected exterior building exterior lighting power. The total exterior connected lighting power shall be the total maximum rated wattage of all lighting that is powered through the energy service for the building.

Exception: Lighting used for the following applications shall not be included.

1. Lighting *approved* because of safety considerations.
2. Emergency lighting automatically off during normal business operation.
3. Exit signs.
4. Specialized signal, directional and marker lighting associated with transportation.
5. Advertising signage or directional signage.
6. Integral to equipment or instrumentation and installed by its manufacturer.
7. Theatrical purposes, including performance, stage, film production and video production.
8. Athletic playing areas.
9. Temporary lighting.
10. Industrial production, material handling, transportation sites and associated storage areas.
11. Theme elements in theme/amusement parks.
12. Used to highlight features of art, public monuments and the national flag.
13. Lighting for water features and swimming pools.
14. Lighting controlled from within sleeping units and dwelling units~~, where the lighting complies with Section R404.1.~~

Reason: This reference to R404.1 made sense in the 2018 code, where the commercial section referred to R404.1 for efficiency requirements in dwelling units. But now that the commercial chapter has its' own efficiency requirements for dwelling units, this requirement to also comply with R404.1 is confusing and irrelevant.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The change is editorial in nature.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: For consistency with previously approved proposal CEPI-135-21

Proposal # 386

CEPI-189-21

Proponents: Jeremy Williams, representing U.S. Department of Energy (jeremy.williams@ee.doe.gov)

2021 International Energy Conservation Code

Revise as follows:

TABLE C405.5.2(2) LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS

LIGHTING ZONES				
Zone 1	Zone 2	Zone 3	Zone 4	
Base Site Allowance	~~350~~ 160 W	~~400~~ 280 W	~~500~~ 400 W	~~900~~ 560 W
Uncovered Parking Areas				
Parking areas and drives	~~0.03~~ 0.015 W/ft^2	~~0.04~~ 0.026 W/ft^2	~~0.06~~ 0.037 W/ft^2	~~0.08~~ 0.052 W/ft^2
Building Grounds				
Walkways and ramps less ~~than 10 feet wide~~	0.50 W/linear foot	0.50 W/linear foot	~~0.60~~ 0.55 W/linear foot	~~0.70~~ 0.60 W/linear foot
~~Walkways and ramps 10 feet wide or greater,~~ plaza areas~~, special feature areas~~	~~0.10~~ 0.028 W/ft^2	~~0.10~~ 0.049 W/ft^2	~~0.11~~ 0.070 W/ft^2	~~0.14~~ 0.098 W/ft^2
Roof terraces and special features	0.04 W/ft^2	0.07 W/ft^2	0.10 W/ft^2	0.14 W/ft^2
Dining areas	~~0.65~~ 0.156 W/ft^2	~~0.65~~ 0.273 W/ft^2	~~0.75~~ 0.390 W/ft^2	~~0.95~~ 0.546 W/ft^2
Stairways	~~0.60 W/ft^2~~ Exempt	~~0.70 W/ft^2~~ Exempt	~~0.70 W/ft^2~~ Exempt	~~0.70 W/ft^2~~ Exempt
Pedestrian tunnels	~~0.12~~ 0.063 W/ft^2	~~0.12~~ 0.110 W/ft^2	~~0.14~~ 0.157 W/ft^2	~~0.21~~ 0.220 W/ft^2
Landscaping	~~0.03~~ 0.014 W/ft^2	~~0.04~~ 0.025 W/ft^2	~~0.04~~ 0.036 W/ft^2	~~0.04~~ 0.050 W/ft^2
Building Entrances and Exits				
Pedestrian and vehicular entrances and exits	~~14~~ 5.6 W/linear foot of opening	~~14~~ 9.8 W/linear foot of opening	~~21~~ 14 W/linear foot of opening	~~21~~ 19.6 W/linear foot of opening
Entry canopies	~~0.20~~ 0.072 W/ft^2	~~0.25~~ 0.126 W/ft^2	~~0.40~~ 0.180 W/ft^2	~~0.40~~ 0.252 W/ft^2
Loading docks	~~0.35~~ 0.104 W/ft^2	~~0.35~~ 0.182 W/ft^2	~~0.35~~ 0.260 W/ft^2	~~0.35~~ 0.364 W/ft^2
Sales Canopies				
Free-standing and attached	~~0.40~~ 0.20 W/ft^2	~~0.40~~ 0.35 W/ft^2	~~0.60~~ 0.50 W/ft^2	0.70 W/ft^2
Outdoor Sales				
Open areas (including vehicle sales lots)	~~0.20~~ 0.072 W/ft^2	~~0.20~~ 0.126 W/ft^2	~~0.35~~ 0.180 W/ft^2	~~0.50~~ 0.252 W/ft^2
Street frontage for vehicle sales lots in addition to “open area” allowance	No allowance	7.2 W/linear foot	~~7~~ 10.3 W/linear foot	~~21~~ 14.4 W/linear foot

~~For SI: 1 foot = 304.8 mm, 1 watt per square foot = W/0.0929 m^2.~~

~~W = watts.~~ For SI: 1 foot = 304.8 mm, 1 watt per square foot = 10.76 W/m^2. W = watts.

TABLE C405.5.2(3) INDIVIDUAL LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS

LIGHTING ZONES				
Zone 1	**Zone 2**	**Zone 3**	**Zone 4**	
Building facades	No allowance	0.075 W/ft^2 of gross above-grade wall area	0.113 W/ft^2 of gross above-grade wall area	0.15 W/ft^2 of gross above-grade wall area
Automated teller machines (ATM) and night depositories	~~135~~ 90 W per location plus ~~45~~ 35 W per additional ATM per location			
Uncovered entrances and gatehouse inspection stations at guarded facilities	~~0.50~~ 0.144 W/ft^2 of area	~~0.50~~ 0.252 W/ft^2 of area	~~0.50~~ 0.360 W/ft^2 of area	~~0.50~~ 0.504 W/ft^2 of area
Uncovered loading areas for law enforcement, fire, ambulance and other emergency service vehicles	~~0.35~~ 0.104 W/ft^2 of area	~~0.35~~ 0.182 W/ft^2 of area	~~0.35~~ 0.260 W/ft^2 of area	~~0.35~~ 0.364 W/ft^2 of area
Drive-up windows and doors	~~200~~ 53 W per drive through	~~200~~ 92W per drive through	~~200~~ 132 W per drive through	~~200~~ 185 W per drive through
Parking near 24-hour retail entrances.	~~400~~ 80 W per main entry	~~400~~ 140 W per main entry	~~400~~ 200 W per main entry	~~400~~ 280 W per main entry

For SI: For SI: 1 watt per square foot = 10.76 W/~~0.0929~~ m^2.

W = watts.

Reason: Many elements in exterior lighting have changed since this section was last modified in the 2018 version. In 2018, lighting fixture device efficacy ranged ranged 80 - 100 lm/W. Since 2018, exterior lighting device efficacy has increased by 20 - 40%. Many exterior lighting devices now exceed 120 lm/W. It is very hard to purchase equipment with efficacy values that low. As a result, the lighting power density values can be reduced in response to the current technology available.
Design practices and research also changed since 2018. In 2018, lighting knowledge about LEDs was still somewhat unknown. At the time, practices were assuming significant degradation assumption in the calculations. Now, industry assumes a degradation of about 15%. This also allows for a reduction in lighting power density through newer guidance on design calculations.

In 2019, the Illuminating Engineering Society (IES) conducted research post 2018 related to exterior lighting. This proposal reflects the revised guidance developed from this new IES research. As a result of the new lighting guidance, certain levels that were previously recommended were now no longer recommended. This proposal aligns with new research from the IES and allows for lower lighting power density values.

Finally, this version first addresses lighting zones. The concept of a lighting zone is that less light is needed because of the adaption state of the eye. Lighting zone 1 is national parks, forest land, rural areas, etc. Lighting Zone 4 is heavy commercial districts like Times Square and the Las Vegas strip. More light is needed in lighting zone 4 than 1 to account for the ambient brightness of the environment. These changes provide values per lighting zone. For example, the previous version had the same value for drive-up windows independent of lighting zone. However, if following good lighting practices, less light (and thus less power) should be provided in lighting zone 1 than 4. This proposed change makes sure that the values ascend based on lighting zone.

This proposal also reflects changes in both lighting technology and practices that allow for lower lighting power density values. The proposed values are similar to those considered in ANSI/ASHRAE/IES Standard 90.1-2022 as well as Washington State Energy Code.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal is similar to an ANSI/ASHRAE/IES Standard 90.1 addendum. The 90.1 addendum met the Std. 90.1 scalar ratio. Exterior lighting fixture prices were surveyed. Prices were supplied by a third party and have remained relatively flat related over the last 5 years independent of the efficacy of the fixtures. Prices have remained flat while efficacy improved. Therefore, costs will not increase in response to this proposal.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Improves exterior lighting efficiency based on LED efficiency improvements and aligns with ASHRAE/IES Standard 90.1.

CEPI-192-21

Proponents: Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Revise as follows:

C405.7 Electrical transformers. Low-voltage dry-type distribution electric transformers shall meet the minimum efficiency requirements of Table C405.7 as tested and rated in accordance with the test procedure listed in DOE 10 CFR 431. The efficiency shall be verified through certification under an approved certification program or, where a certification program does not exist, the equipment efficiency ratings shall be supported by data furnished by the transformer manufacturer.

Exceptions: The following transformers are exempt in accordance with the DOE definition of Distribution Transformers found in 10 CFR 431.192:

~~1.~~ ~~Transformers that meet the *Energy Policy Act of 2005* exclusions based on the DOE 10 CFR 431 definition of special purpose applications.~~

~~2.~~ ~~Transformers that meet the *Energy Policy Act of 2005* exclusions that are not to be used in general purpose applications based on information provided in DOE 10 CFR 431.~~

~~3.~~ 1. Transformers ~~that meet the *Energy Policy Act of 2005* exclusions with multiple voltage taps where the highest tap is not less than~~ with tap range of 20 percent or more ~~than the lowest tap~~.

~~4.~~ 2. Drive (isolation) transformers.

~~5.~~ 3. Rectifier transformers.

~~6.~~ 4. Auto-transformers.

~~7.~~ 5. Uninterruptible power supply~~system~~ transformers.

~~8.~~ 6. Special i~~I~~mpedance transformers.

~~9.~~ 7. Regulating transformers.

~~10.~~ 8. Sealed ~~and nonventilating~~ transformers.

~~11.~~ 9. Machine- tool (control) transformers.

~~12.~~ 10. Welding transformers.

~~13.~~ 11. Grounding transformers.

~~14.~~ 12. Testing transformers.

13. Nonventilated transformers.

TABLE C405.7 MINIMUM NOMINAL EFFICIENCY LEVELS FOR DOE 10 CFR 431 LOW-VOLTAGE DRY-TYPE DISTRIBUTION TRANSFORMERS

Portions of table not shown remain unchanged.

SINGLE-PHASE TRANSFORMERS[a]		THREE-PHASE TRANSFORMERS[a]	
kVA~~[a]~~[b]	Efficiency (%)~~[b]~~[c]	kVA~~[a]~~[b]	Efficiency (%)~~[b]~~[c]
15	97.70	15	97.89
25	98.00	30	98.23
37.5	98.20	45	98.40
50	98.30	75	98.60
75	98.50	112.5	98.74
100	98.60	150	98.83
167	98.70	225	98.94
250	98.80	300	99.02
333	98.90	500	99.14
—	—	750	99.23
—	—	1000	99.28

a. A low-voltage dry-type distribution transformer with a kVA rating not listed in the table shall have its minimum efficiency level determined by linear interpolation of the kVA and efficiency values listed in the table immediately above and below its kVA rating. Extrapolation shall not be used below the minimum values or above the maximum values shown for single-phase transformers and three-phase transformers.

~~a.~~ b. kiloVolt-Amp rating.

~~b.~~ c. Nominal efficiencies shall be established in accordance with the DOE 10 CFR 431 test procedure for low-voltage dry-type transformers.

Reason: This section shows minimum efficiency requirements for low-voltage dry-type transformers that are used in commercial buildings. Federal efficiency standards were updated in 2016, and the revised values were incorporated into the Table.
However, in the federal requirements, there is language that provides information on the efficiency levels for transformers with kVA ratings that are not shown in the table. See the following web site links for the language: https://www.govinfo.gov/content/pkg/CFR-2016-title10-vol3/pdf/CFR-2016-title10-vol3-part431-subpartK.pdf Section 431.196, file page 4 of 18, document page 716

https://www.ecfr.gov/cgi-bin/text-idx?node=pt10.3.431&rgn=div5#se10.3.431_1196

This addendum updates the table to include this language in a footnote, along with language that is needed to show that there are no requirements for transformers below minimum kVA ratings or above maximum kVA ratings shown in the table.

As an example, for a single-phase dry-type transformer, the minimum efficiency requirement for a 15 kVA unit is 97.7% and the minimum efficiency requirement for a 25 kVA unit is 98.0%. If someone purchased a 20 kVA unit, then the minimum efficiency required for that transformer, using linear interpolation, would be 97.85%.

This addendum also updates the language in several places in section 8.4.4 to reference the Code of Federal Regulations (CFR) rather than the Energy Policy Act of 2005 and to align the list of exceptions to distribution transformers with the current regulatory language.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This is just an update to match the existing table of US federal minimum efficiency requirements that have been in place since 2016. It does not change any efficiency requirements, and therefore has no impact on construction costs.

Bibliography: ANSI/ASHRAE/IES Standard 90.1-2019, Energy Standard for Buildings Except Low-Rise Residential Buildings, Addendum ae.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: This will update the language for transformers to align with ASHRAE 90.1 and includes a footnote to clarify efficiency requirements for other transformers.

CEPI-193-21

Proponents: Jeremy Williams, representing U.S. Department of Energy (jeremy.williams@ee.doe.gov)

2021 International Energy Conservation Code

Delete without substitution:

~~SECTION C406~~
~~ADDITIONAL EFFICIENCY REQUIREMENTS~~

Add new text as follows:

SECTION 406
ADDITIONAL EFFICIENCY, RENEWABLE, and LOAD MANAGEMENT REQUIREMENTS

C406.1 Compliance. Buildings shall comply as follows:

1. *Buildings* with greater than 2000 square feet (190 m^2) of floor area shall comply with Section C406.1.1.
2. *Buildings* with greater than 5000 square feet (465 m^2) of *conditioned floor area* shall comply with Sections C406.1.1 and C406.1.2.
3. Build-out construction greater than 1000 square feet (93 m^2) of *conditioned floor area* that does not have final lighting or final HVAC systems installed under a prior building permit shall comply with Section C406.1.3.

Exception: Core and shell *buildings* where no less than 20 percent of the *net floor area* is without final lighting or final HVAC that comply with all of the following:

1. *Buildings* with greater than 5000 (465 m^2) of *conditioned floor area* shall comply with Section C406.1.2.
2. Portions of the *building* where the *net floor area* is without final lighting or final HVAC shall comply with Section C406.1.3
3. Portions of the *building* where the *net floor area* has final lighting and final HVAC systems shall comply with C406.1.1.

C406.1.1 Additional energy efficiency credit requirements. *Buildings* shall comply with measures from C406.2 to achieve not less than the number of required efficiency credits from Table C406.1.1 based on building occupancy group and climate zone.
Where a project contains multiple occupancies, credits in Table C406.1.1 from each building occupancy shall be weighted by the gross floor area to determine the weighted average project energy credits required. Accessory occupancies shall be included with the primary occupancy group for purposes of Section C406.

Exceptions:

1. Unconditioned parking garages that achieve 50% of the credits required for use groups S-1 and S-2 in Table C406.1.1.
2. Portions of buildings devoted to manufacturing or industrial use.

Table C406.1.1 Energy Credit Requirements by Building Occupancy Group

Building Occupancy Group	**Climate Zone**																		
	0A	**0B**	**1A**	**1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
R-2, R-4, and I-1	65	66	67	77	80	86	80	81	90	86	90	90	86	90	90	79	89	80	78
I-2	43	42	38	37	36	38	32	32	30	36	36	35	43	43	44	46	47	50	53
R-1	63	62	66	65	70	71	77	80	84	81	83	88	85	86	90	83	87	87	85
B	62	62	64	66	66	65	64	64	68	70	72	74	71	73	77	71	74	74	71
A-2	70	70	72	72	75	75	70	73	82	69	74	78	67	72	78	60	67	57	51
M	80	79	83	79	81	84	67	74	87	80	66	65	79	62	50	75	67	75	58
E	56	57	55	58	58	57	59	62	59	61	66	62	64	67	67	65	67	63	58
S-1 and S-2	61	60	61	60	58	57	44	54	62	85	68	75	90	82	72	90	89	90	90
All Other	31	31	31	32	32	33	30	32	36	35	35	35	37	36	36	36	37	36	34

C406.1.1.1 Building Core/Shell and Initial Build-Out Construction. Where separate permits are issued for core and shell *buildings* and build-out construction, compliance shall be in accordance with the following requirements.

1. Core and shell buildings or portions of *buildings* shall comply with one of the following:

   1.1 Where the permit includes a central HVAC system or service water heating system with chillers, heat pumps, boilers, service water heating equipment, or loop pumping systems with heat rejection, the project shall achieve not less than 50 percent of the energy credits required in Table C406.1.1 in accordance with Section C406.2.

   1.2 Alternatively, the project shall achieve not less than 33 percent of the energy credits required in Table C406.1.1.

2. For core and shell *buildings* or portions of *buildings* the energy credits achieved shall be subject to the following adjustments:

   2.1 Lighting measure credits shall be determined only for areas with final lighting installed.

   2.2 Where HVAC or service water heating systems are designed to serve the entire building, full HVAC or service water heating measure credits shall be achieved.

   2.3 Where HVAC or service water heating systems are designed to serve individual areas, HVAC or service water heating measure credits achieved shall be reduced in proportion to the floor area with final HVAC systems or final service water heating systems installed.

3. Build-out construction shall be deemed to comply with Section C406.1 where either:

   3.1 Where heating and cooling generation are provided by a previously installed central system, the energy credits achieved in accordance with Section C406.2 under the build-out project are not less than 33 percent of the credits required in Table C406.1.1.

   3.2 Where heating and cooling generation are provided by an HVAC system installed in the build out, the energy credits achieved in accordance with Section C406.2 under the build-out project are not less than 50 percent of the credits required in Table C406.1.1

   3.3 Where the core and shell building was approved in accordance with C407 under 2021 IECC or later.

C406.1.2 Additional renewable and load management credit requirements. Buildings shall comply with measures from C406.3 to achieve not less than the number of required renewable and load management credits from Table C406.1.2 based on building occupancy group and climate zone. Where a project contains multiple occupancies, credits in Table C406.1.2 from each building occupancy shall be weighted by the gross floor area to determine the weighted average project energy credits required. Accessory occupancies shall be included with the primary occupancy group for purposes of Section C406.

Table C406.1.2 Renewable and Load Management Credit Requirements by Building Occupancy Group

Building Occupancy Group	**Climate Zone**																		
	0A	**0B**	**1A**	**1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
R-2, R-4, and I-1	64	59	70	69	73	89	72	90	90	63	90	70	51	75	66	48	58	50	42
I-2	31	32	33	32	33	36	31	40	34	32	43	32	29	37	33	34	33	27	23
R-1	41	40	48	44	48	58	54	61	63	50	61	47	42	55	50	41	51	40	32
B	63	64	74	75	78	89	83	90	90	77	90	86	68	90	83	72	81	68	58
A-2	12	12	13	13	12	17	13	17	17	12	17	13	12	12	12	12	12	8	7
M	71	70	84	84	90	90	90	90	90	81	90	90	77	90	90	76	84	71	58
E	49	55	64	61	69	83	73	90	90	67	90	75	61	86	74	66	76	60	47
S-1 and S-2	90	90	90	90	90	90	90	90	90	90	90	90	70	90	90	61	85	61	53
All Other	56	55	66	63	69	80	69	87	88	59	86	68	51	72	66	51	60	48	40

C406.1.3 Substantial Alterations to Existing Buildings. The *building envelope*, *equipment*, and *systems* in *alterations* to *buildings* exceeding 5000 square feet (46.5 m^2) of *gross conditioned floor area* shall comply with the requirements of Section C406.1.1 and C406.1.2 where the alteration includes replacement of two or more of the following:

1. HVAC unitary systems or HVAC central heating or cooling equipment serving the alteration area, not including ductwork or *piping*
2. 80% or more of the lighting fixtures in the *alteration* area
3. Building envelope components in the *alteration* area including new exterior cladding, fenestration, or insulation.

C406.1.4 Energy Credits Achieved. Energy credits achieved for the project shall be the sum of measure energy credits for individual measures included in the project. Credits are available for the measures listed in Section C406.2. Base energy credits are shown in Tables C406.1.4(1) through C406.1.4(9) based on building occupancies and climate zones. Measure energy credits achieved shall be determined in one of three ways, depending on the measure:

1. The measure energy credit shall be the base energy credit for the measure where no adjustment factor or formula is shown in the measure description in Section C406.2.
2. The measure energy credit shall be the base energy credit for the measure adjusted by a factor or formula as stated in the measure description in Section C406.2. Where adjustments are applied, each measure energy credit shall be rounded to the nearest whole number.
3. The measure energy credit shall be by direct formula as stated in the measure description in Section C406.2, where each individual measure credit shall be rounded to the nearest whole number.

TABLE C406.2(1) Base Energy Credits for Group R-2, R-4, and I-1 Occupancies[a]

ID	Energy Credit Measure	Section	Climate Zone																		
0A			0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8	
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	8	13	7	11	6	8	9	6	1	24	8	9	30	15	5	32	28	31	36
E03	Envelope leak reduction	C406.2.1.3	15	10	12	8	6	16	13	5	1	47	7	9	65	16	1	73	43	52	26
E04	Add Roof Insulation	C406.2.1.4	1	1	1	1	1	1	4	3	1	5	3	4	6	5	1	7	7	6	8
E05	Add Wall Insulation	C406.2.1.5	10	10	6	8	5	6	8	4	1	8	3	4	11	7	1	14	12	13	13
E06	Improve Fenestration	C406.2.1.6	7	7	4	6	9	11	13	3	1	22	5	10	27	18	7	41	33	22	21
H01	HVAC Performance	C406.2.2.1	20	19	16	17	14	13	11	11	5	13	10	8	15	12	7	18	14	17	19
H02	Heating efficiency	C406.2.2.2	x	x	x	x	x	x	3	1	1	6	2	3	10	5	2	14	10	13	16
H03	Cooling efficiency	C406.2.2.3	7	6	4	4	3	3	1	1	1	1	1	1	1	1	x	x	x	x	x
H04	Residential HVAC control	C406.2.2.4	9	10	8	22	20	25	16	17	32	21	24	17	23	27	16	21	24	18	18
H05	DOAS/fan control	C406.2.2.5	32	31	27	28	23	23	28	21	12	42	24	24	56	36	19	73	54	70	79
W01	SHW preheat recovery	C406.2.3.1 a	61	63	74	74	85	88	101	100	121	103	109	122	102	111	130	93	106	99	96
W02	Heat pump water heater	C406.2.3.1 b	50	52	62	61	72	74	86	85	104	88	94	106	88	96	112	81	92	87	84
W03	Efficient gas water heater	C406.2.3.1 c	38	39	46	46	53	55	63	62	76	64	68	76	64	69	81	58	66	62	60
W04	SHW pipe insulation	C406.2.3.2	7	7	8	7	8	8	8	9	10	8	9	9	7	8	9	6	7	6	6
W05	Point of use water heaters	C406.2.3.3 a	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W06	Thermostatic bal. valves	C406.2.3.3 b	3	3	3	3	3	3	3	3	4	3	3	4	3	3	4	3	3	3	2
W07	SHW heat trace system	C406.2.3.3 c	12	12	13	13	14	15	15	15	18	14	15	16	13	14	16	11	13	11	10
W08	SHW submeters	C406.2.3.4	11	11	13	13	15	16	18	18	22	19	20	22	19	20	24	17	20	18	18
W09	SHW distribution sizing	C406.2.3.5	45	46	55	54	63	65	74	73	89	75	80	89	74	81	95	68	77	72	70
W10	Shower heat recovery	C406.2.3.6	15	16	19	19	22	23	26	26	32	27	29	32	27	29	34	25	28	27	26
P01	Energy monitoring	C406.2.4	3	3	2	3	2	2	2	2	2	2	2	2	2	2	2	3	2	2	3
L01	Lighting Performance	C406.2.5.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L02	Lighting dimming & tuning	C406.2.5.2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
L03	Increase occp. sensor	C406.2.5.3	3	3	4	4	4	4	3	4	3	2	3	2	1	2	2	1	1	1	1
L04	Increase daylight area	C406.2.5.4	5	5	5	5	5	5	4	4	4	4	4	3	3	4	3	2	3	3	2
L05	Residential light control	C406.2.5.5	8	8	9	9	9	9	8	8	10	6	8	7	4	6	8	3	5	4	3
L06	Light power reduction	C406.2.5.7	2	2	2	2	2	2	2	2	2	1	2	1	1	1	1	1	1	1	1
Q01	Efficient elevator	C406.2.7.1	4	4	4	4	5	5	5	5	5	4	5	5	4	4	5	4	4	4	3
Q02	Commercial kitchen equip.	C406.2.7.2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q03	Residential kitchen equip.	C406.2.7.3	15	15	17	16	17	18	17	18	20	16	17	18	15	16	18	13	15	13	12
Q04	Fault detection	C406.2.7.4	3	3	2	3	2	2	2	2	1	2	2	1	2	2	1	3	2	3	3

a. "x" indicates credit is not available for that measure.

Table C406.2(2) Base Energy Credits for Group I-2 Occupancies[a]

ID	Energy Credit Measure	Section	Climate Zone																		
0A			0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8	
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	6	11	6	11	7	9	6	6	2	3	3	3	4	3	7	5	5	17	3
E03	Envelope leak reduction	C406.2.1.3	5	3	4	3	5	8	8	3	2	6	2	2	7	3	1	9	7	19	5
E04	Add Roof Insulation	C406.2.1.4	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	2	1	2	3
E05	Add Wall Insulation	C406.2.1.5	1	3	1	3	2	2	9	4	1	4	1	1	3	1	1	3	3	3	3
E06	Improve Fenestration	C406.2.1.6	1	1	1	1	1	1	1	1	1	4	3	5	5	1	1	5	5	2	2
H01	HVAC Performance	C406.2.2.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
H02	Heating efficiency	C406.2.2.2	x	x	x	x	2	3	4	3	7	6	4	6	8	6	10	11	12	15	19
H03	Cooling efficiency	C406.2.2.3	6	6	4	4	3	3	2	2	1	1	1	1	1	1	1	x	x	x	x
H04	Residential HVAC control	C406.2.2.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
H05	DOAS/fan control	C406.2.2.5	41	41	40	40	42	36	42	37	39	49	40	46	56	46	61	65	68	82	93
W01	SHW preheat recovery	C406.2.3.1 a	4	4	4	4	5	5	5	5	6	6	6	6	6	6	6	6	5	5	5
W02	Heat pump water heater	C406.2.3.1 b	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3
W03	Efficient gas water heater	C406.2.3.1 c	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3
W04	SHW pipe insulation	C406.2.3.2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
W05	Point of use water heaters	C406.2.3.3 a	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W06	Thermostatic bal. valves	C406.2.3.3 b	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
W07	SHW heat trace system	C406.2.3.3 c	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1
W08	SHW submeters	C406.2.3.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W09	SHW flow reduction	C406.2.3.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W10	Shower heat recovery	C406.2.3.6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
P01	Energy monitoring	C406.2.4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
L01	Lighting Performance	C406.2.5.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L02	Lighting dimming & tuning	C406.2.5.2	5	5	5	5	5	6	5	6	6	5	6	6	5	5	5	4	4	3	2
L03	Increase occp. sensor	C406.2.5.3	5	5	5	5	5	5	5	5	6	5	5	6	5	5	5	4	4	3	2
L04	Increase daylight area	C406.2.5.4	7	7	7	7	7	7	7	7	8	6	6	6	6	6	5	5	5	5	4
L05	Residential light control	C406.2.5.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L06	Light power reduction	C406.2.5.7	7	7	7	7	7	7	7	7	9	7	7	8	6	7	7	5	5	4	3
Q01	Efficient elevator	C406.2.7.1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1
Q02	Commercial kitchen equip.	C406.2.7.2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q03	Residential kitchen equip.	C406.2.7.3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q04	Fault detection	C406.2.7.4	3	3	3	3	3	3	3	3	2	3	3	2	3	3	3	3	3	4	4

a. "x" indicates credit is not available for that measure.

Table C406.2(3) Base Energy Credits for Group R-1 Occupancies[a]

ID	Energy Credit Measure	Section	Climate Zone																		
0A			0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8	
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	4	7	4	7	3	4	7	2	1	7	2	3	10	6	4	12	9	19	11
E03	Envelope leakage reduction	C406.2.1.3	5	3	4	2	2	2	5	1	1	8	1	2	13	4	1	18	9	18	7
E04	Add Roof Insulation	C406.2.1.4	2	2	2	2	2	2	3	2	1	3	1	2	3	2	2	3	3	2	3
E05	Add Wall Insulation	C406.2.1.5	13	14	8	11	4	4	7	4	1	5	2	4	6	4	3	9	7	10	8
E06	Improve Fenestration	C406.2.1.6	5	5	4	5	7	7	8	2	1	8	2	4	10	5	1	21	17	10	9
H01	HVAC Performance	C406.2.2.1	21	20	17	18	16	13	12	12	11	11	11	8	11	11	8	13	11	14	16
H02	Heating efficiency	C406.2.2.2	x	x	x	x	x	x	1	1	6	2	1	1	3	2	2	6	4	8	11
H03	Cooling efficiency	C406.2.2.3	7	6	4	4	3	2	1	2	1	1	2	1	1	1	1	x	x	x	x
H04	Residential HVAC control	C406.2.2.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
H05	DOAS/fan control	C406.2.2.5	32	30	26	28	25	23	24	22	28	26	22	20	30	26	19	41	34	48	62
W01	SHW preheat recovery	C406.2.3.1 a	18	19	22	22	25	27	31	31	32	34	34	38	37	36	40	36	37	36	35
W02	Heat pump water heater	C406.2.3.1 b	14	15	18	17	20	22	25	25	27	29	29	32	31	31	34	30	32	31	30
W03	Efficient gas water heater	C406.2.3.1 c	11	12	14	14	16	17	19	19	20	21	21	24	23	23	25	22	23	23	22
W04	SHW pipe insulation	C406.2.3.2	3	3	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3
W05	Point of use water heaters	C406.2.3.3 a	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W06	Thermostatic bal. valves	C406.2.3.3 b	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	1	1
W07	SHW heat trace system	C406.2.3.3 c	5	6	6	6	6	7	7	7	7	7	7	8	7	7	8	7	7	6	6
W08	SHW submeters	C406.2.3.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W09	SHW flow reduction	C406.2.3.5	13	14	16	16	18	20	22	22	23	25	25	28	27	26	29	26	27	26	25
W10	Shower heat recovery	C406.2.3.6	4	5	5	5	6	7	8	8	8	9	9	10	10	9	10	9	10	10	9
P01	Energy monitoring	C406.2.4	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
L01	Lighting Performance	C406.2.5.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L02	Lighting dimming & tuning	C406.2.5.2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
L03	Increase occp. sensor	C406.2.5.3	3	3	3	3	3	3	3	3	4	2	3	3	2	2	3	2	2	1	1
L04	Increase daylight area	C406.2.5.4	4	5	5	4	5	5	4	4	5	4	4	4	3	4	3	3	3	3	2
L05	Residential light control	C406.2.5.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L06	Light power reduction	C406.2.5.7	1	1	2	2	2	2	2	2	2	1	2	2	1	1	2	1	1	1	1
Q01	Efficient elevator	C406.2.7.1	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	2	2	2	2
Q02	Commercial kitchen equip.	C406.2.7.2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q03	Residential kitchen equip.	C406.2.7.3	9	9	10	10	10	11	11	11	11	11	11	12	11	11	12	10	11	10	9
Q04	Fault detection	C406.2.7.4	3	3	3	3	2	2	2	2	2	2	2	1	2	2	1	2	2	2	2

a. "x" indicates credit is not available for that measure.

Table C406.2(4) Base Energy Credits for Group B Occupancies[a]

ID	Energy Credit Abbreviated Title	Section	Climate Zone																		
0A			0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8	
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	4	7	4	7	3	4	7	2	0	7	2	3	10	6	4	12	9	19	11
E03	Envelope leak reduction	C406.2.1.3	5	3	4	2	2	2	5	1	0	8	0	2	13	4	0	18	9	18	7
E04	Add Roof Insulation	C406.2.1.4	2	2	2	2	2	2	3	2	1	3	1	2	3	2	2	3	3	2	3
E05	Add Wall Insulation	C406.2.1.5	13	14	8	11	4	4	7	4	1	5	2	4	6	4	3	9	7	10	8
E06	Improve Fenestration	C406.2.1.6	5	5	4	5	7	7	8	2	1	8	2	4	10	5	1	21	17	10	9
H01	HVAC Performance	C406.2.2.1	22	22	19	20	17	17	15	15	11	15	15	11	16	15	11	19	17	18	20
H02	Heating efficiency	C406.2.2.2	x	x	x	x	x	x	1	1	1	3	2	2	5	4	3	9	7	8	12
H03	Cooling efficiency	C406.2.2.3	7	6	4	5	3	3	1	2	1	1	2	1	1	1	1	x	x	x	x
H04	Residential HVAC control	C406.2.2.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
H05	DOAS/fan control	C406.2.2.5	31	31	27	29	25	25	28	26	18	35	28	28	47	38	29	64	53	58	74
W01	SHW preheat recovery	C406.2.3.1 a	8	9	10	9	11	11	12	12	14	13	13	14	13	13	15	12	13	14	14
W02	Heat pump water heater	C406.2.3.1 b	3	3	3	3	4	4	5	4	5	5	5	6	5	5	6	5	5	6	6
W03	Efficient gas water heater	C406.2.3.1 c	5	5	6	6	7	7	8	7	8	8	8	9	8	8	9	8	8	9	8
W04	SHW pipe insulation	C406.2.3.2	3	3	4	4	4	4	4	4	5	4	4	5	4	4	5	4	4	4	4
W05	Point of use water heaters	C406.2.3.3 a	12	15	17	16	18	18	19	19	22	20	20	22	20	20	22	18	19	20	19
W06	Thermostatic bal. valves	C406.2.3.3 b	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
W07	SHW heat trace system	C406.2.3.3 c	4	4	4	4	5	5	5	5	6	5	5	6	5	5	6	5	5	5	5
W08	SHW submeters	C406.2.3.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W09	SHW flow reduction	C406.2.3.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W10	Shower heat recovery	C406.2.3.6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
P01	Energy monitoring	C406.2.4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
L01	Lighting Performance	C406.2.5.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L02	Lighting dimming & tuning	C406.2.5.2	5	5	6	6	6	6	6	6	7	6	6	6	5	5	6	4	5	3	2
L03	Increase occp. sensor	C406.2.5.3	5	6	6	6	6	6	6	6	8	6	6	6	5	5	6	4	5	4	3
L04	Increase daylight area	C406.2.5.4	7	7	8	8	8	8	8	8	9	6	7	7	6	6	6	6	6	7	5
L05	Residential light control	C406.2.5.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L06	Light power reduction	C406.2.5.7	7	7	8	8	8	8	8	8	9	7	8	8	6	7	8	5	6	5	3
Q01	Efficient elevator	C406.2.7.1	4	4	4	4	5	5	5	5	5	5	5	5	5	5	5	4	5	4	4
Q02	Commercial kitchen equip.	C406.2.7.2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q03	Residential kitchen equip.	C406.2.7.3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q04	Fault detection	C406.2.7.4	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	3	3	3	3

a. "x" indicates measure is not available for building occupancy in that climate zone

Table C406.2(5) Base Energy Credits for Group A-2 Occupancies[a]

Portions of table not shown remain unchanged.

ID	Energy Credit Measure	Section	Climate Zone																		
0A			0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8	
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	1	1	1	1	2	2	9	2	1	19	4	5	26	7	3	33	23	29	13
E03	Envelope leak reduction	C406.2.1.3	2	1	1	1	2	3	11	2	1	24	4	6	33	9	3	42	29	36	16
E04	Add Roof Insulation	C406.2.1.4	1	1	0	1	1	1	2	1	1	1	1	1	2	2	1	2	2	1	2
E05	Add Wall Insulation	C406.2.1.5	1	1	0	1	1	2	3	3	1	2	1	2	2	2	2	2	2	2	2
E06	Improve Fenestration	C406.2.1.6	1	1	1	1	1	1	2	2	1	1	2	2	3	2	1	4	4	1	1
H01	HVAC Performance	C406.2.2.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
H02	Heating efficiency	C406.2.2.2	x	x	x	x	1	1	6	3	3	10	6	8	15	11	10	19	15	23	28
H03	Cooling efficiency	C406.2.2.3	6	5	3	4	3	2	1	1	1	1	1	1	1	1	1	x	x	x	x
H04	Residential HVAC control	C406.2.2.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
H05	DOAS/fan control	C406.2.2.5	29	27	20	25	24	21	36	27	15	51	35	38	67	53	45	84	70	97	115
W01	SHW preheat recovery	C406.2.3.1 a	24	26	31	29	33	35	37	38	45	38	41	44	37	40	44	34	38	33	30
W02	Heat pump water heater	C406.2.3.1 b	15	16	19	18	21	23	25	25	29	26	28	30	26	28	31	25	27	24	22
W03	Efficient gas water heater	C406.2.3.1 c	15	16	19	18	21	22	23	24	28	24	25	27	23	25	27	21	24	21	18
W04	SHW pipe insulation	C406.2.3.2	2	3	3	3	3	3	3	3	3	3	3	3	2	3	3	2	2	2	2
W05	Point of use water heaters	C406.2.3.3 a	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W06	Thermostatic bal. valves	C406.2.3.3 b	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
W07	SHW heat trace system	C406.2.3.3 c	3	4	4	4	4	4	4	4	4	4	4	4	3	4	4	3	3	3	3
W08	SHW submeters	C406.2.3.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W09	SHW flow reduction	C406.2.3.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W10	Shower heat recovery	C406.2.3.6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
P01	Energy monitoring	C406.2.4	2	2	2	2	2	1	2	1	1	2	1	1	2	2	1	2	2	2	3
L01	Lighting Performance	C406.2.5.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L02	Lighting dimming & tuning	C406.2.5.2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1	1	1	1	0
L03	Increase occp. sensor	C406.2.5.3	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	0
L04	Increase daylight area	C406.2.5.4	3	3	3	3	3	3	2	2	2	2	2	2	1	2	1	1	1	1	1
L05	Residential light control	C406.2.5.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L06	Light power reduction	C406.2.5.7	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	1	2	1	1
Q01	Efficient elevator	C406.2.7.1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Q02	Commercial kitchen equip.	C406.2.7.2	24	26	28	27	28	29	27	29	32	26	28	29	24	26	28	21	23	19	17
Q03	Residential kitchen equip.	C406.2.7.3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q04	Fault detection	C406.2.7.4	3	2	2	2	2	2	2	2	1	2	2	1	2	2	2	3	2	3	4

a. "x" indicates measure is not available for that measure.

Table C406.2(6) Base Energy Credits for Group M Occupancies[a]

ID	Energy Credit Measure	Section	Climate Zone																		
0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8			
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	2	2	2	2	2	3	15	2	1	36	5	9	45	11	5	51	36	35	15
E03	Envelope leak reduction	C406.2.1.3	3	3	2	2	3	3	19	3	1	44	6	11	56	13	6	64	44	43	19
E04	Add Roof Insulation	C406.2.1.4	8	6	5	7	7	7	18	16	4	19	18	20	21	22	23	24	26	24	30
E05	Add Wall Insulation	C406.2.1.5	64	65	48	62	13	15	23	18	4	27	21	27	25	24	25	23	24	24	16
E06	Improve Fenestration	C406.2.1.6	4	3	3	3	4	4	6	5	2	7	5	7	7	5	7	10	10	3	3
H01	HVAC Performance	C406.2.2.1	31	30	26	28	23	21	23	20	14	27	21	22	29	25	23	32	28	30	33
H02	Heating efficiency	C406.2.2.2	x	x	x	x	x	x	10	3	1	19	8	15	26	17	18	29	24	27	31
H03	Cooling efficiency	C406.2.2.3	10	9	7	7	5	4	2	2	1	1	2	1	1	1	1	x	x	x	x
H04	Residential HVAC control	C406.2.2.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
H05	DOAS/fan control	C406.2.2.5	48	48	42	47	40	38	66	46	31	98	61	82	120	91	90	134	115	125	141
W01	SHW preheat recovery	C406.2.3.1 a	12	13	16	15	18	20	19	21	26	17	21	21	16	19	21	13	16	15	13
W02	Heat pump water heater	C406.2.3.1 b	3	3	4	3	4	5	5	5	7	5	6	6	4	5	6	4	4	4	4
W03	Efficient gas water heater	C406.2.3.1 c	6	7	8	8	10	10	10	11	14	9	11	11	8	10	11	7	8	8	7
W04	SHW pipe insulation	C406.2.3.2	3	3	4	4	4	4	4	4	5	4	4	5	4	4	5	4	4	4	4
W05	Point of use water heaters	C406.2.3.3 a	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W06	Thermostatic bal. valves	C406.2.3.3 b	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
W07	SHW heat trace system	C406.2.3.3 c	4	4	4	4	5	5	5	5	6	5	5	6	5	5	6	5	5	5	5
W08	SHW submeters	C406.2.3.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W09	SHW flow reduction	C406.2.3.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W10	Shower heat recovery	C406.2.3.6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
P01	Energy monitoring	C406.2.4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
L01	Lighting Performance	C406.2.5.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L02	Lighting dimming & tuning	C406.2.5.2	9	9	11	10	12	13	11	13	15	9	12	11	7	9	10	5	7	5	3
L03	Increase occp. sensor	C406.2.5.3	9	9	11	10	12	13	12	13	15	10	12	11	7	10	11	6	8	5	4
L04	Increase daylight area	C406.2.5.4	12	13	15	14	16	17	15	16	20	11	14	13	9	12	11	8	10	10	8
L05	Residential light control	C406.2.5.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L06	Light power reduction	C406.2.5.7	12	12	14	14	15	16	12	15	19	8	12	9	6	10	7	6	7	6	5
Q01	Efficient elevator	C406.2.7.1	3	3	4	3	4	4	4	4	5	3	4	4	3	4	4	3	3	3	2
Q02	Commercial kitchen equip.	C406.2.7.2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q03	Residential kitchen equip.	C406.2.7.3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q04	Fault detection	C406.2.7.4	3	2	2	2	2	2	2	2	1	2	2	1	2	2	2	3	2	3	4

a. "x" indicates credit is not available for that measure.

Table C406.2(7) Base Energy Credits for Group E Occupancies[a]

ID	Energy Credit Measure	Section	Climate Zone																		
0A			0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8	
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	9	22	8	20	9	12	5	11	3	4	9	2	3	6	0	4	3	4	3
E03	Envelope leakage reduction	C406.2.1.3	4	3	3	3	2	5	2	1	1	1	1	1	1	1	1	2	1	1	1
E04	Add Roof Insulation	C406.2.1.4	8	8	4	9	5	7	16	7	1	14	7	10	18	13	13	23	25	22	28
E05	Add Wall Insulation	C406.2.1.5	5	7	4	8	3	6	8	6	2	6	3	6	5	5	6	7	6	7	8
E06	Improve Fenestration	C406.2.1.6	8	10	6	9	11	11	15	9	1	16	8	15	22	18	19	33	29	19	18
H01	HVAC Performance	C406.2.2.1	30	28	25	26	23	21	20	18	15	19	18	17	19	20	15	23	20	25	29
H02	Heating efficiency	C406.2.2.2	x	x	x	x	x	x	4	3	3	5	5	10	9	11	6	15	11	18	26
H03	Cooling efficiency	C406.2.2.3	9	8	6	7	5	4	2	2	1	1	1	1	1	1	1	x	x	x	x
H04	Residential HVAC control	C406.2.2.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
H05	DOAS/fan control	C406.2.2.5	45	42	37	41	36	34	41	39	30	43	46	58	57	65	40	79	63	88	117
W01	SHW preheat recovery	C406.2.3.1 a	7	7	9	8	10	11	13	13	15	14	15	15	15	14	17	13	15	14	12
W02	Heat pump water heater	C406.2.3.1 b	4	4	6	5	7	7	9	9	10	10	10	11	11	10	12	10	11	10	9
W03	Efficient gas water heater	C406.2.3.1 c	4	4	6	5	6	7	8	8	9	9	9	10	9	9	11	8	10	9	7
W04	SHW pipe insulation	C406.2.3.2	3	3	4	4	4	4	4	5	6	5	5	6	5	5	7	4	5	4	4
W05	Point of use water heaters	C406.2.3.3 a	3	4	4	4	4	5	5	5	6	5	5	5	5	5	6	4	5	4	3
W06	Thermostatic bal. valves	C406.2.3.3 b	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	1	2	1	1
W07	SHW heat trace system	C406.2.3.3 c	4	4	4	4	5	5	5	6	7	6	6	7	6	6	8	5	7	5	5
W08	SHW submeters	C406.2.3.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W09	SHW distribution sizing	C406.2.3.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W10	Shower heat recovery	C406.2.3.6	2	2	2	2	3	3	3	3	4	3	3	4	3	3	4	3	3	3	3
P01	Energy monitoring	C406.2.4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4
L01	Lighting Performance	C406.2.5.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L02	Lighting dimming & tuning	C406.2.5.2	5	5	5	6	6	6	5	6	7	6	6	6	5	5	6	4	4	3	2
L03	Increase occp. sensor	C406.2.5.3	4	4	5	5	5	6	6	6	7	6	6	5	4	4	5	3	4	3	2
L04	Increase daylight area	C406.2.5.4	6	6	7	7	7	7	7	7	8	6	6	6	5	5	6	5	5	5	4
L05	Residential light control	C406.2.5.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L06	Light power reduction	C406.2.5.7	6	7	7	7	8	8	8	8	10	7	8	7	6	7	8	5	6	4	2
Q01	Efficient elevator	C406.2.7.1	3	4	4	4	4	5	5	5	5	5	5	5	5	5	5	4	5	4	3
Q02	Commercial kitchen equip.	C406.2.7.2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q03	Residential kitchen equip.	C406.2.7.3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q04	Fault detection	C406.2.7.4	4	4	4	4	3	3	3	3	2	3	3	3	3	3	2	4	3	4	4

a. "x" indicates measure is not available for that measure.

Table C406.2(8) Base Energy Credits for Group S-1 and S-2 Occupancies[a]

ID	Energy Credit Measure	Section	Climate Zone																		
0A			0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8	
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	1	2	1	1	1	2	25	2	1	62	11	14	74	21	6	75	57	56	21
E03	Envelope leak reduction	C406.2.1.3	2	2	1	2	1	3	31	3	1	77	14	17	92	25	8	95	71	69	26
E04	Add Roof Insulation	C406.2.1.4	13	12	10	11	10	11	18	17	7	14	19	18	14	20	22	10	14	12	19
E05	Add Wall Insulation	C406.2.1.5	19	23	13	21	7	10	15	12	3	10	12	13	9	12	12	7	9	9	8
E06	Improve Fenestration	C406.2.1.6	7	5	8	7	6	6	2	4	2	4	1	6	5	1	7	3	4	4	7
H01	HVAC Performance	C406.2.2.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
H02	Heating efficiency	C406.2.2.2	x	x	x	x	x	x	16	3	1	33	17	22	41	31	21	44	38	43	43
H03	Cooling efficiency	C406.2.2.3	7	7	4	5	3	3	1	1	1	1	1	1	1	1	1	x	x	x	x
H04	Residential HVAC control	C406.2.2.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
H05	DOAS/fan control	C406.2.2.5	35	37	26	33	24	27	77	35	14	141	83	96	168	132	90	180	157	177	178
W01	SHW preheat recovery	C406.2.3.1 a	8	7	9	8	10	10	8	10	12	5	8	8	4	6	9	3	4	3	3
W02	Heat pump water heater	C406.2.3.1 b	2	2	2	2	2	2	2	2	3	1	2	2	1	2	2	1	1	1	1
W03	Efficient gas water heater	C406.2.3.1 c	4	4	5	4	5	5	4	5	6	3	4	4	2	3	5	2	2	2	2
W04	SHW pipe insulation	C406.2.3.2	3	3	4	3	3	3	2	3	4	2	2	3	1	2	3	1	1	1	1
W05	Point of use water heaters	C406.2.3.3 a	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W06	Thermostatic bal. valves	C406.2.3.3 b	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
W07	SHW heat trace system	C406.2.3.3 c	4	4	4	3	4	4	3	4	5	2	3	3	2	2	4	2	2	2	2
W08	SHW submeters	C406.2.3.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W09	SHW flow reduction	C406.2.3.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W10	Shower heat recovery	C406.2.3.6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
P01	Energy monitoring	C406.2.4	5	5	6	6	6	6	5	6	6	5	5	5	5	5	6	5	5	5	5
L01	Lighting Performance	C406.2.5.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L02	Lighting dimming & tuning	C406.2.5.2	10	10	12	11	12	14	9	12	14	6	9	9	3	6	9	3	5	3	2
L03	Increase occp. sensor	C406.2.5.3	12	12	14	13	15	14	12	14	17	7	11	11	5	7	11	4	6	3	3
L04	Increase daylight area	C406.2.5.4	15	14	18	16	18	17	13	16	21	7	12	11	5	8	10	4	6	6	5
L05	Residential light control	C406.2.5.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L06	Light power reduction	C406.2.5.7	14	14	17	16	17	17	13	17	19	8	13	12	5	8	12	4	6	4	2
Q01	Efficient elevator	C406.2.7.1	15	14	18	16	18	18	15	18	21	9	14	14	7	10	14	5	7	5	5
Q02	Commercial kitchen equip.	C406.2.7.2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q03	Residential kitchen equip.	C406.2.7.3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q04	Fault detection	C406.2.7.4	3	3	2	3	2	2	3	2	1	5	3	3	5	4	3	6	5	6	6

a. "x" indicates measure is not available for building occupancy in that climate zone

Table C406.2(9) Base Energy Credits for Other Occupancies[a,b]

ID	Energy Credit Measure	Section	Climate Zone																		
0A			0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8	
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	5	9	5	8	5	6	10	5	2	20	6	6	25	10	4	28	22	26	16
E03	Envelope leakage reduction	C406.2.1.3	6	4	5	4	3	7	12	3	2	28	5	6	36	9	3	41	27	33	15
E04	Add Roof Insulation	C406.2.1.4	4	4	3	4	4	4	8	6	2	7	6	7	9	8	9	9	10	9	12
E05	Add Wall Insulation	C406.2.1.5	16	19	11	17	5	6	10	7	2	9	6	8	9	7	7	9	9	10	8
E06	Improve Fenestration	C406.2.1.6	4	4	3	4	5	6	6	4	1	9	4	7	11	7	6	16	14	8	8
H01	HVAC Performance	C406.2.2.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
H02	Heating efficiency	C406.2.2.2	x	x	x	x	x	x	6	2	3	11	6	8	15	11	9	18	15	19	23
H03	Cooling efficiency	C406.2.2.3	7	7	5	5	4	3	1	2	1	x	x	x	x	x	x	x	x	x	x
H04	Residential HVAC control	C406.2.2.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
H05	DOAS/fan control	C406.2.2.5	37	36	31	34	30	28	43	32	23	61	42	49	75	61	49	90	77	93	90
W01	SHW preheat recovery	C406.2.3.1 a	18	19	22	21	25	26	28	29	34	29	31	34	29	31	35	26	29	27	26
W02	Heat pump water heater	C406.2.3.1 b	12	12	15	14	17	17	20	20	24	21	22	25	21	23	26	20	22	21	20
W03	Efficient gas water heater	C406.2.3.1 c	11	11	13	13	15	16	17	17	21	18	19	21	18	19	22	16	18	17	16
W04	SHW pipe insulation	C406.2.3.2	3	3	4	4	4	4	4	4	5	4	4	5	4	4	5	3	4	3	3
W05	Point of use water heaters	C406.2.3.3 a	8	10	11	10	11	12	12	12	14	13	13	14	13	13	14	11	12	12	11
W06	Thermostatic bal. valves	C406.2.3.3 b	1	1	1	1	1	1	1	1	2	1	1	2	1	1	2	1	1	1	1
W07	SHW heat trace system	C406.2.3.3 c	5	5	5	5	6	6	6	6	7	6	6	7	5	6	7	5	5	5	5
W08	SHW submeters	C406.2.3.4	11	11	13	13	15	16	18	18	22	19	20	22	19	20	24	17	20	18	18
W09	SHW distribution sizing	C406.2.3.5	29	30	36	35	41	43	48	48	56	50	53	59	51	54	62	47	52	49	48
W10	Shower heat recovery	C406.2.3.6	6	6	7	7	8	9	10	10	11	10	11	12	10	11	12	10	11	10	10
P01	Energy monitoring	C406.2.4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4
L01	Lighting Performance	C406.2.5.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L02	Lighting dimming & tuning	C406.2.5.2	5	5	5	5	6	6	5	6	7	5	5	5	4	4	5	3	4	3	2
L03	Increase occp. sensor	C406.2.5.3	5	6	6	6	7	7	6	7	8	5	6	6	4	5	6	3	4	3	2
L04	Increase daylight area	C406.2.5.4	7	8	9	8	9	9	8	8	10	6	7	7	5	6	6	4	5	5	4
L05	Residential light control	C406.2.5.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L06	Light power reduction	C406.2.5.7	7	7	8	7	8	8	7	8	9	5	7	6	4	5	6	4	4	3	2
Q01	Efficient elevator	C406.2.7.1	4	4	5	4	5	5	5	5	6	4	5	5	4	4	5	3	4	3	3
Q02	Commercial kitchen equip.	C406.2.7.2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q03	Residential kitchen equip.	C406.2.7.3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q04	Fault detection	C406.2.7.4	3	3	3	3	3	2	3	2	2	3	3	2	3	3	2	4	3	4	4

a. "x" indicates measure is not available for that measure

[b.] Other occupancy groups include all Groups except for Groups A-2, B, E, I, M, and R.

C406.2 Additional Energy Efficiency Credits Achieved. Each energy efficiency credit measure used to meet credit requirements for the project shall have efficiency that is greater than the requirements in Sections C402 through C405. Measures installed in the project that meet the requirements in Sections C406.2.1 through C406.2.7 shall achieve the base credits listed for the measure and occupancy type in Tables C406.2(1) through C406.2(9) or, where calculations required by Sections C406.2.1 through C406.2.7 create or modify the table credits, the credits achieved shall be based upon the calculations. Energy credits achieved for measures shall be determined by one of the following, as applicable:

1. The measure's energy credit shall be the base energy credit for the measure where no adjustment factor or calculation is included in the description of the measure in Section C406.2.

2. The measure's energy credit shall be the base energy credit for the measure adjusted by a factor or equation as stated in the description of the measure in Section C406.2. Where adjustments are applied, each measure's energy credit shall be rounded to the nearest whole number.
3. The measure's energy credit shall be calculation as stated in the measures description in Section C406.2, where each individual measure credit shall be rounded to the nearest whole number.

Energy credits achieved for the project shall be the sum of the individual measure's energy credits. Credits are available for the measures listed in this Section. Where a project contains multiple building occupancy groups:

1. Credits achieved for each occupancy group shall be summed and then weighted by the floor area of each occupancy group to determine the weighted average project energy credits achieved.
2. Credits for improved envelope efficiency and lighting reduction (L06) shall be determined for the building or permitted floor area as a whole. Credits for other measures shall be taken from applicable tables or calculations weighted by the building occupancy group floor area.

C406.2.1 More Efficient Building Envelope. A project shall achieve credits for improved envelope performance by complying with one of the following measures:

1. Section C406.2.1.1: E01
2. Section C406.2.1.2: E02
3. Section C406.2.1.3: E03
4. Both E02 and E03
5. Any combination of
   - 5.1 Section C406.2.1.3: E03
   - 5.2 Section C406.2.1.4: E04
   - 5.3 Section C406.2.1.5: E05
   - 5.4 Section C406.2.1.6: E06

C406.2.1.1 EO1 Improved envelope performance 90.1 Appendix C. *Building* envelope measures shall be installed to improve the energy performance of the project. The achieved energy credits shall be determined using Equation 4-13.

$EC_{ENV.} = 1000 \times (EPF_B - EPF_P)/EPF_B$ **(Equation 4-13)**

where:

$EC_{ENV.}$ = E01 measure energy credits

EPF_B = base envelope performance factor calculated in accordance with ASHRAE 90.1-2019-Appendix C.

EPF_P = proposed envelope performance factor calculated in accordance with ASHRAE 90.1-2019-Appendix C.

C406.2.1.2 E02 Total UA envelope reduction. Energy credits shall be achieved where the total UA of the *building thermal envelope* as designed is not less than 15 percent below the total UA of the *building thermal envelope* in accordance with Section C402.1.5.

C406.2.1.3 E03 Reduced air leakage. Energy credits shall be achieved where tested building air leakage is not less than 10 percent less than the maximum leakage permitted by Section C402.5.2 provided the building is tested in accordance with the applicable method in Section C402.5.2. Energy credits achieved for measure E03 shall be determined as follows:

$EC_{E03} = EC_B \times EC_{adj}$ **(Equation 4-14)**

where:

EC_{E03} = Energy efficiency credits achieved for envelope leakage reduction

EC_B = C406.2.1.3 credits from Tables C406.2(1) through C406.2(9)

$EC_{adj} = Ls/EC_a$

Ls = Leakage savings fraction: the lessor of [(Lr-Lm)/Lr] or 0.8

Lr = Maximum leakage permitted for tested *buildings*, by occupancy group, in accordance with Secction C402.5.2

Lm = Measured leakage in accordance with Section C402.5.2.1 or C402.5.2.2

EC_a = Energy Credit alignment factor: 0.37 for whole building tests in accordance with Section C402.5.2.1 or 0.25 for dwelling and sleeping unit enclosure tests in accordance with Section C402.5.2.2

C406.2.1.4 E04 Add Roof Insulation. Energy credits shall be achieved for insulation that is in addition to the required insulation in Table C402.1.3. All roof areas in the project shall have additional R-10 continuous insulation included in the roof assembly. For attics this is permitted to be achieved with fill or batt insulation rated at R-10 that is continuous and not interrupted by ceiling or roof joists. Where interrupted by joists, the added insulation shall be not less than R-13. Alternatively, one-half of the base credits shall be achieved where the added R-value is one-half of the additional R-value required by this section.

C406.2.1.5 E05 Added wall insulation. Energy credits shall be achieved for insulation applied to not less than 90 percent of all opaque wall area in the project that is in addition to the required insulation in Table C402.1.3.
Opaque walls shall have additional R-5 continuous insulation included in the wall assembly. Alternatively, one-half of the base credits shall be achieved where the added R-value is R-2.5.

C406.2.1.6 E06 Improve fenestration.. Energy credits for one selected fenestration energy credit ID shall be achieved for improved energy characteristics of all vertical fenestration in the project meeting the requirements in one of the rows of Table C406.2.1.6. The area-weighted average U-factor and SHGC of all vertical fenestration shall be equal to or less than the value shown in the selected table row. The area-weighted average visible transmittance (VT) of all vertical fenestration shall be equal to or greater than the value shown in the selected table row.

Table C406.2.1.6 VERTICAL FENESTRATION REQUIREMENTS FOR ENERGY CREDIT E06

Applicable Climate Zones	Maximum U-Factor		Maximum SHGC	Minimum VT
	Fixed	Operable		
0-2	0.45	0.52	0.21	0.28
3	0.33	0.44	0.23	0.30
4-5	0.31	0.38	0.34	0.41
6-7	0.26	0.32	0.38	0.44
8	0.24	0.28	0.38	0.44

C406.2.2 More Efficient HVAC Equipment Performance. All heating and cooling systems shall meet the minimum requirements of Section C403 and efficiency improvements shall be referenced to minimum efficiencies listed in Tables referenced by Section C403.3.2. Where multiple efficiency requirements are listed, equipment shall meet the seasonal or part-load efficiencies including SEER, EER/integrated energy efficiency ratio (IEER), integrated part load value (IPLV), or AFUE. Equipment that is larger than the maximum capacity range indicated in Tables referenced by Section C403.3.2 shall utilize the values listed for the largest capacity equipment for the associated equipment type shown in the table. Where multiple individual heating or cooling systems serve the project, the improvement shall be the weighted average improvement based on individual system capacity.
Systems are permitted to achieve HVAC energy credits by meeting the requirements of either:

1. C406.2.2.1 H01
2. C406.2.2.2 H02
3. C406.2.2.3 H03
4. C406.2.2.4 H04
5. C406.2.2.5 H05
6. Any combination of H02, H03, H04 and H05
7. The combination of H01 and H04

C406.2.2.1 H01 HVAC Performance (TSPR). H01 energy credits shall be achieved for systems allowed to use Section C403.1.3, HVAC total system performance ratio, where the proposed TSPR exceeds the minimum TSPR requirement by 5 percent. If improvement is greater, base energy credits from Table C406.2(1) through C406.2(9) are permitted to be prorated up to a 20 percent improvement using Equation 4-15. Energy credits for H01 may not be combined with energy credits from HVAC measures H02, H03 and H05.

H01 energy credit = H01 base energy credit x TSPRs / 0.05 **(Equation 4-15)**
where:

TSPRs = the lessor of 0.20 and (1-(TSPRp/TSPRt))

where:
TSPRt = TSPRr / MPF
TSPRp = HVAC TSPR of the proposed design calculated in accordance with Sections C409.4, C409.5 and C409.6.
TSPRr = HVAC TSPR of the reference building design calculated in accordance with Sections C409.4, C409.5 and C409.6.
MPF = Mechanical Performance Factor from Table C409.4 based on climate zone and building use type
Where a building has multiple building use types, MPF shall be area weighted in accordance with Section C409.4

C406.2.2.2 H02 More efficient HVAC equipment heating performance. No less than 90 percent of the total HVAC capacity serving the total *conditioned floor area* of the entire building, or tenant space in accordance with Section C406.1.1, shall comply with the requirements of this Section.

1. Equipment installed shall be types that are listed in Tables referenced by Section C403.3.2. Electric resistance heating capacity shall be limited to 20 percent of system capacity, with the exception of heat pump supplemental heating.
2. Equipment shall exceed the minimum heating efficiency requirements listed in Tables referenced by Section C403.3.2 by at least 5 percent. Where equipment exceeds the minimum annual heating efficiency requirements by more than 5 percent, energy efficiency credits for heating shall be determined using Equation 4-16 rounded to the nearest whole number.

$EEC_{HEH} = EEC_{H5} \times (HEI/0.05)$ **(Equation 4-16)**

where:

EEC_{HEH} = energy efficiency credits for heating efficiency improvement EEC_{H5} = C406.2.2.2 credits from Tables C406.2(1) through C406.2(9)

HEI = the lesser of: the improvement (as a fraction) above minimum heating efficiency requirements, or 20 percent(0.20). Where heating equipment with different minimum efficiencies are included in the building, a heating capacity weighted average improvement shall be used. Where electric resistance primary heating or reheat is included in the building it shall be included in the weighted average improvement with an HEI of 0. Supplemental gas and electric heat for heat pump systems shall be excluded from the weighted HEI. For heat pumps rated at multiple ambient temperatures, the efficiency at 47ºF (8.3ºC) shall be used.

For metrics that increase as efficiency increases, HEI shall be calculated as follows:

$HEI = (HM_{DES}/HM_{MIN})-1$

Where:

HM_{DES} = Design heating efficiency metric, part-load or annualized where available

HM_{MIN} = Minimum required heating efficiency metric, part-load or annualized where available from Section C403.3.2

Exception: In low energy spaces complying with Section C402.1.1, no less than 90 percent of the installed heating capacity is provided by electric infrared or gas-fired radiant heating equipment for localized heating applications. Such spaces shall only achieve energy credits for EEC_5.

C406.2.2.3 H03 More efficient HVAC equipment cooling and fan performance.. No less than 90 percent of the total HVAC cooling capacity serving the total conditioned floor area of the entire building or tenant space in accordance with Section C406.1.1, shall comply with all of the requirements of this section.

1. Equipment installed shall be types that are listed in Tables referenced by Section C403.3.2.
2. Equipment shall exceed the minimum cooling efficiency requirements listed in Tables referenced by Section C403.3.2 by at least 5 percent. For water-cooled chiller plants, heat rejection equipment efficiency shall also be increased by at least the chiller efficiency improvement. Where equipment exceeds the minimum annual cooling efficiency and heat rejection efficiency requirements by more than 5 percent, energy efficiency credits for cooling shall be determined using Equation 4-17, rounded to the nearest whole number.

3. Where fan energy is not included in packaged equipment rating or it is and the fan size has been increased from the as-rated equipment condition, fan power or horsepower shall be less than 95 percent of the allowed fan power in Section C403.8.1.

$EEC_{HEC} = EEC_5 \times (CEI / 0.05)$ **(Equation 4-17)**

where:

EEC_{HEC} = energy efficiency credits for cooling efficiency improvement

EEC_5 = the lesser of: the improvement above minimum cooling and heat rejection efficiency requirements expressed as a fraction, or 0.20 (20 percent). Where cooling equipment with different minimum efficiencies are included in the *building*, a cooling capacity weighted average improvement shall be used. Where multiple cooling performance requirements are provided, the *equipment* shall exceed the annualized energy or part-load requirement. Meeting both part-load and full-load efficiencies is not required.

For metrics that increase as efficiency increases, CEI shall be calculated as follows:

$CEI = (CM_{DES}/CM_{MIN}) - 1$

For metrics that decrease as efficiency increases, CEI shall be calculated as follows:

$CEI = (CM_{MIN}/CM_{DES}) - 1$

Where:

CM_{DES} = Design cooling efficiency metric, part-load or annualized where available

CM_{MIN} = Minimum required cooling efficiency metric, part-load or annualized where available from Section C403.3.2

For Data Centers using ASHRAE Standard 90.4, CEI shall be calculated as follows:

$CEI = (AMLC_{MAX}/AMLC_{DES}) - 1$

Where:

$AMLC_{DES}$ = As-Designed Annualized Mechanical Load Component calculated in accordance with ASHRAE Standard 90.4, Section 6.5

$AMLC_{MAX}$ = Maximum Annualized Mechanical Load Component from ASHRAE Standard 90.4, Table 6.5

C406.2.2.4 H04 Residential HVAC control.. HVAC systems serving *dwelling units* or *sleeping units* shall be controlled to automatically activate a setback at least 5°F (3°C) for both heating and cooling. The temperature controller shall be configured to provide setback during occupied sleep periods. The unoccupied setback mode shall be configured to operate in conjunction with one of the following:

1. A manual main control device by each *dwelling unit* main entrance that initiates setback and non-ventilation mode for all HVAC units in the dwelling unit and is clearly identified as "Heating/Cooling Master Setback."
2. Occupancy sensors in each room of the *dwelling unit* combined with a door switch to initiate setback and non-ventilation mode for all HVAC units in the dwelling within 20 minutes of all spaces being vacant immediately after a door switch operation. Where separate room HVAC units are used, an individual occupancy sensor on each unit that is configured to provide setback shall meet this requirement.
3. An advanced learning thermostat or controller that recognizes occupant presence and automatically creates a schedule for occupancy and provides a dynamic setback schedule based on when the spaces are generally unoccupied.
4. An automated control and sensing system that uses geographic fencing connected to the *dwelling unit* occupants' cell phones and initiates the setback condition when all occupants are away from the building.

C406.2.2.5 H05 Dedicated Outdoor Air System. Credits for this measure are only allowed where single zone HVAC units are not required to have multi-speed or variable-speed fan control in accordance with Section C403.8.6.1. HVAC controls and ventilation systems shall include all of the following:

1. Zone controls shall cycle the heating/cooling unit fans off when not providing required heating and cooling or shall limit fan power to 0.12 watts/cfm of zone outdoor air.
2. Outdoor air shall be supplied by an independent ventilation system designed to provide no more than 110 percent of the minimum outdoor air to each individual occupied zone, as specified by the *International Mechanical Code*.

3. The ventilation system shall have energy recovery with an *enthalpy recovery ratio* of 65 percent or more at heating design conditions in climate zones 3 through 8 and an enthalpy recovery ratio of 65 percent or more at cooling design conditions in climate zones 0, 1, 2, 3A, 3B, 4A, 4B, 5A, and 6A. In "A" climate zones, energy recovery shall include latent recovery. Where no humidification is provided, heating energy recovery effectiveness is permitted to be based on *sensible energy recovery ratio*. Where energy recovery effectiveness is less than the 65 percent required for full credit, adjust the credits from Section C406.2 by the factors in Table C406.2.2.5.
4. Where the ventilation system serves multiple zones and the system is not in a latent recovery outside air dehumidification mode. partial economizer cooling through an outdoor air bypass or wheel speed control shall automatically do one of the following:

   4.1. Set the energy recovery leaving-air temperature 55°F (13°C) or 100 percent outdoor air bypass when a majority of zones require cooling and outdoor air temperature is below 70°F (21°C).

   4.2 The HVAC ventilation system shall include supply-air temperature controls that automatically reset the supply-air temperature in response to representative building loads, or to outdoor air temperatures. The controls shall reset the supply-air temperature not less than 25 percent of the difference between the design supply-air temperature and the design room-air temperature.

5. Ventilation systems providing mechanical dehumidification shall use recovered energy for reheat within the limits of item 4. This shall not limit the use of latent energy recovery for dehumidification.

Where only a portion of the building is permitted to be served by constant air volume units or the *enthalpy recovery ratio* or *sensible energy recovery ratio* is less than 65 percent, the base energy credits shown in Section C406.2 shall be prorated as follows:

$EC_{DOAS} = EC_{BASE} \times FLOOR_{CAV} \times ERE_{ADJ}$ **(Equation 4-18)**

where:

EC_{DOAS} = Energy credits achieved for H06

EC_{base} = H06 base energy credits in Section C406.2

$FLOOR_{CAV}$ = Fraction of whole project *gross conditioned floor area* not required to have variable speed or multi-speed fan airflow control in accordance with Section C403.8.6.

ERE_{adj} = The energy recovery adjustment from Table C406.2.2.5 based on the lower of actual cooling or heating *enthalpy recovery ratio* or *sensible energy recovery ratio* where required for the climate zone. Where recovery ratios vary, use a weighted average by supply airflow.

C406.2.3 Reduced Energy Use In-service Water Heating. Projects with service water-heating equipment that serves the whole building, a building addition or a tenant space shall achieve credits through compliance with the requirements of this section. Systems are permitted to achieve energy credits by meeting the requirements of either:

1. C406.2.3.1 by selecting one allowed measure W01, W02 or W03
2. C406.2.3.2 W04
3. C406.2.3.3 by selecting one allowed measure W05, W06, or W07
4. C406.2.3.4 W08
5. C406.2.3.5 W09
6. C406.2.3.6 W10
7. Any combination of measures in C402.2.3.1 through C402.2.3.6 as long no more than one allowed measure from C406.2.3.1 and C406.2.3.3 are selected.

C406.2.3.1 Service water-heating system efficiency. A project is allowed to achieve energy credits from only one of Sections C406.2.3.1.1 through C406.2.3.1.4.

C406.2.3.3 Water-heating distribution temperature maintenance. A project is allowed to claim energy credits from only one of the following SHW distribution temperature maintenance measures.

1. **W04: Service Hot Water Piping Insulation Increase.** Where service hot water is provided by a central water heating system, the hot water pipe insulation thickness shall be at least 1.5 times the thickness required in Section C404.4. All service hot water piping shall be insulated from the hot water source to the fixture shutoff. Where no more than 50 percent of hot water piping does not have increased insulation due to installation in partitions, the credit shall be prorated as a percentage of lineal feet of piping with increased insulation.

2. **W05 Point of use water heaters**. Credits are available for office or school buildings larger than 10,000 ft^2 (930 m^2). Fixtures requiring hot water shall be supplied from a localized source of hot water with no recirculating system or heat trace piping. Supply piping from the water heater to the termination of the fixture supply pipe shall be insulated to the levels shown in Table C403.12.3 without exception. The volume from the water heater to the termination of the fixture supply pipe shall be limited as follows:

   1.1 Non-residential lavatories: not more than 2 oz (60 mL)

   1.2 All other plumbing fixtures or appliances: not more than 0.25 gallons (0.95 L)

   Exception: Where all remotely located hot water uses meet the requirements for measure W05, separate water heaters serving commercial kitchens or showers in locker rooms shall be permitted to have a local recirculating system or heat trace piping.

3. **W06 Thermostatic balancing valves.** Credits are available where service water heating is provided centrally and distributed throughout the building. Each recirculating system branch return connection to the main SHW supply piping shall have an automatic thermostatic balancing valve set to a minimal return water flow when the branch return temperature is greater than 115°F (46°C).

4. **W07 Heat trace system.** Credits are available for projects with gross floor area greater than 10,000 square feet (930 m^2) and a central water-heating system. The energy credits achieved shall be from Tables C406.1.2(1) through C406.1.2(9). This system shall include self-regulating electric heat cables, connection kits, and electronic controls. The cable shall be installed directly on the hot water supply pipes underneath the insulation to replace standby losses.

C406.2.3.4 W08 Water-heating system submeters. Each individual *dwelling unit* in a Group R-2 occupancy served by a central service water-heating system shall be provided with a service hot water meter connected to a reporting system that provides individual *dwelling unit* reporting of actual domestic hot water use. Preheated water serving the cold water inlet to showers need not be metered.

C406.2.3.5 W09 Service hot water flow reduction. Dwelling unit, sleeping unit, and guest room plumbing fixtures that are connected to the service water-heating system shall have a flow or consumption rating less than or equal to the values shown in Table C406.2.3.5.

Table C406.2.3.5
Maximum Flow Rating for Residential Plumbing Fixtures with Heated Water

Plumbing Fixture	**Maximum Flow Rate**
Faucet for private lavatory,[a] hand sinks, or bar sinks	1.50 gpm at 60 psi (0.095 L/s at 410 kPa)
Faucet for residential kitchen sink [a,b,c]	1.8 gpm at 60 psi 0.11 L/s at 410 kPa)
Shower head (including hand-held shower spray) [a, b, d]	2.0 gpm at 80 psi (0.13 L/s at 550 kPa)

a. Showerheads, lavatory faucets and kitchen faucets are subject to U.S. Federal requirements listed in 10 CFR 430.32(o)-(p).
b. Maximum flow allowed is less than required by flow rates listed in U.S. 10 CFR 430.32(o)-(p) for showerheads and kitchen faucets.
c. Residential kitchen faucet may temporarily increase the flow above the maximum rate, but not above 2.2 gallons per minute at 60 psi (0.14 L/s at 410 kPa) and must default to the maximum flow rate listed.
d. When a shower is served by multiple shower heads, the combined flow rate of all shower heads controlled by a single valve shall not exceed the maximum flow rate listed or the shower shall be designed to allow only one shower head to operate at a time.

C406.2.3.6 W10 Shower drain heat recovery. Cold water serving *building* showers shall be preheated by shower drain heat recovery units that comply with Section C404.7. The efficiency of drain heat recovery units shall be 54 percent or greater measured in accordance with CSA B55.1. Full credits are applicable to the following *building* uses: I-2, I-4, R-1, R-2 and also group E where there are more than eight showers. Partial credits are applicable to *buildings* where all but ground floor showers are served where the base energy credit from Section C406.2 is adjusted by Equation 4-21.

W10 credit = W10 base energy credit X (showers with drain heat recovery / total showers in building) **(Equation 4-21)**

C406.2.4 P01 Energy Monitoring. A project not required to comply with C405.12 can achieve energy credits for installing an energy monitoring system that complies with all the requirements of C405.12.1 through C405.12.5.

C406.2.5 Energy Savings in Lighting Systems. Projects are permitted to achieve energy credits for increased lighting system performance by meeting the requirements of either:

1. C406.2.5.2 L02
2. C406.2.5.3 L03
3. C406.2.5.4 L04
4. C406.2.5.5 L05
5. C406.2.5.6 L06
6. Any combination of L03, L04, L05 and L06
7. Any combination of L02, L03 and L04

Where lighting energy credit measures include reductions in lighting power, the lighting shall achieve ANSI/IES recommended practice for minimum illuminance levels as referenced at “The Interactive Illuminance Selector,” which includes minimum recommended illuminance levels from various ANSI/IES RP-## standards.

C406.2.5.1 L01 Lighting system performance (reserved). *Reserved for future use*

C406.2.5.2 L02 Enhanced digital lighting controls.. Measure credits shall be achieved where no less than 50 percent of the gross floor area within the project shall comply with the requirements of this section.

1. Lighting controls function. Interior general lighting shall be located, scheduled and operated in accordance with Section C405.2 and shall be configured with the following enhanced control functions:

   1.1. Luminaires shall be configured for continuous dimming.

   1.2 Each luminaire shall be individually addressed.

      Exceptions:

      1. Multiple luminaires mounted on no more than 12 linear feet (3.66 m) of a single lighting track and addressed as a single luminaire.
      2. Multiple linear luminaires that are ganged together to create the appearance of a single longer fixture and addressed as a single luminaire, where the total length of the combined luminaires is not more than 12 feet (3.66 m).

   1.3 No more than eight luminaires within a daylight zone are permitted to be controlled by a single *daylight responsive control.*

2. Luminaires shall be controlled by a digital control system configured with the following capabilities:

   2.1. Sheduling and illumination levels of individual luminaires and groups of luminaires are capable of being reconfigured through the system.

   2.2 Load shedding.

   2.3 Occupancy sensors and daylight responsive controls are capable of being reconfigured through the system.

3. Construction documents shall include submittal of a Sequence of Operations, including a specification outlining each of the functions required by this section.
4. High-end trim. Luminaires shall be initially configured with the following:

   4.1. High-end trim, setting the maximum light output of individual luminaires or groups of luminaires to support visual needs of a space or area, shall be implemented and construction documents shall state that maximum light output or power of controlled lighting shall be initially reduced by at least 15 percent from full output. The average maximum light output or power of the controlled lighting shall be documented without high-end trim and with high-end trim to verify reduction of light output or power by at least 15 percent when tuned.

   4.2 Where lumen maintenance control is used, controls shall be configured to limit the initial maximum lumen output or maximum lighting power to 85 percent or less of full light output or full power draw and lumen maintenance controls shall be limited to increasing lighting power by 1 percent per year.

   4.3 High-end trim and lumen maintenance controls shall be accessible only to authorized personnel.

Where *general lighting* in more than 50 percent of the *gross lighted floor area* receives *high-end trim*, the base credits from Tables C406.1.2(1) through C406.1.2(9) shall be prorated as follows:

[Tuned lighted floor area,%] × [Base energy credits for C406.2.5.2] / 50%

C406.2.5.3 L03 Increase occupancy sensor. To achieve this credit, automatic partial OFF or automatic full OFF occupancy sensors shall be installed in all space types not required by C405.2.1 and shall be installed as follows:

C406.2.5.4 L04 Increase daylight area. The total daylight area of the project (DLA_{BLDG}) with continuous daylight dimming meeting the requirements of C405.2.4 shall be at least 5 percent greater than the typical daylit area (DLA_{TYP}).
Credits for measure L04 shall be determined based on Equation 4-23:

$EC_{DL} = EC_{DL5} \times 20 \times [(DLA_{BLDG}/GLFA) - DLA_{TYP}]$ **(Equation 4-23)**

where:

EC_{DL} = The lesser of actual area of *daylight zones* in the *building* with continuous daylight dimming, ft^2 or m^2 and (GLFA x DLA_{max}) see Table C406.2.5.4. *Daylight zones* shall meet the criteria in Sections C405.2.4.2 and C405.2.4.3 for primary sidelit *daylight zones*, secondary sidelit *daylight zones*, and toplit *daylight zones*.

GLFA = Project gross lighted floor area, ft^2 or m^2

DLA_{TYP} = Typical % of *building* area with daylight control (as a fraction) from Table C406.2.5.4:

EC_{DL5} = C406.2.5.4 L04 base energy credits from Section C406.2

TABLE C406.2.5.4
ADDED DAYLIGHTING PARAMETERS

***Building* use type**	**DLA_{TYP}**	**DLA_{max}**
Group B; Office ≤ 5000 ft^2 (460 m^2)	10%	20%
Group b; Office > 5000 ft^2 (460 m^2)	21%	31%
Group M; Retail with ≤ 1000 ft^2 (900 m^2) *roof* area	0%	20%
Group M; Retail >1000 ft^2 (900 m^2) *roof* area	60%	80%
Group E; Education	42%	52%
Groups S-1 and S-2; Warehouse	50%	70%
Group I-2, R, and other; Medical, hotel, multifamily, dormitory, and other	NA	NA

C406.2.5.5 L05 Residential light control. In *buildings* with Group R-2 occupancy spaces, interior lighting systems shall comply with the following:

1. Common area Restrooms, laundry rooms, storage rooms, and utility rooms shall have automatic full OFF occupancy sensor controls that comply with the requirements of C405.2.1.1. Each additional control device shall control no more than 5,000 sq.ft (464 m^2).
2. Each dwelling unit shall have a main control by the main entrance that turns off all the lights and all switched receptacles in the dwelling unit. Two switched receptacles shall be provided in living and sleeping rooms or areas and clearly identified. All switched receptacles shall be located within 12 inches (30 cm) of an unswitched receptacle. The main control shall be permitted to have two controls, one for permanently wired lighting and one for switched receptacles. The main controls should be clearly identified as “lights master off” and “switched outlets master off.”

C406.2.5.6 L06 Reduced lighting power.. Interior lighting within the whole building shall comply with all the requirements of this section. The net connected interior lighting power (LPn) shall be 95 percent or less than the net interior lighting power allowance (LPAn) determined in accordance with Section C405.3.2.2. In R-1 and R-2 occupancies the credit is calculated for all common areas other than dwelling units and sleeping units. No less than 95 percent of the permanently installed light fixtures in *dwelling units* and *sleeping units*, excluding kitchen appliance lighting, shall be provided by high efficacy lamps with a minimum efficacy of 90 lumens per watt or high efficacy luminaires that have a minimum efficacy of 55 lumens per watt. Energy credits shall not be greater than four times the L06 base credit from Section C406.2 and shall be determined using Equation 4-24:

$EC_{LPA} = EC_5 \times 20 \times (LPA_n - LP_n)/LPA_n$ **(Equation 4-24)**

where:

EC_{LPA} = additional energy credit for lighting power reduction

LP_n = net connected interior lighting power calculated in accordance with Section C405.3.1, watts, excluding any additional lighting power allowed in Section C405.3.2.2.1

LPA_n = interior lighting power allowance calculated in accordance with the requirements of Section C405.3.2.2, watts, less any additional interior lighting power allowed in Section C405.3.2.2.1

EC5 = L06 base credit from Section C406.2

C406.2.7 Efficient Equipment Credits. Projects are permitted to achieve energy credits using any combination of Efficient Equipment Credits Q01 through Q04.

C406.2.7.1 Q01 Efficient Elevator Equipment. Qualifying elevators in the *building* shall be Energy efficiency class A per ISO 25745-2, Table 7. Only *buildings* 3 or more floors above grade may use this credit. Credits shall be prorated based on Equation 4-25, rounded to the nearest whole credit. Projects with a compliance ratio below 0.5 do not qualify for this credit.

$EC_e = EC_t \times CR_e$ **(Equation 4-25)**

where:

EC_e = Elevator energy credit achieved for the *building*

EC_t = C406.2.7.1 Table energy credit

CR_e = Compliance Ratio = (F_A / F_B)

F_A = Sum of floors served by class A elevators

F_B = Sum of floors served by all *building* elevators and escalators

C406.2.7.2 Q02 Efficient Commercial Kitchen Equipment.. For *buildings* and spaces designated as Group A-2, or facilities whose primary business type involves the use of a commercial kitchen where at least one gas or electric fryer is installed before the issuance of the Certificate of Occupancy all fryers, dishwashers, steam cookers and ovens installed before the issuance of the Certificate of Occupancy shall comply with all of the following:

1. Achieve performance levels in accordance with the equipment specifications listed in Tables C406.2.7.2 (1) through C406.2.7.2 (4) when rated in accordance with the applicable test procedure.
2. Have associated performance levels listed on the construction documents submitted for permitting.

Table C406.2.7.2(1) Minimum Efficiency Requirements: Commercial Fryers

Heavy-Load Cooking Energy Efficiency	**Idle Energy Rate**	**Test Procedure**	
Standard Open Deep-Fat Gas Fryers	≥ 50%	≤ 9,000 Btu/hr (≤ 2,600 watts)	ASTM F1361
Standard Open Deep-Fat Electric Fryers	≥ 83%	≤ 800 watts	
Large Vat Open Deep-Fat Gas Fryers	≥ 50%	≤ 12,000 Btu/hr (≤ 3,500 watts)	ASTM F2144
Large Vat Open Deep-Fat Electric Fryers	≥ 80%	≤ 1,100 watts	

For SI: BTU/h = 0.293W

Table C406.2.7.2(2) Minimum Efficiency Requirements: Commercial Steam Cookers

Fuel Type	**Pan Capacity**	**Cooking Energy Efficiency[a]**	**Idle Energy Rate**	**Test Procedure**
Electric Steam	3-pan	50%	400 W	ASTM F1484
	4-pan	50%	530 W	
	5-pan	50%	670 W	
	6-pan and larger	50%	800 W	
Gas Steam	3-pan	38%	6,250 Btu/h 1.83 kw	
	4-pan	38%	8,350 Btu/h 2.45 kW	
	5-pan	38%	10,400 Btu/h 3.05 kW	
	6-pan and larger	38%	12,500 Btu/h 3.66 kW	

a. Cooking Energy Efficiency is based on heavy-load (potato) cooking capacity

TABLE C406.2.7.2(3)
MINIMUM EFFICIENCY REQUIREMENTS: COMMERCIAL DISHWASHERS

Machine Type	**High Temperature Efficiency Requirements**			**Low Temperature Efficiency Requirements**			**Test Procedure**
	Idle Energy Rate[a]	Washing Energy	Water Consumption[b]	Idle Energy Rate[a]	Washing Energy	Water Consumption[b]	
Under Counter	≤ 0.50 kW	≤0.35 kWh/rack	≤ 0.86 GPR (≤3.3 LPR)	≤ 0.25 kW	≤0.15 kWh/rack	≤ 1.19 GPR (≤4.5 LPR)	ASTM F1696 ASTM F1920
Stationary Single Tank Door	≤ 0.55 kW	≤0.35 kWh/rack	≤ 0.89 GPR (≤3.4 LPR)	≤ 0.30 kW	≤0.15 kWh/rack	≤ 1.18 GPR (≤4.47 LPR)	
Pot, Pan , and Utensil	≤ 0.90 kW	kWh/rack≤ 0.55 + 0.05 x SF_{rack}[c] (≤ 0.55 + 0.0046 x SM_{rack}[c])	≤ 0.58 GPR (≤2.2 LPSM)	N/A	N/A	N/A	
Single Tank Conveyor	≤ 1.20 kW	≤0.36 kWh/rack	≤ 0.70 GPR (≤2.6 LPSM)	≤ .85 kW	≤0.16 kWh/rack	≤ 0.79 GPR (≤ 3.0 LPR)	
Multiple Tank Conveyor	≤ 1.85 kW	≤0.36 kWh/rack	≤ 0.54 GPR (≤2.0 LPSM)	≤ 1.00 kW	≤0.22 kWh/rack	≤ 0.54 GPR (≤ 2.0 LPR)	
Single Tank Flight Type	Reported	Reported	GPH ≤ 2.975cx + 55.00 (LPH ≤ 0.276d + 208)	N/A	N/A	N/A	
Multiple Tank Flight Type	Reported	Reported	GPH ≤ 4.96c + 17.00 (LPH ≤ 0.461d + 787)	N/A		N/a	

a. Idle results should be measured with the door closed and represent the total idle energy consumed by the machine including all tank heaters and controls. The most energy consumptive configuration in the product family shall be selected to test the idle energy rate. Booster heater (internal or external) energy consumption shall be measured and reported separately, if possible, per ASTM F1696 and ASTM F1920 Sections 10.8 and 10.9, respectively. However, if booster energy cannot be measured separately it will be included in the idle energy rate measurements.

b. GPR = gallons per rack, LPR = Liters per rack, GPSF = gallons per square foot of rack, LPSM = liters per square meter of rack, GPH = gallons per hour, c = [maximum conveyor belt speed (feet/minute)] × [conveyor belt width (feet)], LPH = liters per hour, d = [maximum conveyor belt speed (m/minute)] × [conveyor belt width (m)]

c. PPU Washing Energy is still in format kWh/rack when evaluated; SFrack (SMrack) is Square Feet of rack area (square meters of rack area), same as in PPU water consumption metric.

Table C406.2.7.2(4) Minimum Efficiency Requirements: Commercial Ovens

Fuel Type	Classification	Idle Rate	Cooking Energy Efficiency, %	Test Procedure
Convection Ovens				
Gas	Full-Size	≤ 12,000 Btu/h	≥ 46	ASTM F1496
Electric	Half-Size	≤ 1.0 Btu/h	≥ 71	
	Full-Size	≤ 1.60 Btu/h		
Combination Ovens				
Gas	Steam Mode	≤ 200P[a] + 6,511 Btu/h (≤ 0.059 P[a] + 1.9 kW)	≥ 41	ASTM F2861
	Convection Mode	≤ 150P[a] + 5,425 Btu/h (≤ 0.044 P[a] + 1.6 kW)	≥ 56	
Electric	Steam Mode	≤ 0.133P[a] + 0.6400 kW	≥ 55	
	Convection Mode	≤ 0.080P[a] + 0.4989 kW	≥ 76	
Rack Ovens				
Gas	Single	≤ 25,000 Btu/h (7.3 kW)	≥ 48	ASTM F2093
	Double	≤ 30,000 Btu/h (8.8 kW)	≥ 52	

a. P = Pan Capacity: the number of steam table pans the combination oven is able to accommodate in accordance with ASTM F1495

C406.2.7.3 Q03 Efficient Residential Kitchen Equipment.. For projects with Group R-1 and R-2 occupancies, energy credits shall be achieved where all dishwashers, refrigerators, and freezers comply with all of the following:

1. Achieve the Energy Star Most Efficient 2021 label in accordance with the specifications current as of:
   1.1 Refrigerators and freezers 5.0, 9/15/2014
   1.2 Dishwashers 6.0, 1/29/2016
2. Be installed before the issuance of the certificate of occupancy.

For Group R-1 where only some guest rooms are equipped with both refrigerators and dishwashers, the table credits shall be prorated as follows:

[Section C406.2 base credits] × [floor area of guest rooms with kitchens] / [total guest room floor area] **(Equation 4-26)**

C406.2.7.4 Q04 Fault detection and diagnostics system.. A project not required to comply with C403.2.3 can achieve energy credits for installing a fault detection and diagnostics system to monitor the HVAC system's performance and automatically identify faults. The installed system shall comply with items 1 through 6 in Section C403.2.3.

C406.3 Renewable and Load Management Credits achieved.. Renewable energy and load management measures installed in the *building* that comply with Sections C406.3.1 through C406.3.8 shall achieve the credits listed for the occupancy group in Tables C406.3(1) through C406.3(9) or where calculations are required in Sections C406.3 to determine credits or modify the table credits, the credits achieved shall be based upon the Section C406.3 calculations. Measure credits achieved shall be determined in one of two ways, depending on the measure:

1. The measure credit shall be the base energy credit for the measure where no adjustment factor or formula is shown in the description of the measure in Section C406.3.
2. The measure credit shall be the base energy credit for the measure adjusted by a factor or formula as stated in the description of the measure in Section C406.3. Where adjustments are applied, each energy credit shall be rounded to the nearest whole number.

Load management and renewable credits achieved for the project shall be the sum of credits for individual measures included in the project. Credits are available for the measures listed in this Section. Where a project contains multiple building use groups credits achieved for each building use group shall be summed and then weighted by the gross floor area of each building use group to determine the weighted average project energy credits achieved.

The load management measures in Sections C406.3.2 (G01) through C406.3.7 (G06) require load management control sequences that are capable of and configured to automatically provide the load management operation specified based on indication of a peak period related to high short-term electric prices, grid condition, or peak building load. Such a peak period shall, where possible, be initiated by a demand response signal from the controlling entity, such as a utility or service operator. When communications are disabled or unavailable, all demand responsive controls shall continue backup demand response based on a local schedule or building demand monitoring. The local building schedule shall be adjustable without programming and reflect the electric rate peak period dates and times. The load management control sequences shall be activated for peak period control by either:

1. A certified OpenADR 2.0a or OpenADR 2.0b Virtual End Node (VEN), as specified under Clause 11, Conformance, in the applicable OpenADR 2.0 Specification, or
2. A device certified by the manufacturer as being capable of responding to a demand response signal from a certified OpenADR 2.0b VEN by automatically implementing the control functions requested by the VEN for the equipment it controls, or
3. A device that complies with IEC 62726-10-1, an international standard for the open automated demand response system interface between the appliance, system, or energy management system and the controlling entity, or
4. An interface that complies with the communication protocol required by a controlling entity, to participate in an automated demand response program, or
5. Where the controlling entity does not have a demand response program or protocol available, local demand response control shall be provided based on either:
   - 5.1. Building demand management controls that monitor building electrical demand and initiate controls to minimize monthly or peak time period demand charges, or,
   - 5.2 Where buildings are less than 25,000 gross square feet, a local building schedule that reflects the electric rate peak period dates and times. In this case a binary input to the control system shall be provided that activates the demand response sequence.

Table C406.3(1) Renewable and Load Management Credits for Group R-2, R-4, and I-1 Occupancies

ID	Energy Credit Abbreviated Title	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
R01	Renewable Energy	C406.3.1	9	15	11	17	18	20	19	21	13	10	13	9	9	11	10	9	10	9	7
G01	Lighting load management	C406.3.2	16	7	9	12	12	16	11	14	12	11	16	14	8	11	14	5	7	7	11
G02	HVAC load management	C406.3.3	42	41	21	35	23	37	30	28	28	17	33	24	20	22	23	10	13	15	17
G03	Automated shading	C406.3.4	11	x	7	18	10	13	5	13	12	2	14	7	10	13	11	1	8	8	16
G04	Electric energy storage	C406.3.5	10	10	10	11	10	13	13	14	17	16	13	17	14	13	17	14	14	14	15
G05	Cooling energy storage	C406.3.6	28	6	31	13	22	21	21	37	11	12	22	11	9	17	9	7	17	2	3
G06	SHW energy storage	C406.3.7	17	17	19	18	19	19	20	20	22	19	19	21	19	19	20	18	19	18	17
G07	Building thermal mass	C406.3.8	7	2	11	5	16	28	22	27	60	19	43	46	32	58	37	27	45	40	19

x = Credits excluded from this *building* use type and climate zone.

Table C406.3(2) Renewable and Load Management Credits for Group I-2 Occupancies

ID	Energy Credit Abbreviated Title	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
R01	Renewable Energy	C406.3.1	6	6	6	6	6	8	7	9	8	6	8	6	6	7	7	6	7	5	4
G01	Lighting load management	C406.3.2	11	12	13	13	13	12	12	12	6	13	16	12	13	14	15	14	14	12	12
G02	HVAC load management	C406.3.3	10	11	10	10	8	21	10	10	13	11	18	11	12	14	13	12	11	9	7
G03	Automated shading	C406.3.4	1	1	1	1	x	x	x	1	x	x	2	x	x	2	x	x	1	1	x
G04	Electric energy storage	C406.3.5	13	13	13	13	14	15	14	15	15	14	15	15	14	15	15	13	14	13	12
G05	Cooling energy storage	C406.3.6	25	6	33	14	25	19	27	37	27	16	22	19	14	18	11	11	20	2	3
G06	SHW energy storage	C406.3.7	4	4	4	4	4	4	4	4	4	4	4	5	4	4	4	4	4	4	4
G07	Building thermal mass	C406.3.8	6	2	10	4	15	25	20	24	57	18	39	44	31	53	33	26	40	34	14

x = Credits excluded from this *building* use type and climate zone.

Table C406.3(3) Renewable and Load Management Credits for Group R-1 Occupancies

ID	Energy Credit Abbreviated Title	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
R01	Renewable Energy	C406.3.1	9	8	12	9	11	11	10	12	13	9	12	8	9	11	9	8	9	7	5
G01	Lighting load management	C406.3.2	12	12	11	12	12	14	14	13	15	14	13	11	10	11	14	9	11	8	8
G02	HVAC load management	C406.3.3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
G03	Automated shading	C406.3.4	2	2	2	3	1	2	3	2	4	3	2	1	1	1	3	1	2	1	1
G04	Electric energy storage	C406.3.5	9	9	10	10	9	13	13	15	13	14	13	14	14	12	16	13	12	12	13
G05	Cooling energy storage	C406.3.6	31	7	38	17	29	24	31	44	26	18	26	16	15	21	11	12	24	2	4
G06	SHW energy storage	C406.3.7	25	25	28	26	28	29	29	30	31	29	30	31	28	29	31	26	28	25	24
G07	Building thermal mass	C406.3.8	6	1	10	4	14	24	19	23	53	17	38	41	30	52	33	26	42	37	17

x = Credits excluded from this *building* use type and climate zone.

Table C406.3(4) Renewable and Load Management Credits for Group B Occupancies

ID	Energy Credit Abbreviated Title	Section	Climate Zone																		
			0A	**0B**	**1A**	**1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
R01	Renewable Energy	C406.3.1	14	14	17	15	17	19	18	22	24	17	22	16	14	18	18	14	17	14	11
G01	Lighting load management	C406.3.2	10	11	11	12	11	11	11	12	9	10	11	10	10	11	10	10	11	10	9
G02	HVAC load management	C406.3.3	x	10	10	9	9	3	8	12	7	12	8	11	9	10	12	8	9	10	2
G03	Automated shading	C406.3.4	4	7	7	8	7	8	5	6	6	4	6	5	4	5	5	5	5	4	7
G04	Electric energy storage	C406.3.5	14	15	14	14	16	16	17	16	18	17	16	18	17	17	18	16	15	17	18
G05	Cooling energy storage	C406.3.6	28	7	36	16	27	24	28	45	27	17	27	15	15	20	9	12	25	2	4
G06	SHW energy storage	C406.3.7	5	5	6	6	6	6	7	7	8	7	7	7	7	7	8	6	7	6	6
G07	Building thermal mass	C406.3.8	3	1	5	2	6	9	6	7	14	4	11	8	9	15	5	8	12	15	7

x = Credits excluded from this *building* use type and climate zone.

Table C406.3(5) Renewable and Load Management Credits for Group A-2 Occupancies

ID	Energy Credit Abbreviated Title	Section	Climate Zone																		
			0A	**0B**	**1A**	**1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
R01	Renewable Energy	C406.3.1	2	2	2	2	2	2	2	3	4	2	3	2	2	3	2	2	2	2	1
G01	Lighting load management	C406.3.2	4	4	5	5	4	5	5	5	5	4	5	5	4	4	5	4	5	4	1
G02	HVAC load management	C406.3.3	32	26	37	28	31	26	27	22	23	20	17	14	19	14	10	16	14	14	1
G03	Automated shading	C406.3.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
G04	Electric energy storage	C406.3.5	4	4	4	4	5	5	5	5	4	4	4	4	3	4	4	4	3	3	2
G05	Cooling energy storage	C406.3.6	15	4	17	8	12	10	10	16	6	5	7	3	3	4	1	2	4	x	x
G06	SHW energy storage	C406.3.7	13	13	15	14	15	16	16	17	19	16	17	19	16	17	18	15	16	14	13
G07	Building thermal mass	C406.3.8	3	1	5	2	7	12	8	10	21	6	15	14	8	18	10	6	12	8	3

x = Credits excluded from this *building* use type and climate zone.

Table C403.6(6) Renewable and Load Management Credits for Group M Occupancies

ID	Energy Credit Abbreviated Title	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
R01	Renewable Energy	C406.3.1	8	8	12	9	11	12	12	17	17	11	13	9	10	11	10	9	10	9	6
G01	Lighting load management	C406.3.2	16	16	18	19	17	19	19	21	17	18	21	21	18	21	22	18	22	18	16
G02	HVAC load management	C406.3.3	x	x	16	15	15	6	15	21	13	23	15	23	17	19	26	14	17	18	3
G03	Automated shading	C406.3.4	7	11	11	12	11	13	10	11	11	7	11	11	8	10	11	8	9	8	12
G04	Electric energy storage	C406.3.5	6	10	8	10	11	12	11	10	14	11	10	12	10	11	12	11	9	10	8
G05	Cooling energy storage	C406.3.6	40	9	51	22	35	31	34	53	21	17	28	10	11	19	4	9	18	2	2
G06	SHW energy storage	C406.3.7	3	3	4	3	4	4	4	4	5	4	4	5	4	4	5	4	4	4	3
G07	Building thermal mass	C406.3.8	5	1	6	3	8	12	10	10	20	7	17	15	14	24	10	13	20	24	12

x = Credits excluded from this *building* use type and climate zone.

Table C406.3(7) Renewable and Load Management Credits for Group E Occupancies

ID	Energy Credit Abbreviated Title	Section	Climate Zone																		
			0A	**0B**	**1A**	**1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
R01	Renewable Energy	C406.3.1	10	11	13	12	13	16	15	21	22	15	19	15	14	17	16	13	16	12	10
G01	Lighting load management	C406.3.2	7	12	12	13	13	15	14	16	13	12	16	16	10	14	18	16	13	14	14
G02	HVAC load management	C406.3.3	18	22	32	23	25	31	26	26	20	23	31	24	20	31	12	18	27	16	9
G03	Automated shading	C406.3.4	7	13	16	12	18	17	17	18	13	12	17	17	10	15	13	14	10	16	17
G04	Electric energy storage	C406.3.5	16	16	18	17	19	21	21	23	26	22	24	24	23	24	24	20	22	19	19
G05	Cooling energy storage	C406.3.6	36	9	46	21	36	32	39	62	39	24	37	22	20	28	13	16	31	3	4
G06	SHW energy storage	C406.3.7	5	5	6	5	6	6	7	7	8	7	7	8	7	7	8	7	7	7	6
G07	Building thermal mass	C406.3.8	7	2	11	5	17	28	23	27	63	21	44	48	37	60	38	31	50	47	21

x = Credits excluded from this *building* use type and climate zone.

Table C406.3(8) Renewable and Load Management Credits for Group S-1 and S-2 Occupancies

ID	Energy Credit Abbreviated Title	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
R01	Renewable Energy	C406.3.1	38	37	55	45	53	53	49	58	66	36	56	38	29	41	36	24	32	23	16
G01	Lighting load management	C406.3.2	13	26	32	28	32	35	36	33	36	31	27	37	32	23	28	36	22	25	22
G02	HVAC load management	C406.3.3	18	46	37	37	28	36	29	26	22	23	17	12	16	13	5	14	8	10	3
G03	Automated shading	C406.3.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
G04	Electric energy storage	C406.3.5	40	40	47	41	47	44	40	44	42	30	38	31	21	31	26	24	29	23	21
G05	Cooling energy storage	C406.3.6	20	5	21	11	14	14	11	21	5	5	9	2	2	5	1	1	3	x	x
G06	SHW energy storage	C406.3.7	3	3	3	3	4	3	4	4	4	3	4	4	3	3	4	2	2	2	2
G07	Building thermal mass	C406.3.8	7	2	12	5	17	29	23	28	66	18	44	47	28	56	37	20	39	29	13

x = Credits excluded from this *building* use type and climate zone.

Table C406.3(9) Renewable and Load Management Credits for Other[a] Occupancies

ID	Energy Credit Abbreviated Title	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
R01	Renewable Energy	C406.3.1	12	13	16	14	16	18	17	20	21	13	18	13	12	15	14	11	13	10	8
G01	Lighting load management	C406.3.2	11	13	14	14	14	16	15	16	14	14	16	16	13	14	16	14	13	12	12
G02	HVAC load management	C406.3.3	24	24	23	22	20	23	21	21	18	18	20	17	16	18	14	13	14	13	6
G03	Automated shading	C406.3.4	5	6	7	9	8	9	7	9	8	5	9	7	5	8	7	5	6	6	9
G04	Electric energy storage	C406.3.5	14	15	16	15	16	17	17	18	19	16	17	17	15	16	17	14	15	14	14
G05	Cooling energy storage	C406.3.6	28	7	34	15	25	22	25	39	20	14	22	12	11	17	7	9	18	2	3
G06	SHW energy storage	C406.3.7	9	9	11	10	11	11	11	12	13	11	12	13	11	11	12	10	11	10	9
G07	Building thermal mass	C406.3.8	6	2	9	4	13	21	16	20	44	14	31	33	24	42	25	20	33	29	13

a. Other occupancy groups include all Groups except for Groups A-2, B, E, I, M, and R.

C406.3.1 R01 Renewable Energy. Projects installing on-site renewable energy systems with a capacity of at least 0.1 watts per gross square foot (1.08 W/m2) of building area or securing off-site renewable energy shall achieve energy credits for this measure calculated as follows:

$EC_R = EC_{0.1} \times (R_t + R_{off} - R_{ex}) / (0.1 \times PGFA)$ **(Equation 4-27)**

where:

EC_R = C406.3.1 R01 energy credits achieved for this project
R_t = Actual total rating of on-site renewable energy systems (W)
PGFA = Project gross floor area, ft^2
$EC_{0.1}$ = C406.3.1 R01 base credits from Tables C406.3(1) through C406.3(9)
R_{off} = Actual total equivalent rating of off-site renewable energy contracts (W), calculated as follows:

$R_{OFF} = TRE/(REN \times 20)$

where:

TRE = Total off-site renewable electrical energy in kilowatt-hours (kWh) that is procured in accordance with Sections C405.13.2.1 through C405.13.4
REN = Annual off-site renewable electrical energy from Table C405.13.2, in units of kilowatt-hours per watt of array capacity

R_{ex} = Rating (W) of renewable energy resources capacity excluded from credit calculated as follows:
$R_{ex} = RR_r + RR_x + RR_c$

where:

RR_r = Rating of on-site renewable energy systems required by Section C405.13.1, without exception (W).
RR_x = Rating of renewable energy resources used to meet any exceptions of this code (W).
RR_c = Rating of renewable energy resources used to achieve other energy credits in Section C406 (W).
Where renewable requirements, exceptions, or credits are expressed in annual kWh or Btu rather than Watts of output capacity, they shall be converted as 3413 Btu = 1 kWh and converted to W equivalent capacity as follows:
RR_w = Actual total equivalent rating of renewable energy capacity (W), calculated as follows:

$RR_w = TRE_x / (REN \times PGFA)$

where:

TRE_x = Total renewable energy in kilowatt-hours (kWh) that is excluded from R01 energy credits

Table 406.3.1 Renewable Capacity Limits (RA_L) without Electric Storage, W/ft[2]

Building Occupancy Group	Climate Zone																		
	0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
RA_{L1}: R-2, R-4, and I-1 with gas water heat [a]	1.3	1.3	1.0	1.0	1.0	0.9	0.9	0.8	0.7	0.9	0.8	0.9	0.9	0.9	0.9	1.0	0.9	1.0	1.3
RA_{L2}: R-2, R-4, and I-1 with electric or solar water heat [a]	7.6	6.8	5.9	5.1	4.2	4.2	4.2	3.4	2.5	4.2	3.4	3.4	3.4	3.4	3.4	4.2	3.4	4.2	5.1
I-2	10.3	9.7	8.2	8.2	8.2	7.3	7.2	6.2	6.2	7.5	6.2	7.3	7.5	6.5	7.3	7.3	7.2	7.2	8.8
R-1	4.1	3.8	3.4	2.9	3.1	2.7	2.6	2.3	2.2	2.7	2.0	2.7	2.7	2.1	1.9	2.6	2.2	2.7	3.2
RA_{L3}: B with IT & phone equip. > 0.5 W/ft[2b]	5.2	5.2	4.6	4.6	4.3	4.0	4.0	3.8	3.5	3.8	3.8	4.0	4.0	4.0	4.0	4.0	4.0	4.3	5.2
RA_{L4}: B with IT & phone equip. ≤ 0.5 W/ft[2b]	2.7	2.7	2.1	2.1	2.1	1.9	1.9	1.6	1.6	1.8	1.6	1.8	1.8	1.8	1.8	1.9	1.9	2.0	2.6
A-2	26.9	26.3	19.4	20.0	18.0	14.9	14.9	13.9	12.7	14.8	12.5	14.0	13.7	13.1	13.2	14.4	13.6	14.4	16.5
M	6.5	6.4	4.5	4.8	4.3	3.5	3.5	3.0	2.9	3.2	2.9	3.2	3.2	2.9	2.8	3.1	2.9	3.1	3.3
E	3.9	4.2	2.8	3.0	2.6	2.1	2.0	1.7	1.6	1.9	1.4	1.9	1.9	1.9	1.9	1.9	1.9	1.9	2.4
S-1 and S-2	1.3	1.3	1.0	1.0	0.7	0.7	0.7	0.7	0.6	0.7	0.6	0.7	0.7	0.7	0.7	0.9	0.9	0.9	1.0
All Other	3.4	3.3	2.6	2.5	2.9	2.7	2.7	2.1	2.3	2.6	2.3	2.7	2.7	2.5	3.1	3.1	2.8	3.2	3.2

a. For buildings that include residential occupancy (Group R-2, R-4 and I-1), RA_L shall be adjusted as follows:
   1. Where 70% or more of service water-heating capacity is gas, $RA_L = RA_{L1}$
   2. Where 70% or more of service water-heating capacity is electric resistance or solar water/pool heating is included with electric resistance backup, use RA_{L2}
   3. Where 70% or more of service water-heating capacity is heat pump water heating, adjust as follows: $RA_L = RA_{L1} + \{ (RA_{L2} - RA_{L1}) / 3 \}$
   4. Where solar water/pool heating is included with gas backup, prorate based on relative capacity as follows: RA_L = [% gas peak capacity] · RA_{L1} + [% solar peak capacity] · RA_{L2}
   5. Where electric water heating is mixed with gas water heating, prorate based on relative capacity as follows: RA_L = [% gas peak capacity] · RA_{L1} + [% electric peak capacity] · RA_{L2}

b. Office (Group B) IT & phone equipment density is calculated based on total building area, not just server and equipment room area, and power for distributed computers or terminals in office areas is not included. Where the total building density of IT & phone equipment is greater than 0.5 W/sf, $RA_L = RA_{L3}$, otherwise $RA_L = RA_{L4}$.

Table C406.3.1 Renewable Capacity LImits (RA_L) without Electric Storage, W/m²

Building Occupancy Group	**Climate Zone**																		
	0A	**0B**	**1A**	**1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
RA_{L1}: R-2, R-4, and I-1 with gas water heat [a]	14	14	11	11	11	10	10	9	8	10	9	10	10	10	10	11	10	11	14
RA_{L2}: R-2, R-4, and I-1 with electric or solar water heat [a]	82	73	64	55	45	45	45	37	27	45	37	37	37	37	37	45	37	45	55
I-2	111	104	89	88	88	78	78	67	67	81	67	78	81	70	79	78	78	78	94
R-1	44	40	36	31	33	29	28	24	24	29	22	29	29	23	21	28	24	29	34
RA_{L3}: B with IT & phone equip. > 0.5 W/ft²[b]	56	56	50	50	46	43	43	41	38	41	41	43	43	43	43	43	43	46	56
RA_{L4}: B with IT & phone equip. ≤ 0.5 W/ft²[b]	29	29	23	23	23	20	20	17	17	19	17	19	19	19	19	20	20	22	27
A-2	289	283	209	215	193	160	160	150	136	159	135	150	147	141	142	155	147	155	178
M	70	68	48	51	46	38	38	32	31	35	31	35	35	31	30	34	31	33	36
E	42	45	31	32	28	23	22	18	17	21	15	21	21	21	20	21	20	20	26
S-1 and S-2	14	14	11	11	8	8	8	8	6	8	6	8	8	8	8	10	10	10	11
All Other	36	35	28	27	32	29	29	23	24	28	25	29	29	27	34	33	30	35	34

[same footnotes as IP version]

C406.3.2 G01 Lighting Load Management. Luminaires shall have dimming capability and automatic load management controls that shall gradually reduce *general lighting* power during peak periods. The load management controls shall reduce lighting power in 75 percent of the building area by at least 20 percent with *continuous dimming* over a period no longer than 15 minutes. Where less than 75 percent, but at least 50 percent of the project *general lighting* is controlled, the credits from Tables C406.3 shall be prorated as follows:

[building area with lighting load management, %] x [table credits for C406.3.2] / 75% **(Equation 4-28)**

> **Exception:** Warehouse or retail storage building areas shall be permitted to achieve this credit by switching off at least 25 percent of lighting power in 75 percent of the building area without dimming, or as adjusted by Equation 4-28.

G406.3.3 G02 HVAC Load Management. Automatic load management controls shall be configured:

1. Where electric cooling is in use to gradually increase the cooling setpoint by at least 3°F (1.7°C) over a minimum of three hours or reduce effective cooling capacity to 60% of installed capacity during the peak period.
2. Where electric heating is in use to gradually decrease the heating setpoint by at least 3°F (1.7°C) over a minimum of three hours or reduce effective heating capacity to 60% of installed capacity during the peak period.
3. Where HVAC systems are serving multiple zones and have less than 70 percent outdoor air required, include controls that provide excess outdoor air preceding the peak period and reduce outdoor air by at least 30 percent during the peak period, in accordance with ASHRAE Standard 62.1 Section 6.2.5.2 Short Term Conditions or provisions for *approved* engineering analysis in the International Mechanical Code Section 403.3.1.1, Outdoor Airflow Rate.

C406.3.4 G03 Automated Shading Load Management. Where fenestration on east, south, and west exposures exceeds 20 percent of wall area, load management credits shall be achieved as follows:

1. Automatic exterior shading devices or dynamic glazing that are capable of reducing solar gain (SHGC) through sunlit fenestration by at least 50 percent when fully closed shall receive the full credits in Tables C406.3(1) through C406.3(9). The exterior shades shall have fully open and fully closed SHGC determined in accordance with AERC 1.
2. Automatic interior shading devices with a minimum solar reflectance of 0.50 for the surface facing the fenestration shall receive 40 percent of the credits in Tables C406.3(1) through C406.3(9).
3. All shading devices, dynamic glazing, or shading attachments shall:

   3.1. Provide at least 90 percent coverage of the total fenestration on east, south, and west exposures in the *building.*

   3.2 Be automatically controlled and shall modulate in multiple steps or continuously the amount of solar gain and light transmitted into the space in response to peak periods and either daylight levels or solar intensity

   3.3. Include a manual override located in the same enclosed space as the shaded vertical fenestration that shall override operation of automatic controls no longer than four hours. Such override shall be locked out during peak periods.

For this section, directional east, south, or west exposures shall exclude fenestration that is plus or minus 45 degrees of facing true north in the northern hemisphere. In the southern hemisphere, where the south exposure is referred to, it shall be replaced by the north exposure and the referenced south exposure shall be replaced by the north exposure.

C406.3.5 G04 Electric Energy Storage. Electric storage devices shall be charged and discharged by automatic load management controls to store energy during non-peak periods and use stored energy during peak periods to reduce *building* demand. Electric storage devices shall have a minimum capacity of 1.5 Wh/ft^2 (87 Wh/m^2) of gross *building* area. Base credits in Tables C406.3-1 through C406.3-8 are based on installed electric storage of 5 Wh/ft^2 (54 Wh/m^2) and shall be prorated for actual installed storage capacity between 1.5 and 15 Wh/ft^2 (16 to 160 Wh/m^2), as follows:

[Installed electric storage capacity, Wh/ft^2 (Wh/m^2)]] / 5 (54) × [C406.3.5 Credits from Tables] **(Equation 4-29)**

Larger energy storage shall be permitted however, credits are limited to the range of 1.5 to 15 Wh/ft^2 (16 to 160 Wh/m^2).

C403.6.6 G05 Cooling Energy Storage. Automatic load management controls shall be capable of activating ice or chilled water storage *equipment* to reduce demand during summer peak periods. Storage tank standby loss shall be demonstrated through analysis to be no more than 2 percent of storage capacity over a 24 hour period for the cooling design day.
Base credits in Section C406.3 are based on storage capacity of the design peak hour cooling load with a 1.15 sizing factor. Credits shall be prorated for installed storage systems sized between 0.5 and 4.0 times the design day peak hour cooling load, rounded to the nearest whole credit. Larger storage shall be permitted but the associated credits are limited to the range above. Energy credits shall be determined as follows:

ECs = EC1.0 x (1.44 X SR + 0.71) / 2.15 **(Equation 4-30)**
where:

ECs = Cooling Storage credit achieved for Project
EC1.0 = G05 base energy credit for building use type and climate zone based on 1.0 ton-hours storage per design day ton (kWh/kW) of cooling load
SR = Storage ratio in ton-hours storage per design day ton (kWh/kW) of cooling load where $0.5 \leq SR \leq 4.0$

G406.3.7 G06 SWH Energy Storage. Where SHW is heated by electricity, automatic load management controls comply with ANSI/CTA-2045-B shall preheat stored SHW before the peak period and suspend electric water heating during the peak period. Storage capacity shall be provided by either:

1. Preheating water above 140°F (60°C) delivery temperature with at least 1.34 kWh of energy storage per kW of water-heating capacity. Tempering valves shall be provided at the water heater delivery location.
2. Providing additional heated water tank storage capacity above peak SHW demand with equivalent peak storage capacity to item 1. Where heat pump water heating is used, the credits achieved shall be 1/3 of the credits in Tables C406.3(1) through C406.3(9).

C406.3.8 G07 Building Thermal Mass. The project shall have additional passive interior mass and a night flush control of the HVAC system. The credit is available to projects that have at least 80 percent of gross floor area unoccupied between midnight and 6:00 a.m. The project shall meet the following requirements:

1. Interior to the building envelope insulation, provide 10 lb/ft (50 kg/m) of project conditioned floor area of passive thermal mass in the building interior wall, the inside of the exterior wall, or interior floor construction. Mass construction shall have mass surfaces directly contacting the air in conditioned spaces with directly attached gypsum panels allowed. Mass with carpet or furred gypsum panels or exterior wall mass that is on the exterior of the insulation layer (e.g., the portion of CMU block on the exterior of insulation filled cell cavities) shall not be included toward the building mass required.

2. HVAC units for 80 percent or more of the supply airflow in the project shall be equipped with outdoor air economizers and fans that have variable or low speed capable of operating at 66 percent or lower airflow and be included in the night flush control sequence.

3. Night flush controls shall be configured with the following sequence or another night flush strategy shall be permitted where demonstrated to be effective, avoids added morning heating, and is approved by the authority having jurisdiction.

3.1. Summer mode shall be activated when outdoor air temperature exceeds 70ºF (21ºC) and shall continue uninterrupted until deactivated when outdoor air temperature falls below 45ºF (7ºC). During summer mode, the occupied cooling set point shall be set 1ºF (0.6ºC) higher than normal and the occupied heating set point shall be reset 2ºF (1.1ºC) lower than normal.

3.2. When all the following conditions exist, night flush shall be activated:

3.2.1. Summer mode is active in accordance with item 3.1.

3.2.2. Outdoor air temperature is 5ºF (2.8ºC) or more below indoor average zone temperature.

3.2.3. Indoor average zone temperature is greater than morning occupied heating set point.

3.2.4. In climate zones 0A through 3A, outdoor dewpoint is below 50ºF (10ºC) or outdoor air enthalpy is less than indoor air enthalpy.

3.2.5. Local time is between 10:00 pm and 6:00 am.

3.3. When night flush is active, automatic night flush controls shall operate outdoor air economizers at low fan speed not exceeding 66 percent during the unoccupied period with mechanical cooling and heating locked out.

Revise as follows:

C407.2 Mandatory requirements. Compliance based on total building performance requires that a proposed design meet all of the following:

1. The requirements of the sections indicated within Table C407.2.

2. An annual energy cost that is less than or equal to 80 the percent age of the annual energy cost (PAEC) of the standard reference design calculated in Equation 4-31. Energy prices shall be taken from a source approved by the code official, such as the Department of Energy, Energy Information Administration's State Energy Data System Prices and Expenditures reports. Code officials shall be permitted to require time-of-use pricing in energy cost calculations. The reduction in energy cost of the proposed design associated with on-site renewable energy shall be not more than 5 percent of the total energy cost. The amount of renewable energy purchased from off-site sources shall be the same in the standard reference design and the proposed design**.**

Exception: Jurisdictions that require site energy (1 kWh = 3413 Btu) rather than energy cost as the metric of comparison.

PAEC = 100 x (0.85 + 0.025 - ECr/1000) **(Equation 4-31)**

where:

PAEC = *Percentage of annual energy cost applied to standard reference design*

EC_r = Energy efficiency credits required for the *building* in accordance with Section C406.1 (do not include load management and renewable credits)

TABLE C407.2 REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE

SECTION [a]	TITLE
Envelope	
C402.5	Air leakage—thermal envelope
Mechanical	
C403.1.1	Calculation of heating and cooling loads
C403.1.2	Data centers
C403.2	System design
C403.3	Heating and cooling equipment efficiencies
C403.4, except C403.4.3, C403.4.4 and C403.4.5	Heating and cooling system controls
C403.5.5	Economizer fault detection and diagnostics
C403.7, except C403.7.4.1	Ventilation and exhaust systems
C403.8, except C403.8.6	Fan and fan controls
C403.9	Large-diameter ceiling fans
C403.11, except C403.11.3	Refrigeration equipment performance
C403.12	Construction of HVAC system elements
C403.13	Mechanical systems located outside of the building thermal envelope
C404	Service water heating
C405, except C405.3	Electrical power and lighting systems
C406.1.2	Additional renewable and load management credit requirements
C408	Maintenance information and system commisioning

a. Reference to a code section includes all the relative subsections except as indicated in the table.

Add new text as follows:

APPENDIX CD
ENERGY CREDITS

CD101
General

CD101.1 Purpose. This purpose of this Appendix is to supplement the *International Energy Conservation Code and* requires projects to comply with Advanced Energy Credit Package requirements.

CD101.2 Scope. This Appendix applies to all buildings, in accordance with Section C406.1, required to comply with, either Section C406.1.1 or Section C406.1.3.

CD102
Advanced Energy Credit Package

CD102.1 Advanced Energy Credit Package requirements. The requirements of this Section supercede the requirements of Section C406.1.1. Projects shall comply with measures from C406.2 to achieve the minimum number of required efficiency credits from Table CD102.1 based on building occupancy group and climate zone. Projects with multiple occupancies, unconditioned parking garages, *alterations*, and *buildings* with separate shell-and- core and build-out construction permits shall comply as follows:
Where a project contains multiple occupancies, credits in Table CD102.1 from each building occupancy shall be weighted by the gross floor area to determine the weighted average project energy credits required. Accessory occupancies shall be included with the primary occupancy group for purposes of Section C406 and Appendix CD.

Exceptions:

1. Unconditioned parking garages that achieve 50 percent of the credits required for use groups S-1 and S-2 in Table CD102.1.
2. Portions of buildings devoted to manufacturing or industrial use.

Table CD102.1 Energy Credit Requirements by Building Occupancy Group

Building Occupancy Groups	**Climate Zone**																		
	0A	**0B**	**1A**	**1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
R-2, R-4, and I-1	179	174	188	197	200	200	200	200	200	200	200	200	193	200	200	200	200	200	200
I-2	78	75	73	71	80	90	100	85	90	97	83	90	99	90	96	107	106	130	117
R-1	106	100	110	105	109	122	123	125	131	137	129	136	157	139	147	171	158	180	176
B	114	110	112	115	108	107	116	111	114	126	118	123	135	125	125	152	142	153	141
A-2	83	81	82	82	86	86	108	91	97	126	99	111	147	117	113	160	143	163	151
M	113	113	121	118	123	127	116	116	133	109	100	92	99	134	125	171	146	150	137
E	91	95	91	100	96	100	105	104	101	113	110	110	120	117	122	131	132	126	131
S-1 and S-2	108	106	111	109	109	108	89	106	108	134	100	130	200	143	123	200	190	189	148
All Other	54	53	55	56	57	60	61	60	63	68	60	65	73	68	69	84	79	84	78

Add new standard(s) as follows:

ANSI

American National Standards Institute
25 West 43rd Street, 4th Floor
New York, NY 10036

ANSI/CTA-2045-B – 2018 Modular Communications Interface for Energy Management

IEC

IEC Regional Centre for North America
446 Main Street 16th Floor
Worcester, MA 01608

IEC International Electrotechnical Commission. IEC 62746-10-1 - 2018 Systems interface between customer energy management system and the power management system - Part 10-1: Open automated demand response

OpenADR

OpenADR Alliance
111 Deerwood Road Suite 200
San Roman, CA 94583

OpenADR OpenADR Alliance. OpenADR 2.0a and 2.0b – 2019: Profile Specification Distributed Energy Resources

Add new definition as follows:

SENSIBLE ENERGY RECOVERY RATIO. change in the dry-bulb temperature of the outdoor air supply divided by the difference between the outdoor air and entering exhaust air dry-bulb temperatures, expressed as a percentage.

Add new text as follows:

TABLE C406.2.2.5 DOAS ENERGY RECOVERY ADJUSTMENTS

ERE_{adj} based on lower of actual heating or cooling energy recovery effectiveness where required		
Cooling ERR is ≥	Heating enthalpy recovery ratio or sensible energy recovery ratio is ≥	Energy Recovery Effectivness Adjustment (ERE_{adj})
65%	65%	1.00
60%	60%	0.67
55%	55%[a]	0.33
50%	50%[a]	0.25

a. In climate zones where heating recovery is required for this measure, for dwelling units a heating recovery effectiveness below 60 percent is not allowed.

C406.2.3.1.1 W01 Recoverd or renewable water heating. The *building* service water-heating system shall have one or more of the following that are sized to provide not less than 30 percent of the *building's* annual hot water requirements, or sized to provide not less than 70 percent of the *building's* annual hot water requirements if the *building* is required to comply with Section C403.10.5:

1. Waste heat recovery from SHW, heat recovery chillers, *building* equipment, or process equipment.
2. A water-to-water heat pump that precools chilled water return for *building* cooling.
3. On-site renewable energy water-heating systems.

C406.2.3.1.2 W02 Heat pump water heater. Air-source heat pump *water heaters* shall be installed according to manufacturer's instructions and at least 30 percent of design end use service water heating requirements shall be met using only heat pump heating at an ambient condition of 67.5 F, db without supplemental electric resistance or fossil fuel heating. For a heat pump water heater with supplemental electric resistance heating, the heat pump only capacity shall be deemed at 40 percent of first hour draw. Where the heat pump only capacity exceeds 50 percent of the design end use load excluding *recirculating* system losses, the credits from the Section C406.2 tables shall be prorated as follows:

$EC_{HPWH} = (EC_{BASE}/0.5) \times \{(CAP_{HPWH})/(ENDLOAD)$ [not greater than 2]\} **(Equation 4-19)**

where:

EC_{HPWH} = Energy credits achieved for W02

EC_{BASE} = W02 base energy credits Section 13.5.3

ENDLOAD = End use peak hot water load, excluding load for heat trace or recirculation, Btu/hr or kW

CAP_{HPWH} = the heat pump only capacity at 50ºF (10ºC) entering air and 70ºF (21ºC) entering potable water without supplemental electric resistance or fossil fuel heat, Btu/hr or kW

The heat pump service water heating system shall comply with the following requirements:

1. For systems with an installed total output capacity of more than 100,000 Btu/hr (30 kW) at an ambient condition of 67.5ºF (19.7ºC), db a preheat storage tank with greater than or equal 0.75 gallons per 1000 Btu/hr (≥9.7 L/kW) of design end use service water heating requirements shall be heated only with heat pump heating when the ambient temperature is greater than 45ºF (7.2ºC)
2. For systems with piping temperature maintenance, either a heat trace system or a separate water heater in series for recirculating system and final heating shall be installed.
3. Heat pump *water heater* efficiency shall meet or exceed one of the following:
   3.1 Output-capacity-weighted-average UEF of 3.0 in accordance with 10 CFR 430 Appendix E.
   3.2 Output-capacity-weighted-average COP of not less than 4.0 tested at 50ºF (10ºC) entering air and 70ºF (21ºC) entering potable water in accordance with AHRI standard 1300.

Where the heat pump capacity at 50° F (10° C) entering air and 70° F (21° C) entering water exceeds 50 percent of the design end-use load excluding recirculating system losses, the base credits from Section C406.2 shall be prorated based on Equation 4-20.

W02 credit = base W02 table credit x (HP_{LF}/50%) **(Equation 4-20)**

where:

HP_{LF} = Heat pump capacity as a fraction of the design end-use SHW requirements excluding recirculating system losses, not to exceed 80 percent.

C406.2.3.1.3 W03 Efficient fossil fuel water heater. The combined input-capacity-weighted-average equipment rating of all gas water-heating equipment in the *building* shall be not less than 95 percent Et or 0.93 UEF. This measure shall receive only thirty percent of the listed energy credits for *buildings* required to comply with C404.2.1. Projects where the installed *building* service water heating capacity is less than 200,000 Btu/hr (59 kW) and weighted UEF is not less than 0.82 shall achieve 25 percent of the base table W03 credit.

C406.2.3.1.4 Combination service water heating systems. shall achieve credits using one of the measure combinations as follows:

1. (W01 + W02) Where service water heating employs both energy recovery and heat pump water heating, W01 may be combined with W02 and receive the sum of both credits.
2. (W01 + W03) Where service water heating employs both energy recovery and efficient gas water heating, W01 may be combined with W03 and receive the sum of the W01 credit and the portion of the W03 credit based on item 4.
3. (W02 + W03) Where service water heating employs both heat pump water heating and efficient gas water heating, W02 may be combined with W03 and receive the sum of the W02 credit and the portion of the W03 credit based on item 4.

For items 2 and 3, the achieved W03 credit shall be the Section C406.2.3.1.3 W03 credit multiplied by the fractional share of total water heating installed capacity served by gas water heating that is not less than 95 percent Et or 0.93 UEF. In no case shall the achieved W03 credit exceed 60 percent of the W03 credit in Section C406.2 tables. In *Buildings* that have a service water heating design generating capacity greater than 900,000 Btu/h that proportioned W03 credit shall be further multiplied by 30 percent.

C406.2.5.3.1 Occupant sensor controls. *Occupant sensor controls* shall be installed to control lights in the following space types:

1. Courtroom
2. Electrical/mechanical room
3. Food preparation area
4. Laboratory
5. Elevator lobby
6. Pharmacy area
7. Vehicular maintenance area
8. Workshop
9. Chapel in a facility for the visually impaired
10. Recreation room in a facility for the visually impaired
11. Exercise area in a fitness center
12. Playing area in a fitness center
13. Exam/treatment room in a healthcare facility
14. Imaging room in a healthcare facility
15. Physical therapy room in a healthcare facility
16. Library reading area
17. Library stacks
18. Detailed manufacturing area
19. Equipment room in a manufacturing facility
20. Low-bay area in a manufacturing facility
21. Post office sorting area
22. Religious fellowship hall
23. Religious worship/pulpit/choir area
24. Hair salon
25. Nail salon
26. Banking activity area
27. Computer room, data center
28. Laundry/washing area
29. Medical supply room in a healthcare facility

30. Telemedicine room in a healthcare facility

31. Museum restoration room

C406.2.5.3.2 Occupant sensor control function. *Occupant sensor controls* shall automatically turn lights off within 10 minutes after all occupants have left the space. A manual control complying with C405.2.6 shall allow occupants to turn off lights. *Time-switch controls* are not required.

Exception:In spaces where an automatic shutoff could endanger occupant safety or security *occupant sensor controls* shall uniformly reduce lighting power to not more than 20 percent of full power within 10 minutes after all occupants have left the space. *Time-switch controls* complying with C405.2.2.1 shall automatically turn lights off.

C406.2.5.3.3 Occupant sensor time function. *Occupant sensor controls* installed in accordance with Sections C405.2.1.1, C405.2.1.2, C405.2.1.3, and C405.2.1.4 shall automatically turn lights off or reduce lighting power within 10 minutes after all occupants have left the space. Where lighting power is reduced, the unoccupied setpoint shall be 20 percent of full power or in egress areas to the power level required to meet egress light levels.

Revise as follows:

ASTM

ASTM International
100 Barr Harbor Drive, P.O. Box C700
West Conshohocken, PA 19428-2959

F1696—~~2018~~ 2020	Standard Test Method for Energy Performance of Stationary-Rack, Door-Type Commercial Dishwashing Machines
F1920—~~2015~~ 2020	Standard Test Method for Performance of Rack Conveyor Commercial Dishwashing Machines

Add new text as follows:

AERC

Attachments Energy Rating Council
355 Lexington Ave 15th Floor
New York, NY 10017

AERC AERC 1-2017. Procedures for Determining Energy Performance Properties of Fenestration Attachments

IES Illuminating Engineering Society. ANSI/IES RP-1-2020 Recommended Practice: Lighting Office Spaces
ANSI/IES RP-2-2020 Recommended Practice: Lighting Retail Spaces
ANSI/IES RP-3-2020 Recommended Practice: Lighting Educational Facilities
ANSI/IES RP-4-2020 Recommended Practice: Lighting Library Spaces
ANSI/IES RP-6-2020 Recommended Practice: Lighting Sports and Recreational Areas
ANSI/IES RP-7-2020 Recommended Practice: Lighting Industrial Facilities
ANSI/IES RP-8-2021 Recommended Practice: Lighting Roadway and Parking Facilities
ANSI/IES RP-9-2020 Recommended Practice: Lighting Hospitality Spaces
ANSI/IES RP-10-2020 Recommended Practice: Lighting Common Applications
ANSI/IES RP-11-2020 Recommended Practice: Lighting for Interior and Exterior Residential Environments
ANSI/IES RP-27-2020 Recommended Practice: Photobiological Safety for Lighting Systems
ANSI/IES RP-29-2020 Recommended Practice: Lighting Hospital and Healthcare Facilities
ANSI/IES RP-30-2020 Recommended Practice: Lighting Museums
ANSI/IES RP-41-2020 Recommended Practice: Lighting Theaters and Worship Spaces

Reason: In the 2021 IECC, energy credit measures were expanded from 8 alternate options to 15measures that can be flexibly selected to achieve a 2.5% level of building energy cost savings. A similar package of measures has been proposed for ASHRAE Standard 90.1-2022, with 32 energy efficiency, renewable energy, and load management measures available. Building-type-specific targets were developed with a goal of 5% total energy cost savings.
This proposal includes 40 energy efficiency measures and builds on the former energy credit approaches with a base goal of around 7% energy savings. The energy efficiency credits here are based on site energy use and each credit represents 1/10 of 1% building energy use. Renewable and Load Management measures add cost savings based on grid cost impact represented by a time-of-use electric price structure. While measure goals vary by building type and climate zone, a national weighted goal is as follows:

- The package of cost effective measures achieves a weighted national average of 7.0% site energy savings
- The package of cost effective load management and renewable measures achieves an average of 7.3% utility cost savings

If these measures were adopted nationally into building codes, potential national savings for expected new construction using various metrics would be as given in Table 1 while the impact of renewable and selected load management measures is shown in Table 2.

Table 1. Impact of Energy Credit Measures

Metric[a]	Units	Base Package
National Annual Site Energy Savings	million Btu	7,760,000
Consumer Annual Energy Cost Savings	million $US	$154.0m
Annual Emission Reductions, CO_2	metric tons	995,000

(a) The values shown here are based on national average values. Custom results can be generated for states and local jurisdictions to support adoption of advanced code concepts.

Table 2. Impact of Renewable and Load Management Credit Measures

Metric	Units	Base Package
Consumer Annual Energy Cost Savings	million $US	$158.2m

1. The Code Approach

Energy codes include mandatory requirements that all buildings must fulfill prescriptive requirements that can be used without following a performance path, or whole-building performance paths where equivalent energy performance to the prescriptive path is demonstrated. To fit into the existing code structure, additional energy credits constitute a new prescriptive requirement; however, instead of all measures being required, the building designer can select from various options to achieve a defined level of energy performance. To maintain equivalent energy impact, whole-building performance paths must be adjusted to reflect the impact of the required energy credits.

2. Energy Credit Development Energy credits have been developed from typical measures used in green building programs, new construction utility incentive programs, and Advanced Energy Design Guidelines (ASHRAE 2019b). A detailed discussion of the methodology used to develop individual credits can be found in the published Energy Credit Tech Brief at https://www.energycodes.gov/stretch-codes

Referenced Standards.

ANSI/CTA-2045-B-2018 Modular COmmunications Interface for Energy Management: https://shop.cta.tech/products/modular-communications-interface-for-energy-management

OpenADR 2.0a and 2.0b – 2019: Profile Specification Distributed Energy Resources : https://www.openadr.org/specification-download

The following notes should be included in the Commentary:

Section C406.2.3.5 *Note to adopting jurisdictions, consider including the following commentary to clarify the requirements of C406.2.3.5 Where low water supply pressures are anticipated, user satisfaction may be enhanced if flow restrictors are specified to provide ≥80% of the rated flow at 20 psi (140 kPa).Where the distribution sizing protocol is applied to other than multifamily residential buildings, a variance to the plumbing code may be needed.*

Section C406.2.5.4 *Note to adopting jurisdictions, consider including the following informative note to clarify the requirements of C406.2.5.4. In IES LM83, spatial daylight autonomy (sDA) means the amount of daylight received in a space over a portion of operating hours each year. It is written as sDA###,YY% where the ### indicates the desired lux provided by the daylight. The YY% indicates the portion of operating hours per year to receive that daylight. It also includes an area requirement or statement. For example, sDA200,60% for 30% of regularly occupied spaces means that 30% of regularly occupied spaces receive at least 200 lux for at least 60% of the operating hours each year.*

Section C406.3.1 *On-site renewable energy may include thermal service water heating or pool water heating in which case ratings in Btu/h can be converted to W where W = Btu/h / 3.413.*

Section C406.3.4 *This credit can be met by exterior roller, movable blind, or movable shutter shading devices; however fixed overhang, screen or shutter shading will not meet the requirement. Roller shades that reject solar gain but still allow a view are allowed as long as they provide an effective 50% reduction in net solar gain, e.g., have a shading coefficient of less than 0.5 for the shading material itself. Interior shading devices will not meet the requirement. Electrochromatic windows that achieve 50% of SHGC would qualify.*

Section C406.3.8 *The simplified night flush sequence described will operate in “Summer Mode” below the 70F OA trigger temperature down until OA of 45F is hit when the “Summer Mode” is deactivated until the OA rises above 70F again. Other strategies may be implemented that cool the space* *below the heating setpoint and adjust the morning heating setpoint to avoid morning reheating.*

Section C407.2 *The formula above allows adjustment for the current energy credits required in the IECC (2.5% or 0.025) and the new energy efficiency credit requirements that come from Section C406.1.1.*

Coordination with Proposal CEPI-76-21

This proposal includes language that coordinates with proposal CEPI-76-21 HVAC Total System Performance Ratio. Energy Credit H01 described in Section C406.2.2.1 allows projects using TSPR an easy way to document energy credits and is contingent on the approval of CEPI-76-21. The proposed coordinating language includes:

1. Section 406.2.2 numbered list items 1 and 7.

2. Section C406.2.2.1,

3. the base energy credits for H01 in Tables C406.1.4(1) through C406.1.4(9).

If Proposal CEPI-76-21 is not approved for publication in the 2024 IECC then the coordinating language for energy credit H01 needs to be removed from this proposal prior to publication.

Cost Impact: The code change proposal will increase the cost of construction.
While baseline prescriptive requirements usually undergo individual review for cost effectiveness, the approach to energy credit measures is different. Each measure can be selected for a particular building; however, not all measures are required, so the approach is to find at least one package of measures that are shown to be cost effective.

The energy credit requirements are justified based on a selection of a package of measures that meet the requirement and are cost effective for each building use type and climate zone. About one quarter of the measures were selected for inclusion in the cost effectiveness analysis, based on their general applicability and reliable savings. Two requirement packages were determined for evaluation of cost effectiveness:· The package included standard efficiency measures with a cap of 10% for required credits to allow for measure selection flexibility. While the energy credits are limited to 10% whole-building savings, in many cases the selected measures that were cost effective exceeded that savings level. Table 8 provides an overview of measures selected for inclusion in the package. Measures are selected with the goal of 7% savings or 70 credits for this package. Measure selection may be climate zone specific. For example, cooling efficiency only makes sense in warm climate zones. The climate zones (CZ) or application of measures is shown along with individual measure lives shown for determining cost effectiveness.

Based on this selection of measures, the scalar value or payback for each building type for the selected group of measures is given in Table 9. This represents the cost for all measures included in the package divided by the annual consumer energy cost savings. Note that for multifamily buildings and hotels, the SHW distribution redesign results in a significant cost reduction, so the overall package cost is less than the baseline and the "CE" indicates that the packages in those buildings are immediately cost effective. A scalar limit or threshold is developed for each combination of climate zone and building type based on the individual measure lives shown in Table 7, weighted by the measure cost savings. The measures included in the base package and therefore credits required are adjusted so that all building types in all climate zones have a consumer payback that is less than the scalar limit, indicating cost effectiveness for the efficiency credit requirements.

Table 7. Scalar Ratio Method Economic Parameters and Scalar Ratio Limit

Input Economic Variables	Heating (gas) SRh	Cooling (electricity) SRc
Economic Life – Years (example)	40	40
Down Payment - $	0.00	0.00
Energy Escalation Rate - %[a]	2.90	2.25
Nominal Discount Rate - %[b]	8.1	8.1
Loan Interest Rate - %	5.0	5.0
Federal Tax Rate - %[b]	NA[b]	NA[b]
State Tax Rate - %[b]	NA[b]	NA[b]
Heating – Natural Gas Price, $/therm	0.983	
Cooling - Electricity Price $/kWh		0.1099
Scalar Ratio Limit (weight: 0.25/0.75)	**25.4**	**22.0**

(a) The energy escalation rate used in the scalar calculation for 90.1-2022 includes inflation, so it is a nominal rather than a real escalation rate.
(b) Beginning with addenda for 90.1-2016, SSPC 90.1 eliminated tax analysis from the Scalar Method by using a pre-tax discount rate.

Table 8. Matrix of Base Package Efficiency Measures

ID	Energy Credit Abbreviated Title	Measure Life, yr	Multifamily /Dormitory	Health Care	Hotel/Motel	Office	Restaurant	Retail	School/ Education	Warehouse/ Semiheated
E01	Glazing U & SHGC reduction	40	CZ 0A-1A	all CZ	all CZ	all CZ			all CZ	
E02	UA Reduction (15%)	40						All CZ		
H02	Heating efficiency	18		CZ 5-8	CZ 5-8	CZ 5-8	CZ 5-8	CZ 5B-8	CZ 5-8	CZ 4C-8
H03	Cooling efficiency.	15	CZ 0-2	CZ 0-2	CZ 0-3B	CZ 0-3B	CZ 0-3B	CZ 0-3B	CZ 0-3B	CZ 0-3B
H04	Residential HVAC control.	15	CZ 0-3, 6-8							
W02	Heat pump water heater	19					30% all CZ	CZ0, 4B-5		
W03	Efficient gas water heater	15	all CZ	all CZ	all CZ	all CZ	70% all CZ		all CZ	
W06	Thermostatic balancing valves	15	all CZ	all CZ	all CZ	all CZ			all CZ	
W08	SHW distribution sizing	15	all CZ		all CZ					
L03	Increase occupancy sensor	15		all CZ						all CZ
L04	Increase daylighting area	15						CZ 0-5		all CZ
L06	Light power reduction	20	5% all CZ	15% all CZ	15% all CZ	15% all CZ	10% all CZ	10% all CZ	15% all CZ	10-15% all CZ
Q02	Efficient kitchen equipment	15	(a)		(a)		all CZ		(a)	
Q04	Fault detection	15		all CZ	all CZ	CZ 0-4			all CZ	

[a] Dining areas and kitchens in dormitories, hotels, and schools treated as a separate area where efficient kitchen equipment credits apply

Table 9. Scalar Ratios for Base Package Efficiency Measures by Climate Zone and Building Type

	Climate Zone																		
Building Use Type	0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
Multifamily/Dormitory	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE
Health Care	3.0	3.3	3.3	3.3	3.2	3.6	2.7	2.8	2.4	2.5	2.6	2.3	2.6	2.6	2.0	2.6	2.5	2.3	2.3
Hotel/Motel	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE
Office	11.7	12.1	13.1	12.7	13.2	13.6	13.3	13.1	12.6	11.0	10.7	11.7	10.9	10.7	11.8	9.6	10.0	9.8	9.1
Restaurant	3.2	3.5	4.2	3.9	4.3	4.7	4.9	4.9	4.9	4.7	4.7	4.7	3.5	3.8	4.0	3.1	3.4	2.8	2.4
Retail Buildings	4.0	4.3	4.8	4.6	5.4	5.5	6.1	6.2	4.9	4.4	5.0	5.3	4.3	4.6	5.2	3.4	4.5	5.1	5.0
School/Education	6.5	7.3	8.5	7.8	8.8	9.8	9.1	9.0	8.0	7.1	7.1	7.8	6.6	6.1	7.2	5.4	6.1	5.2	4.4
Warehouse	8.3	8.1	9.4	8.9	9.8	9.5	8.0	7.7	2.7	2.8	2.7	2.9	1.8	2.4	3.0	1.4	1.8	1.5	1.5

Bibliography: Hart, R, J. McNeil, M. Tillou, E. Franconi, C. Cejudo, C. Nambiar, H. Nagada, D. Maddox, J. Lerond, M. Rosenberg. 2021. Expanded Energy and Load Management Credits in Energy Codes. PNNL-32001, Pacific Northwest National Laboratory, Richland, WA.
https://www.energycodes.gov/sites/default/files/2021-07/TechBrief_EnergyCredits_July2021.pdf

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: CEPI-193-21 expands the number of energy savings options compared to IECC-2021 and more than doubles the additional energy saving requirement on average. The proposal also customizes the additional efficiency requirements by building type and climate zone to better match individual building energy savings potential. The proposal puts renewable energy into a separate category with load management measures to encourage preparation of buildings to meet the future needs of the electric grid. Renewable requirements can also be met with off-site renewable contracts.

CEPI-203-21

Proponents: Helen Sanders, Facade Tectonics Institute/Technoform North America, representing Facade Tectonics Institute

2021 International Energy Conservation Code

Revise as follows:

C405.12 Energy monitoring. New buildings with a gross *conditioned floor area* of 25,000 square feet (2322 m^2) or larger shall be equipped to measure, monitor, record and report energy consumption data in compliance with Sections C405.12.1 through C405.12.5. A plan for quantifying annual energy type and use disclosure in compliance with Sections C405.12.1 through C405.12.8 shall be submitted with the construction documents.

> **Exception:** R-2 occupancies and individual tenant spaces are not required to comply with this section provided that the space has its own utility services and meters and has less than 5,000 square feet (464.5 m^2) of *conditioned floor area*.

C405.12.1 Electrical energy metering. For all electrical energy supplied to the building and its associated site, including but not limited to site lighting, parking, recreational facilities and other areas that serve the building and its occupants, meters or other measurement devices shall be provided to collect energy consumption data for each end-use category required by Section C405.12.2.

Revise as follows:

C405.12.2 End-use electric metering categories. Meters or other approved measurement devices shall be provided to collect energy use data for each end-use category indicated in Table C405.12.2. Where multiple meters are used to measure any end-use category, the data acquisition system shall total all of the energy used by that category. Not more than 5 percent of the measured load for each of the end-use categories indicated in Table C405.12.2 shall be permitted to be from a load that is not within that category.

Exceptions:

1. HVAC and water heating equipment serving only an individual dwelling unit shall not require end-use metering.
2. End-use metering shall not be required for fire pumps, stairwell pressurization fans or any system that operates only during testing or emergency.
3. End-use metering shall not be required for an individual tenant space having a floor area not greater than 2,500 square feet (232 m^2) where a dedicated source meter complying with Section C405.12.3 is provided.

TABLE C405.12.2 ELECTRICAL ENERGY USE CATEGORIES

LOAD CATEGORY	DESCRIPTION OF ENERGY USE
Total HVAC system	Heating, cooling and ventilation, including but not limited to fans, pumps, boilers, chillers and water heating. Energy used by 120-volt equipment, or by 208/120-volt equipment that is located in a building where the main service is 480/277-volt power, is permitted to be excluded from total HVAC system energy use.
Interior lighting	Lighting systems located within the building.
Exterior lighting	Lighting systems located on the building site but not within the building.
Plug loads	Devices, appliances and equipment connected to convenience receptacle outlets.
Process load	Any single load that is not included in an HVAC, lighting or plug load category and that exceeds 5 percent of the peak connected load of the whole building, including but not limited to data centers, manufacturing equipment and commercial kitchens.
Building operations and other miscellaneous loads	The remaining loads not included elsewhere in this table, including but not limited to vertical transportation systems, automatic doors, motorized shading systems, ornamental fountains, ornamental fireplaces, swimming pools, in-ground spas and snow-melt systems.
Electric hot water heating	Electricity used to generate hot water. Exception: Electric water heating with design capacity that is less than 10% of building service rating

C405.12.3 Electric Meters. Meters or other measurement devices required by this section shall be configured to automatically communicate energy consumption data to the data acquisition system required by Section C405.12.4. Source meters shall be allowed to be any digital-type meter. Lighting, HVAC or other building systems that can self-monitor their energy consumption shall be permitted instead of meters. Current sensors shall be permitted, provided that they have a tested accuracy of ±2 percent. Required metering systems and equipment shall have the capability to provide at least hourly data that is fully integrated into the data acquisition system and graphical energy report in accordance with Sections C405.12.4 and C405.12.5. Non-intrusive load monitoring (NILM) packages that extract energy consumption data from detailed electric waveform analysis can be substituted for individual meters if the equivalent data can be made available for collection in C405.12.4 and reporting in C405.12.5

C405.12.4 Electrical energy dData acquisition system. A data acquisition system shall have the capability to store the data from the required meters and other sensing devices for a minimum of 36 months. The data acquisition system shall have the capability to store real-time energy consumption data and provide hourly, daily, monthly and yearly logged data for each end-use category required by Section C405.12.2. The data acquisition system shall have the capability of providing building total peak electric demand and the time(s) of day and time(s) of year at which the peak occurs. Peak demand shall be integrated over the same time period as the underlying meter reading rate, which is typically 15 minutes but shall be no longer than one hour.

C405.12.5 Graphical energy report. A permanent and readily accessible reporting mechanism shall be provided in the building that is accessible by building operation and management personnel. The reporting mechanism shall have the capability to graphically provide the electrical energy consumption for each end-use category required by Section C405.12.2 at least every hour, day, month and year for the previous 36 months. The graphical report shall also incorporate natural gas interval data or the ability to enter gas utility bills into the report.

Add new text as follows:

C405.12.6 Non-electrical energy. Consumption of non-electrical energy such as gas, district heating or cooling, unregulated fuel sources, or other non-renewable energy shall be automatically metered or a method developed for usage calculation annually or more frequently from energy bills. Natural gas usage shall be monitored through on site interval metering or from utility interval data.

C405.12.7 Renewable energy. The ability to measure the production of on-site renewable energy shall be provided with the same or greater frequency as metered systems.

C405.12.8 Plan for disclosure. The plan for annual energy use data gathering and disclosure shall include the following:

1. Property information including building type, total gross floor area, year built or year planned for construction completion, and occupancy type.
2. Total annual building site energy use per unit area (square foot) of gross floor area as collected or documented through C405.12.5 (electrical) and C405.12.6 (non-electrical) sources, separated by energy type (electric, gas, district cooling or heating, unregulated fuel sources etc.). Electrical energy shall be further broken down by load type as identified in Table C405.12.2.
3. Annual site generated renewable energy per unit area (square foot) of gross floor area.
4. Peak electric demand per unit area (square foot) of gross floor area, with an estimate of relative building system contribution to that peak, and the time and date of the peak.

5. For projects using the section C407 Total Building Performance approach to show compliance, include the following information from the building simulation:

    5.1. Modeling software used.

    5.2 Assumptions made that impact the simulated annual energy use per unit (square foot or square meter) of gross floor area (e.g. occupancy schedules, daylighting assumptions, climate file, plug loads, envelope performance including use of shading systems).

    5.3 Simulated annual energy use per unit (square foot or square meter) of gross floor area.

    5.4 Peak load, the time of date and time of peak and the hourly load profile on the day that experiences peak load.

Reason: Historically, energy efficiency has been a means to address concerns over oil and fuel shortages, using demand reduction to limit our "vulnerability to energy supply disruptions"[1]. Over the past five decades, however, the role of energy efficiency has morphed into something even more critical – playing a key part in slowing down the rate of anthropogenic climate change highlighted by the IPCC's most recent Sixth Assessment Report and mitigating the impacts that climate change is already manifesting with dire consequences. As the International Code Council's Energy Efficiency website itself states, "The International Code Council family of solutions is helping our communities forge a path forward on energy and sustainability to confront the impacts of a changing climate."[2]With buildings making up nearly 40% of the total greenhouse gas emissions globally[3], it is imperative that we start enforcing accountability for actual building energy use rather than continue to rely on predicted energy consumption, which may not accurately reflect the building's true energy consumption. Of course, operational energy is not the only option we should pursue to mitigate the risks of climate change, but we should consider this a reasonable starting point, in line with the trajectory of the IECC.
We need to close the information loop on building energy performance, and we need to do it fast. If we don't start tracking actual energy use now, and correlating that to design intent, how will we know what aspects of building design, operations, and maintenance require our focus and dedication to rectify or improve upon? This proposal is for the 2024 code cycle, which means we only have two additional opportunities beyond this cycle to implement tangible step changes before we hit 2030, the target date for achieving zero energy buildings.

Furthermore, in the context of the current COVID-19 pandemic, we are seeing significant shifts in the way buildings are being used, with more flexibility in office schedules, hotdesking or hoteling, variable occupancy levels, and the need for more (natural) ventilation. These shifts make it even harder for energy models to predict energy use in a meaningful and informative way using current best standards and methods. Ongoing post-occupancy measurement and verification is the only way to reliably track and manage energy use. Without data, we cannot glean information and turn that into knowledge and even wisdom of how our buildings operate.

We are already seeing the following costs/risks associated with Business As Usual (BAU) here in the US and in Canada:- Shifting map of hurricane zones such that more areas are experiencing higher risks[4] (*e.g.,* Hurricane Sandy affecting New England)

- More extreme wildfires that create their own weather systems, making it even harder to contain them[5] (*e.g.,* Bootleg Fire in Oregon)

- Heat domes that exceed scientific predictions, even accounting for climate change[6] (*e.g.,* Pacific NW in early 2021)

Some are calling this the "social" cost of carbon, but it all boils down to a financial cost to humans – often inequitably – in the end.

Fabia Jeddere-Fisher, Senior Lecturer in Energy Engineering of University of the West of England (UWE) Bristol, Department of Architecture & Built Environment who is in charge of "metering, monitoring, and reporting energy use" and "identifying and setting targets for energy/carbon savings across the UWE estate" noted that Display Energy Certificate ratings do in fact impact the way building users interact with the buildings.

Proposal:

The FTI Advocacy Committee proposes the following new clause under **Chapter 4 – "Commercial Energy Efficiency", Section C407 – "Total Building Performance", Sub-Section, C407.2 – "Mandatory requirements"**:

Energy use intensity (EUI) shall be publicly declared for all buildings that are equal to or greater than 50,000 SF after 12 months of continuous occupied building use within the first 36 months of occupancy. These EUI declarations, based on actual measured energy consumption, will need to be displayed publicly on the building and accessible online.

The following information shall be reported and displayed publicly:

- Property information for each building, including:

o Property name

o Property address

o Property type

o Total gross floor area

o Year built / planned for construction completion

o Occupancy

- Predicted energy use as calculated for the *proposed design* using code-approved compliance software tools, per Section C407.5 – "Calculation software tools".

- Total building site energy use as documented on utility bills, broken down by energy type (*e.g.,* electricity, gas, etc.)*

- If energy use is tied to the electrical grid, provide the following information:

o Peak electric demand

o Date/time of peak

o Load-duration curves for all 8,760 hours of the year (TBD: Some might be monthly, hourly for the year, seasonal, etc.)

*<u>Note:</u> Consideration may also be needed to account for the following:

· Other energy sources on site (*e.g.,* oil, wood pellets, heat recovery incinerators, etc.)

· District heating/cooling (*e.g.,* steam or chilled water delivered to site)

· On-site electrical generation (*e.g.,* photovoltaics, fossil fuel, waste combustion, etc.)

· Waste heat generated on site but used offsite at another building

We have suggested 50,000 sq.ft. as the building size limit because of the relatively large impact that large buildings have on the overall energy usage, yet these comprise a relatively small number of actual buildings. The CBECS database indicates there are approximately 6 million commercial buildings with an average size of 16K sq.ft. Buildings of size greater than 50,000 sq.ft. represent a very small portion, ~5%, of the building stock in number, but around 50% of the floor area, and thus 50% of the energy impact. The 2018 Commercial Building Energy Consumption Survey[7] indicates that the top 3% of the largest buildings use 34% of the energy nationwide. Therefore addressing disclosure for the big buildings first is much easier both logistically and administratively, while not giving up much impact or savings.

The intent of this proposal is for benchmarking energy use, providing more transparency for building tenants, providing a needed feedback loop for energy simulation improvement, and getting the infrastructure in place for future measurement and verification opportunities, such as the possibility of including sub-metering for spotting trends and providing insight into potential areas of improvement.

The infrastructure to report actual building energy use is already in place, and some building energy labels "have gained significant market share".[8] In the US, one such established benchmarking platform is the ENERGY STAR® Portfolio Manager, an online reporting tool developed by the US Environmental Protection Agency (EPA). The following are two more platforms that can also be considered:

- ASHRAE Building Energy Quotient

- International Performance Measurement and Verification Protocol (IPMVP)

The additional effort required by building owners to comply with this proposed code development is not so onerous that it cannot be implemented at a national level. The ASHRAE 90.1 Standard has required sub-metering since the 2013 code cycle, which has been adopted by a number of states already. This EUI declaration proposal for IECC does not currently require sub-metering (to keep it simple and low cost), but it could be a consideration for future code cycles leading up to 2030.

In the future, the following incentives could be included in the further code cycles:

- Building owners will receive a rebate or credit for buildings that perform better than their predicted energy use.

- The IECC shall provide an opportunity for buildings that perform worse than their predicted energy use to make improvements over a subsequent 12-month period change their EUI.

<u>**Precedents in the US:**</u>

A number of states and cities already require commercial building energy disclosure[9] to some extent, including, but not limited to:

- California
- District of Columbia
- New Jersey
- New York
- Oregon
- Washington State
- Austin[10]
- Boston[11]
- Los Angeles[12]
- San Francisco[13]

A map of US cities and states with benchmarking programs and policies is given in this reference[14] and see attached version of this narrative with illustrations. Even more states require at least some or all of their public buildings and facilities to benchmark energy use[15], including, but not limited to the following states:

- Alabama
- Arkansas
- California
- Colorado
- Connecticut
- Florida
- Maryland
- Michigan
- Mississippi
- Nebraska
- New Mexico
- New York
- Ohio
- Pennsylvania
- Texas
- Washington State

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Reporting data that is already available from utility bills, construction documents, and building simulations already submitted for code compliance and so will not change the cost of construction. If there is any administrative cost to disclosure, it should be minimal in the budget of a 50,000 sq.ft. building.

Bibliography: [1]https://www.ase.org/sites/ase.org/files/resources/Media%20browser/ee_commission_history_report_2-1-13.pdf
[2]https://www.iccsafe.org/products-and-services/codes-standards/energy/

[3]https://www.eia.gov/tools/faqs/faq.php?id=86&t=1

[4]https://www.c2es.org/content/hurricanes-and-climate-change/

[5]https://www.nytimes.com/2021/07/19/climate/bootleg-wildfire-weather.html

[6]https://www.theguardian.com/environment/2021/jul/02/canadian-inferno-northern-heat-exceeds-worst-case-climate-models

[8]2018 Commercial Building Energy Consumption Survey: https://www.eia.gov/consumption/commercial/pdf/CBECS%202018%20Preliminary%20Results%20Flipbook.pdf

[7]https://www.osti.gov/servlets/purl/1168594

[8]https://database.aceee.org/state/building-energy-disclosure

[9]https://austinenergy.com/ae/energy-efficiency/ecad-ordinance/for-commercial-buildings/for-commercial-buildings

[10]https://www.boston.gov/departments/environment/building-energy-reporting-and-disclosure-ordinance

[11]https://www.betterbuildingsla.com/

[12]https://sfenvironment.org/existing-buildings-energy-performance-ordinance

[13]https://www.energystar.gov/buildings/program-administrators/state-and-local-governments/see-federal-state-and-local-benchmarking-policies

[14]https://database.aceee.org/state/public-building-requirements

Attached Files

- **FTI proposal to IECC 2024 for Energy Use Declaration.docx**
  https://energy.cdpaccess.com/proposal/453/1233/files/download/146/

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Requires new buildings greater than 25,000 sf be equipped with equipment to measure, monitor, record and report energy consumption data. A proposed annual consumption by energy type and disclosure report shall be submitted as part of the CDs.

CEPI-207-21

Proponents: James Ranfone, representing American Gas Association

2021 International Energy Conservation Code

Revise as follows:

C407.2 Mandatory requirements. Compliance based on total building performance requires that a proposed design meet all of the following:

1. The requirements of the sections indicated within Table C407.2.
2. An annual energy cost that is less than or equal to 80 percent of the annual energy cost of the *standard reference design*. Energy prices shall be taken from a source *approved* by the *code official*, such as the Department of Energy, Energy Information Administration's *State Energy Data System Prices and Expenditures* reports. *Code officials* shall be permitted to require time-of-use pricing in energy cost calculations. The reduction in energy cost of the proposed design associated with *on-site renewable energy* shall be not more than 5 percent of the total energy cost. The amount of renewable energy purchased from off-site sources shall be the same in the *standard reference design* and the *proposed design*.

Exceptions: ~~Jurisdictions that require site energy (1 kWh = 3413 Btu) rather than energy cost as the metric of comparison.~~

1. Jurisdictions that require site energy (1 kWh = 3413 Btu) rather than energy cost as the metric of comparison.
2. Where energy use based on source energy expressed in Btu or Btu per square foot of conditioned floor area is substituted for the energy cost, the energy use shall be calculated using source energy factors from Table C407.2.1. For electricity, U.S. locations shall use values eGRID subregions. Locations outside the U.S. shall use the value for "All other electricity" or locally derived values.

Add new text as follows:

Table C407.2.1 Source Energy Conversion Factors for Electricity

Fossil Fuels Delivered to Buildings	
Natural Gas	1.092
LPG or propane	1.151
Fuel oil (residual)	1.191
Fuel oil (distillate)	1.158
Coal	1.048
Gasoline	1.187
Other fuels not specified in this table	1.048
Electricity	
AKGD-ASCC Alaska Grid	2.47
AKMS-ASCC Miscellaneous	1.35
AZNM-WECC Southwest	2.57
CAMX-WECC California	1.66
ERCT-ERCOT All	2.32
FRCC-FRCC All	2.78
HIMS-HICC Miscellaneous	3.15
HIOA-HICC Oahu	3.87
MROE-MRO East	2.92
MROW-MRO West	2.21
NEWE-NPCC New England	2.66
NWPP-WECC Northwest	1.48
NYCW-NPCC NYC/Westchester	2.89
NYLI-NPCC Long Island	2.84
NYUP-NPCC Upstate NY	1.81
PRMS-Puerto Rico Miscellaneous	3.27
RFCE-RFC East	2.90
RFCM-RFC Michigan	2.93
RFCW-RFC West	2.97
RMPA-WECC Rockies	2.16
SPNO-SPP North	2.21
SPSO-SPP South	2.05
SRMV-SERC Mississippi Valley	2.84
SRMW-SERC Midwest	3.09
SRSO-SERC South	2.89
SRTV-SERC Tennessee Valley	2.82
SRVC-SERC Virginia/Carolina	2.91
All other electricity	2.51
Thermal Energy	
Chilled water	0.60
Steam	1.84
Hot Water	1.73

Reason: The proposed change brings C407.2 into greater consistency with R405.3 and source energy metric usage in Federal energy programs including Energy Star for Commercial Buildings and Home Energy Score. This revised exception provides the only means of assessing energy performance on fuel cycle energy consumption and ultimately carbon footprints since site energy metrics alone cannot account for these upstream energy system losses. In addition, the allowance in the proposed exception language for use of "other multipliers" addresses a persistent criticism of national average multipliers, which may not reflect regional or local mixes of renewable energy in meeting building demands, and encourages authorities having jurisdiction to use locally-relevant multipliers that are available from utilities and other sources. Also, greater usefulness of the exception is critical since the basic requirements of C407.2 focusing on energy cost is not consistent with the intent of the IECC as stated in C101.3, which addresses energy use and conservation, not energy cost.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Cost Impact: The code change proposal will not increase or decrease the cost of construction The proposal would not increase the cost of construction since the proposal is for changes to an exception. If the use of source energy metrics allows more alternatives for achieving energy performance improvements, it may decrease construction costs ultimately.Cost Impact: The code change proposal will not increase or decrease the cost of construction The proposal would not increase the cost of construction since the proposal is for changes to an exception. If the use of source energy metrics allows more alternatives for achieving energy performance improvements, it may decrease construction costs ultimately.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: This proposal revises the building performance exception to include a source energy comparison based on ASHRAE Standard 189.1-2020 conversion factors. This revised exception provides the only means of assessing energy performance on fuel cycle energy consumption and ultimately carbon footprints since site energy metrics alone cannot account for these upstream energy system losses.

Proposal # 492

CEPI-208-21

Proponents: Marcin Pazera, representing Polyisocyanurate Insulation Manufacturers Association (mpazera@pima.org); Justin Koscher, Polyisocyanurate Insulation Manufacturers Association, representing Polyisocyanurate Insulation Manufacturers Association (jkoscher@pima.org)

2021 International Energy Conservation Code

Revise as follows:

TABLE C407.2 REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE

SECTION [a]	TITLE
Envelope	
C402.2.1.2	Minimum thickness, lowest point
C402.2.1.3	Suspended ceilings
C402.2.1.4	Joints staggered
C402.2.1.5	Skylight curbs
C402.5	Air leakage—thermal envelope
Mechanical	
C403.1.1	Calculation of heating and cooling loads
C403.1.2	Data centers
C403.2	System design
C403.3	Heating and cooling equipment efficiencies
C403.4, except C403.4.3, C403.4.4 and C403.4.5	Heating and cooling system controls
C403.5.5	Economizer fault detection and diagnostics
C403.7, except C403.7.4.1	Ventilation and exhaust systems
C403.8, except C403.8.6	Fan and fan controls
C403.9	Large-diameter ceiling fans
C403.11, except C403.11.3	Refrigeration equipment performance
C403.12	Construction of HVAC system elements
C403.13	Mechanical systems located outside of the building thermal envelope
C404	Service water heating
C405, except C405.3	Electrical power and lighting systems
C408	Maintenance information and system commisioning

a. Reference to a code section includes all the relative subsections except as indicated in the table.

Reason: This section clarifies the code's intent that general roof insulation installation requirements apply to all of the IECC compliance methods by including the installation criteria when using total building performance in the IECC.
Currently, the proposed design that utilizes the total building performance path under Section C407 must meet only the mandatory air leakage provisions for the thermal envelope in Section C402.5. This proposal intends to add insulation installation requirements for roof assemblies as mandatory requirements. The specific sections proposed for addition include: minimum thickness, lowest point (Section C402.2.1.2), suspended ceilings (Section C402.2.1.3), joints staggered (C402.2.1.4). In addition, the proposal adds mandatory requirements for insulating skylight curbs, which is already part of (Section C402.2.1.5). This proposal does not bring new requirements into the IECC. It merely, references requirements in existing sections of the IECC for mandatory compliance. More importantly, the provisions that are being added have been developed and recognized as important measures that improve roof and overall performance of building envelopes from an energy, moisture, and air leakage standpoint. As an example, the practice of installing insulation above roof deck in minimum of two layers with joints staggered is not only required by the IECC but it is also recognized by roofing industry stakeholders as an approach that improves overall performance of roof systems.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal will not increase the cost of construction. The proposal does not introduce new requirements into the IECC, but clarifies that these important insulation installation requirements also apply to the total building performance compliance method.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: The modeling SC unanimously agreed to additional insulation requirements (suspended ceilings, staggered joints and skylight curbs) to Table C407.2.

CEPI-209-21

Proponents: Jay Crandell, P.E., ABTG/ARES Consulting, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2021 International Energy Conservation Code

Revise as follows:

TABLE C407.2 REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE

SECTION [a]	TITLE
Envelope	
C401.3	Thermal envelope certificate
C402.2.6	Insulation of radiant heating system
C402.5	Air leakage—thermal envelope
Mechanical	
C403.1.1	Calculation of heating and cooling loads
C403.1.2	Data centers
C403.2	System design
C403.3	Heating and cooling equipment efficiencies
C403.4, except C403.4.3, C403.4.4 and C403.4.5	Heating and cooling system controls
C403.5.5	Economizer fault detection and diagnostics
C403.7, except C403.7.4.1	Ventilation and exhaust systems
C403.8, except C403.8.6	Fan and fan controls
C403.9	Large-diameter ceiling fans
C403.11, except C403.11.3	Refrigeration equipment performance
C403.12	Construction of HVAC system elements
C403.13	Mechanical systems located outside of the building thermal envelope
C404	Service water heating
C405, except C405.3	Electrical power and lighting systems
C408	Maintenance information and system commisioning

a. Reference to a code section includes all the relative subsections except as indicated in the table.

Reason: When this table was introduced last cycle to consolidate various mandatory requirements to be considered in the total building performance path, many details from the mechanical provisions were included. However, many similar mandatory details in the envelope provisions were missed. These include matters that apply regardless of the compliance path used. For example, an envelope certificate should apply regardless of the compliance path. This does not change requirements or limit the use of the performance path to adjust criteria. Instead, it ensures minimum practices are at least satisfied even when otherwise altering insulation and performance requirements for the building thermal envelope.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal does not change requirements but ensures that minimum practices are used consistently for all compliance paths, even though the criteria for those practices may be traded off in the the performance path.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: removal of insulation installation and airspaces from mandatory provisions

Proposal # 167

CEPI-211-21

Proponents: Anurag Goel, representing enVerid Systems (agoel@enverid.com); Kimberly Cheslak, NBI, representing NBI (kim@newbuildings.org)

2021 International Energy Conservation Code

Revise as follows:

TABLE C407.4.1(1) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

BUILDING COMPONENT CHARACTERISTICS	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Space use classification	Same as proposed	The space use classification shall be chosen in accordance with Table C405.3.2(1) or C405.3.2(2) for all areas of the building covered by this permit. Where the space use classification for a building is not known, the building shall be categorized as an office building.
Roofs	Type: insulation entirely above deck	As proposed
	Gross area: same as proposed	As proposed
	U-factor: as specified in Table C402.1.4	As proposed
	Solar absorptance: 0.75	As proposed
	Emittance: 0.90	As proposed
Walls, above-grade	Type: same as proposed	As proposed
	Gross area: same as proposed	As proposed
	U-factor: as specified in Table C402.1.4	As proposed
	Solar absorptance: 0.75	As proposed
	Emittance: 0.90	As proposed
Walls, below-grade	Type: mass wall	As proposed
	Gross area: same as proposed	As proposed
	U-Factor: as specified in Table C402.1.4 with insulation layer on interior side of walls	As proposed
Floors, above-grade	Type: joist/framed floor	As proposed
	Gross area: same as proposed	As proposed
	U-factor: as specified in Table C402.1.4	As proposed
Floors, slab-on-grade	Type: unheated	As proposed
	F-factor: as specified in Table C402.1.4	As proposed
Opaque doors	Type: swinging	As proposed
	Area: Same as proposed	As proposed
	U-factor: as specified in Table C402.1.4	As proposed
Vertical fenestration other than opaque doors	Area 1. The proposed vertical fenestration area; where the proposed vertical fenestration area is less than 40 percent of above-grade wall area. 2. 40 percent of above-grade wall area; where the proposed vertical fenestration area is 40 percent or more of the above-grade wall area.	As proposed
	U-factor: as specified in Table C402.4	As proposed
	SHGC: as specified in Table C402.4 except that for climates with no requirement (NR) SHGC = 0.40 shall be used	As proposed
	External shading and PF: none	As proposed
Skylights	Area 1. The proposed skylight area; where the proposed skylight area is less than that permitted by Section C402.1. 2. The area permitted by Section C402.1; where the proposed skylight area exceeds that permitted by Section C402.1.	As proposed

BUILDING COMPONENT CHARACTERISTICS	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
	U-factor: as specified in Table C402.4	As proposed
	SHGC: as specified in Table C402.4 except that for climates with no requirement (NR) SHGC = 0.40 shall be used.	As proposed
Lighting, interior	The interior lighting power shall be determined in accordance with Section C405.3.2. Where the occupancy of the building is not known, the lighting power density shall be 1.0 watt per square foot based on the categorization of buildings with unknown space classification as offices.	As proposed
Lighting, exterior	The lighting power shall be determined in accordance with Tables C405.5.2(1), C405.5.2(2) and C405.5.2(3). Areas and dimensions of surfaces shall be the same as proposed.	As proposed
Internal gains	Same as proposed	Receptacle, motor and process loads shall be modeled and estimated based on the space use classification. End-use load components within and associated with the building shall be modeled to include, but not be limited to, the following: exhaust fans, parking garage ventilation fans, exterior building lighting, swimming pool heaters and pumps, elevators, escalators, refrigeration equipment and cooking equipment.
Schedules	Same as proposed **Exception:** Thermostat settings and schedules for HVAC systems that utilize radiant heating, radiant cooling and elevated air speed, provided that equivalent levels of occupant thermal comfort are demonstrated by means of equal Standard Effective Temperature as calculated in Normative Appendix B of ASHRAE Standard 55.	Operating schedules shall include hourly profiles for daily operation and shall account for variations between weekdays, weekends, holidays and any seasonal operation. Schedules shall model the time-dependent variations in occupancy, illumination, receptacle loads, thermostat settings, mechanical ventilation, HVAC equipment availability, service hot water usage and any process loads. The schedules shall be typical of the proposed building type as determined by the designer and approved by the jurisdiction.
~~Mechanical ventilation~~ Outdoor Airflow	~~Same as proposed~~ Where the proposed design specifies mechanical ventilation: 1. For systems 1-4 as specified in Tables C407.4.1(2) and C407.4.1(3), the outdoor airflow rate shall be determined in accordance with Section C403.7 and IMC Section 403.3.1.1.2.3.4 Equation 4-8, using a system ventilation efficiency (E_v) of 0.75. 2.For systems 5-11 as specified in Tables C407.4.1(2) and C407.4.1(3), the outdoor airflow rate shall be determined in accordance with Section C403.7 and IMC Section 403.3. Where the proposed design specifies natural ventilation, as proposed.	As proposed, in accordance with Section C403.2.2.
Heating systems	Fuel type: same as proposed design	As proposed
	Equipment type[a]: as specified in Tables C407.4.1(2) and C407.4.1(3)	As proposed
	Efficiency: as specified in the tables in Section C403.3.2.	As proposed
	Capacity[b]: sized proportionally to the capacities in the proposed design based on sizing runs, and shall be established such that no smaller number of unmet heating load hours and no larger heating capacity safety factors are provided than in the proposed design.	As proposed

BUILDING COMPONENT CHARACTERISTICS	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
	Fuel type: same as proposed design	As proposed
	Equipment type: as specified in Tables C407.4.1(2) and C407.4.1(3)	As proposed
Cooling systems	Efficiency: as specified in Tables C403.3.2(1), C403.3.2(2) and C403.3.2(3)	As proposed
	Capacity[b]: sized proportionally to the capacities in the proposed design based on sizing runs, and shall be established such that no smaller number of unmet cooling load hours and no larger cooling capacity safety factors are provided than in the proposed design.	As proposed
	Economizer[d]: same as proposed, in accordance with Section C403.5.	As proposed
Service water heating[e]	Fuel type: same as proposed	As proposed
	Efficiency: as specified in Table C404.2	For Group R, as proposed multiplied by SWHF. For other than Group R, as proposed multiplied by efficiency as provided by the manufacturer of the DWHR unit.
	Capacity: same as proposed	As proposed
	Where no service water hot water system exists or is specified in the proposed design, no service hot water heating shall be modeled.	
Energy Recovery	Where the proposed design specifies mechanical ventilation, as specified in Section C403.7.4 based on the standard reference design airflows. Where the proposed design specifies natural ventilation, as proposed.	As proposed
Fan Power	As specified in Section C403.8 for the proposed design. Exceptions: 1. Where the fan power of the proposed design is exempted from the requirements of Section C403.8, as proposed. 2. Fan systems addressed by C403.8.1: Fan system BHP power shall be as proposed or to the limits specified in C403.8.1, whichever is smaller. If the limit is reached, the power or each fan shall be reduced proportionally until the limit is met. 3. Fan systems serving areas where the mechanical ventilation is provided in accordance with an engineered ventilation system design of Section 403.2 of the IMC shall not use the particulate filtration or air cleaner pressure drop adjustment available in Table C403.8(12) when calculating the fan system BHP limit for the portion of the airflow being treated to comply with the engineered ventilation system design.	As proposed

For SI: 1 watt per square foot = 10.7 w/m^2.

SWHF = Service Water Heat Recovery Factor, DWHR = Drain Water Heat Recovery.

a. Where no heating system exists or has been specified, the heating system shall be modeled as fossil fuel. The system characteristics shall be identical in both the standard reference design and proposed design.

b. The ratio between the capacities used in the annual simulations and the capacities determined by sizing runs shall be the same for both the standard reference design and proposed design.

c. Where no cooling system exists or no cooling system has been specified, the cooling system shall be modeled as an air-cooled single-zone system, one unit per thermal zone. The system characteristics shall be identical in both the standard reference design and proposed design.

d. If an economizer is required in accordance with Table C403.5(1) and where no economizer exists or is specified in the proposed design, then a supply-air economizer shall be provided in the standard reference design in accordance with Section C403.5.

e. The SWHF shall be applied as follows:

1. Where potable water from the DWHR unit supplies not less than one shower and not greater than two showers, of which the drain water from the same showers flows through the DWHR unit then SWHF = [1 **–** (DWHR unit efficiency × 0.36)].
2. Where potable water from the DWHR unit supplies not less than three showers and not greater than four showers, of which the drain water from the same showers flows through the DWHR unit then SWHF = [1 **–** (DWHR unit efficiency × 0.33)].
3. Where potable water from the DWHR unit supplies not less than five showers and not greater than six showers, of which the drain water from the same showers flows through the DWHR unit, then SWHF = [1 **–** (DWHR unit efficiency × 0.26)].
4. Where Items 1 through 3 are not met, SWHF = 1.0.

Reason: Section 403.2.2 Ventilation of the 2021 IECC allows for minimum outdoor airflow rates to be determined in accordance with (a) prescriptive ventilation rates under Table 403.3.1.1 of the 2021 IMC or (b) an engineered ventilation systems design as defined by Section 403.2 of the 2021 IMC. The latter approach may lead to a more efficient design by incorporating source control or removal measures, including air cleaning, to offset a portion of the outside air requirement under the prescriptive ventilation rate approach. Despite these two approaches for determining minimum outdoor airflow rates, baseline and proposed case ventilation rates must be the same. As such, the IECC does not enable design teams using an engineered ventilation system design to take energy credit for a more energy efficient engineered ventilation systems design. The proposed change fixes this.
According to Section 403.2 of the 2021 IMC, “Where a registered design professional demonstrates that an engineered ventilation system design will prevent the maximum concentration of containments from exceeding that obtainable by the rate of outdoor air ventilation determined in accordance with Section 403.3, the minimum required rate of outdoor air shall be reduced in accordance with such engineered system design.” In other words, when source-control and/or removal measures are incorporated into an engineered ventilation system design, minimum outside airflow may be lowered to account for the efficiency of the source-control and/or removal measures. Using this approach, the implemented source-control and/or removal measures may offset a portion of the outside air required by conventional ventilation system designs sized using prescriptive ventilation rates found in Table 403.3.1.1 in order to achieve a more energy efficient design.

The proposed change will allow design teams using an engineered ventilation systems design to take energy credit for a more energy efficient engineered ventilation systems design in accordance with Section 403.2 of the 2021 IMC. This is currently not allowed because baseline and proposed case ventilation rates must be the same as per Table C407.4.1(1).

A 2017 report by the U.S. Department of Energy’s Building Technology Office (BTO) called “Energy Savings Potential and RD&D Opportunities for Commercial Building HVAC Systems” identified Ventilation Reduction through Advanced Filtration as a top energy saving technology for commercial building HVAC systems. The report also said, “The largest barrier to market adoption is acceptance by building code jurisdictions (pg. 44).” More recently the U.S. Green Building Council has endorsed performance-based indoor air quality designs and assessments to reduce ventilation energy consumption by developing two pilot credits based on this approach: EQpc124 for LEED BD+C andEQpc119for LEED O+M. The next step to unlock the full potential of ventilation energy efficiency using source control and removal measures is to update the IECC to allow design teams using an engineered ventilation systems design to take energy credit for a more energy efficient engineered ventilation systems design.

Link to Energy Savings Potential and RD&D Opportunities for Commercial Building HVAC Systems" report:

https://www.energy.gov/sites/prod/files/2017/12/f46/bto-DOE-Comm-HVAC-Report-12-21-17.pdf

Cost Impact: The code change proposal will decrease the cost of construction.
The code change proposal will decrease the cost of construction. Designs the use the IAQ Procedure typically result in reduced minimum outdoor airflows relative to prescriptive ventilation rates. Designing towards this reduced outside airflow can have a systemic effect on the HVAC design and can allow for the following first cost saving measures: 1. Reduce overall load on central heating and cooling equipment; 2. Reduce overall capacity of cooling and heating coils inside HVAC equipment; 3. Downsize or eliminate energy recovery systems; 4. Eliminate demand control ventilation / CO sensors, if applicable; 5. Downsize outside air intakes and respective ductwork; and 6. Downsize or eliminate general-exhaust / relief air fans.Example 6-AA IAQ Procedure, Single-Zone System in ASHRAE 62.1 User's Manual provides an example of how minimum outdoor airflow can be reduced by 1,000 CFM (47%) when applying the IAQ Procedure with air cleaning and comparing it with prescriptive ventilation rates. The reduction in minimum outdoor airflow results in a range of annual energy and energy cost savings depending on project location (climate) and utility rates. See Appendix A, attached, which includes a table with estimated load reduction and energy savings associated with a 1,000 CFM reduction in outside airflow across the different United States metro areas. Also included in Appendix A, is the calculation methodology used to populate the

table.

1,000 CFM Reduction in Outdoor Airflow. Workday Operation (7am to 7 pm, 6 days)					
Top 20 US Metro Areas	Cooling Energy Savings (kBtu)	Heating Energy Savings (kBtu)	Total Energy Savings (kBtu)	Cooling Load Reduction (Tons)	Heating Load Reduction (MBH)
New York-Northern NJ-Long Island, NY-NJ-PA	8,099	41,984	50,083	3.6	66
Los Angeles-Long Beach-Santa Ana, CA	4,384	222	4,607	2.9	34
Chicago-Joliet-Naperville, IL-IN-WI	6,430	65,265	71,695	5.3	79
Dallas-Fort Worth-Arlington, TX	20,342	12,088	32,430	3.9	58
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	8,099	41,984	50,083	5.3	64
Houston-Sugar Land-Baytown, TX	28,129	3,018	31,147	4.7	48
Washington-Arlington-Alexandria, DC-VA-MD-WV	10,635	30,634	41,269	5.4	61
Miami-Fort Lauderdale-Pompano Beach, FL	38,263	0	38,263	5.1	28
Atlanta-Sandy Springs-Marietta, GA	15,614	16,843	32,457	5.2	57
Boston-Cambridge-Quincy, MA-NH	5,608	48,778	54,386	3.5	72
Detroit-Warren-Livonia, MI	6,255	64,649	70,904	4.7	74
Riverside-San Bernardino-Ontario, CA	4,384	222	4,607	3.5	41
Phoenix-Mesa-Glendale, AZ	14,981	817	15,799	4.7	38
Minneapolis-St. Paul-Bloomington, MN-WI	4,363	72,688	77,051	5.1	91
San Diego-Carlsbad-San Marcos, CA	3,431	13	3,444	1.7	32
St. Louis, MO-IL	10,480	30,823	41,303	4.7	75
Tampa-St. Petersburg-Clearwater, FL	32,637	938	33,575	5	38
Baltimore-Towson, MD	10,531	33,510	44,041	5.1	61

Appendix A – Energy Savings and Peak Load Reduction Calculations Methodology

A.1 General. Reducing outside air in a system results in a reduced cooling coil entering enthalpy (cooling equipment) & increased heating coil entering temperature (heating equipment). 2017 ASHRAE Handbook—Fundamentals[1] calculations are modified to quantity the difference in energy use & peak load when a system has utilized ASHRAE 62.1 IAQP to reduce outside air requirement.

A.2 Cooling Energy Savings. Sensible and latent cooling energy savings from load reduction is based on decreasing outside airflow (Q_{OAr}) requirements after applying IAQP and air cleaning. Outside air reduction is offset by increased return air to maintain constant primary airflow.

A.2.1 Methodology. For each occupied hour, calculate the enthalpy of outside air (h_{oa}) using 5-year (2009 to 2013) historical weather data[2] and return air enthalpy (h_{ra}) using assumed indoor conditions.

For each occupied hour:

$$Cooling\ Energy\ savings\ (BTUs) = \frac{Q_{OAr} \times (h_{oa} - h_{ra})}{Cooling\ COP}$$

where outside air reduction (Q_{OAr}) is assumed to be 1,000 CFM, h_{ra} is assumed based on summer return air condition [*75°F$_{dry\ bulb}$ / 50% relative humidity*], and *COP is the* coefficient of performance (*assumed 3.0*),

A.3 Heating Energy Savings. Sensible heating energy savings from load reduction based on decreasing outside airflow (Q_{OAr}) requirements after applying IAQP and air cleaning. Outside air reduction is offset by increased return air to maintain constant primary airflow.

A.3.1 Methodology. For each occupied hour, calculate the temperature of outside air (t_{oa}) using 5-year (2009 to 2013) historical weather data[2] return air temperature (t_{ra}) using assumed indoor conditions. Return air conditions are assumed to be:

For each occupied hour:

$$Heating\ Energy\ savings\ (BTUs) = \frac{Q_{OAr} \times (t_{oa} - t_{ra})}{Heating\ COP}$$

where outside air reduction (Q_{OAr}) is assumed to be 1,000 CFM, h_{ra} is assumed based on winter return air condition [*68°F$_{dry\ bulb}$*], and *COP is the* coefficient of performance (*assumed 1.0*).

A.4 Peak Cooling & Heating Load Reduction. Cooling and heating load reduction are calculated in a similar methodology to energy savings, but only for the hottest (summer) and coldest (winter) hours of the year. Summer design day temperatures were determined using the 0.4% dry bulb temperatures and 0.5% mean coincident wet bulb temperature (MCWB). Winter design day temperatures were determined using the 99.6% dry bulb temperature.

[1] *Calculations from "2017 ASHRAE Handbook—Fundamentals Chapter 1: psychrometrics"*

[2] *Weather data from "2017 ASHRAE Handbook—Fundamentals Appendix: Design Conditions for Selected Locations"*

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: This CCP allows proposed ventilation to be modeled as designed and baseline ventilation to reflect IMC ventilation requirements.

Proposal # 38

CEPI-212-21

Proponents: Jay Crandell, P.E., ABTG/ARES Consulting, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2021 International Energy Conservation Code

Revise as follows:

TABLE C407.4.1(1) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

Portions of table not shown remain unchanged.

BUILDING COMPONENT CHARACTERISTICS	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Roofs	Type: insulation entirely above deck	As proposed
	Gross area: same as proposed	As proposed
	U-factor: as specified in Table C402.1.4	As proposed
	Solar absorptance: 0.75, except as specified in Section C402.3 and Table C402.3 for Climate Zones 0, 1, 2, and 3	As proposed
	Emittance: 0.90, except as specified in Section C402.3 and Table C402.3 for Climate Zones 0, 1, 2, and 3	As proposed

Reason: This proposal aligns the standard reference design roof parameters with conditions required in the prescriptive path for roof solar reflectance and thermal emittance in Section C402.3. The prescriptive provisions are intended to serve as the basis for the standard reference design in the performance path of Section C407.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal addresses an apparent error or omission in aligning the standard reference design with the prescriptive path which is unchanged by this proposal and is the basis of cost-effectiveness.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: this proposal corrects the solar absorptance and emittance factors contained in Table C407.4.1(1).

Proposal # 335

CEPI-215-21

Proponents: Kimberly Cheslak, New Buildings Institute, representing NBI (kim@newbuildings.org); Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Revise as follows:

C408.2 Mechanical systems and service water-heating systems commissioning and completion requirements. Prior to the final mechanical and plumbing inspections, the *registered design professional or approved agency* shall provide evidence of mechanical systems *commissioning* and completion in accordance with the provisions of this section.
Construction document notes shall clearly indicate provisions for *commissioning* and completion requirements in accordance with this section and are permitted to refer to specifications for further requirements. Copies of all documentation shall be given to the owner or owner's authorized agent and made available to the *code official* upon request in accordance with Sections C408.2.4 and C408.2.5.

Exceptions: The following systems are exempt:

1. Buildings with less than 10,000 square feet (929 m^2)and ~~Mechanical systems and service water-heating systems in buildings where the total mechanical equipment capacity is less than 480,000 Btu/h (140.7 kW) cooling capacity and 600,000 Btu/h (175.8 kW)~~ combined heating, cooling, and service water-heating ~~and space-heating~~ capacity of less than 960,000 Btu/h (280 kW).
2. Systems included in Section C403.5 that serve individual *dwelling units* and *sleeping units*.

Reason: Changes to exception will expand the applicability of commissioning requirements in commercial buildings. This approach is based off the combined heating, cooling and hot water heating capacity from 90.1-2019, and further informed by the prevalence of city and state benchmarking, retro-commissioning and BPS policies that continue to target 10,000 square feet as a cut off for determining compliance. By ensuring that buildings of this size have completed commissioning at construction, owners and facility managers are better equipped to operate the building as intended and meet continuing performance requirements.

Cost Impact: The code change proposal will increase the cost of construction.
Commissioning and functional testing are highly valuable activities that produce real savings in new construction. A research report covering 82 new construction projects has found that median payback is around 4.2 years and the benefit-to cost ratio is 1.1 years. (Mills, E. 2011. "Building commissioning: a golden opportunity for reducing energy costs and greenhouse gas emissions in the United States." Energy Efficiency.) This cost is based on full commissioning that includes commissioning of all Owner's Project Requirements, not just those requirements relevant to Standard 90.1. While some settings corrected during commissioning can decay, the cited study shows good persistence for a 5 year follow-up period, with longer-term impact expected; as assemblies, sequences and settings are correct at occupancy and documentation on proper system operation is available for operating staff later at the site. Based on an average persistence of 10 years, the average heating and cooling scalar limit for 90.1 is 8.5 years and the overall commissioning payback in the cited study is much lower at 4.2 years.

While many of the projects in the Mills study included design phase commissioning, this is required in Standard 90.1 only for buildings with at least 10,000 square feet of conditioned area. Buildings with simple HVAC systems up to 25,000 square feet and non-refrigerated warehouses are exempt. A 2011 study (California Statewide Utility Codes and Standards Program. September 2011. "Draft Measure Information Template – Design-Phase Commissioning.") specifically looked at the cost of design phase commissioning. Looking just at the impact of design review included in commissioning, for buildings above 25,000 square feet, the cost ranges from $0.38 to $0.10 per square foot, with the cost reducing with size and an average of $0.22 per square foot. A weighted average of present value cost savings across climate zones is $1.08 to $1.47 for larger buildings resulting in a BCR of 2.8 for the highest cost and lowest savings situation. When the savings are adjusted to match the 90.1 scalar analysis, the payback is in the range of 2.5 to 7.7 years for five common building types. All these paybacks are under the scalar threshold of 8.7. Again, this analysis is just for the added cost of design review included in the commissioning process.

Bibliography: ANSI/ASHRAE/IES Addenda m, ai, aj, au, az, bg, dn to ANSI/ASHRAE/IES Standard 90.1-2016 https://www.ashrae.org/file%20library/technical%20resources/standards%20and%20guidelines/standards%20addenda/90.1-2016/90_1_2016_m_ai_aj_au_az_bg_dn_20210324.pdf
https://www.buildingrating.org/

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason:amend the capacity thresholds and add an area threshold so that more buildings are required to follow the commissioning requirements of C408.

CEPI-217-21

Proponents: Sean Denniston, representing New Buildings Institute (sean@newbuildings.org)

2021 International Energy Conservation Code

Add new definition as follows:

EXTERIOR WALL ENVELOPE. A system or assembly of exterior wall components, including exterior wall finish materials, that provides protection of the building structural members, including framing and sheathing materials, and conditioned interior space, from the detrimental effects of the exterior environment.

WORK AREA. That portion or portions of a building consisting of all reconfigured spaces as indicated on the construction documents. Work area excludes other portions of the building where incidental work entailed by the intended work must be performed and portions of the building where work not initially intended by the owner is specifically required by this code.

Add new text as follows:

C503.6 Additional energy efficiency credits. *Alterations* shall achieve a total of 5 credits in accordance with Section C506.

Exceptions:

1. A*lterations* that require compliance with only one of: C402.1, C403.3, C404.2, or C405.3.
2. *Alterations* that are part of an *addition* complying with section C502.
3. *Alterations* that comply with Section C407.

Revise as follows:

C502.3 Compliance. *Additions* shall comply with Sections C502.3.1 through C502.3.~~6.2~~ 7.

Add new text as follows:

C502.3.7 Additional energy efficiency credits. *Additions* shall comply with measures from sections C406.2 and C406.3 to achieve not less than 50 percent the number of required efficiency credits from Table C406.1.1 based on building occupancy group and climate zone. Where a project contains multiple occupancies, credits in Table C406.1.1 from each building occupancy shall be weighted by the gross floor area to determine the weighted average project energy credits required. Accessory occupancies shall be included with the primary occupancy group for purposes of this section. *Alterations* to the existing building that are not part of an *addition*, but permitted with an *addition*, may be used to achieve the required credits.

Exceptions:

1. *Buildings* in Utility and Miscellaneous Group U, Storage Group S, Factory Group F, High-Hazard Group H.
2. *Additions* less than 1,000 ft^2 and less than 50 percent of existing floor area.
3. *Additions* that do not include the addition or replacement of equipment covered by Tables C403.3.2(1) through C403.3.2(16) or C404.2.
4. *Additions* that do not contain *conditioned space.*
5. Where the *addition* alone or the existing building and *addition* together comply with Section C407.

C503.6 Additional energy efficiency credits. *Alterations* shall comply with measures from sections C406.2 and C406.3 to achieve not less than 10 percent the number of required efficiency credits from Table C406.1.1 based on building occupancy group and climate zone. Where a project contains multiple occupancies, credits in Table C406.1.1 from each building occupancy shall be weighted by the gross floor area to determine the weighted average project energy credits required. Accessory occupancies shall be included with the primary occupancy group for purposes of this section.

Exceptions:

1. Alterations that include replacement of no more than one of the following:

   1.1. HVAC unitary systems or HVAC central heating or cooling equipment serving the work area of the *alteration.*

   1.2 Water heating equipment serving the *work area* of the *alteration*.

   1.3 50 percent or more of the lighting fixtures in the *work area* of the *alteration*.

   1.4 50 percent or more of the area of interior surfaces of the *thermal envelope* in the *work area* of the *alteration*.

   1.5 50 percent or more of the *building's exterior wall envelope*, including fenestration.

2. *Alterations* to *buildings* in Utility and Miscellaneous Group U, Storage Group S, Factory Group F, High-Hazard Group H.
3. *Alterations* that do not contain conditioned space.
4. Portions of *buildings* devoted to manufacturing or industrial use.
5. *Buildings* in Climate Zone 0A.
6. *Alterations* that are permitted with an *addition* complying with Section C502.3.7.
7. *Alterations* that comply with Section C407.

Reason: Since 2012, the IECC has leveraged Section C406 to achieve additional efficiency in the prescriptive path. This section has received steady improvements over the subsequent code cycles with an expansion in the number of options and the adoption of a more flexible credit approach to the additional efficiency option. However, there is one significant gap in C406, it does not apply to additions or alterations. C502 and C503 do not reference C406 in the sections with which additions and alterations must comply. The exclusion from C406 is a significant loophole. Additions and large alterations are prime opportunities for achieving greater energy efficiency utilizing C406.
This missed opportunity is particularly significant given the advent of Building Performance Standards (BPS). These policies set performance requirements that subject existing buildings need to meet. States and local jurisdiction around the country including the states of WA and CO and cities like New York, Boston, Washington DC, and St Louis have already adopted Building Performance Standards (BPS). Many more cities are considering this policy tool as they come to realize that meeting their climate goals will require achieving significant energy and/or carbon improvements in existing buildings. This creates a need for the IECC to be much more proactive in tailoring requirements specifically for existing buildings. Building energy retrofits that are implemented as part of alterations, additions and changes in occupancy are far more cost-effective than stand-alone retrofit projects implemented only to meet a BPS. By incorporating reasonable and cost-effective retrofits into typical existing building projects, the IECC will both provide additional energy, carbon and cost savings to building owners and tenants and help ensure that more building retrofits are undertaken at opportune and cost-effective times.

This proposal creates a framework to apply C406 to additions and large alterations. It creates a new Section C506 that provides guidance for how to utilize C406 for existing buildings. C506.1 essentially replaces and mirrors C406.1, providing charging language for how to calculate credit totals and utilize the sections (C406.2-12) that establish the requirements for each credit option. This section C506 is utilized by new sections in C502 and C503 to set credit requirements for additions and alterations, respectively.

The new Section C502.2.7.1 sets requirements for additions. As additions generally have to meet the requirements for new construction, the credit requirement has been set at 10 credits, the same as C406 for new construction. The section specifically allows additions and alterations to comply together under this section, eliminating the possibility that a building with both an addition and alteration would have to achieve credits for each individually. The section includes a number of important exceptions for situations where achieving the full 10 credits would be less feasible due to lower energy building types, more limited credit options and more limited project scope:

1. Occupancies such as storage, utility, factory and high hazard that generally have low energy usage.
2. Small additions
3. Additions that do not include new HVAC or hot water systems that achieve 5 credits
4. Additions that do not include conditioned space that achieve 5 credits
5. Group R and I occupancies in more temperate climate zones that achieve 5 credits
6. Additions that comply with C407.

The new section C503.7 requires that large alterations achieve 5 credits. The section includes important exceptions:

1. The first exception ensures that the requirements only apply to large additions with significant scope. The exemption is worded to address small alterations that only impact one of the main buildings systems: envelope (C402), HVAC (C403), water heating (C404) and lighting (C405). Alterations that impact two or more of these systems – and must therefore comply with two or more of these sections – will have a larger scope with more opportunities to choose from among the available credit options.
2. An exception that reflects the allowance for alterations and additions to comply together under C502.
3. An exception for buildings that model using C407.

By limiting requirement to large alterations and keeping the credit requirement low, the proposal ensures that projects will likely have sufficient credit options within the existing scope of the project. The project team will be able to pick credit options that apply to building elements that are already within the project scope.

The savings for this proposal would be at least 2.5% for additions and 1.25% for alterations based on the modeling for the C406 credit options done by PNNL for the 2021 edition of the IECC. However, the savings should be higher for alterations in particular since the baselines for alterations include many below-code existing building features. Depending on how inefficient the rest of the building is, the impact of this proposal could be substantially higher without any greater cost than new construction C406 measures.

Cost Impact: The code change proposal will increase the cost of construction.

This proposal is crafted so that it will only impact major renovations / large-scope alterations that are already impacting the major systems that serve as the basis for credits under C406. This means that these projects are already undertaking the cost of bringing two or more of these major systems up to current code requirements, and the incremental cost is therefore only the cost from code rather than the cost of a standalone retrofit. Therefore, the costs for this proposal are the same as the costs for C406 requirements for new construction. However, savings for each package will generally be much higher since the rest of the building will nearly always have specifications that fall short of the latest energy code and each package will deliver greater savings. As a result, any package that is cost effective for new construction will be even more cost effective for major alterations.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: This proposal requires that additions and alterations to existing buildings achieve C406 efficiency credits.

Proposal # 408

CEPI-219-21

Proponents: Sean Denniston, representing New Buildings Institute (sean@newbuildings.org)

2021 International Energy Conservation Code

Add new text as follows:

C503.3.2 **Duct Testing.** Ducts and plenums designed to operate at static pressures not less than 3 inches water gauge (747 Pa) that serve an *alteration* shall be tested in accordance with this section where the *alteration* includes any of the following:

1. Where 25 percent or more of the total length of the ducts in the system are relocated.
2. Where the total length of all ducts in the system is increased by 25 percent or more.

Ducts and plenums shall be leak tested in accordance with the SMACNA HVAC Air Duct Leakage Test Manual and shown to have a rate of air leakage (CL) less than or equal to 12.0 as determined in accordance with Equation 4-8 of section C403.12.2.3. Documentation shall be available demonstrating that representative sections totaling not less than 25 percent of the duct area have been tested and that all tested sections comply with the requirements of this section.

Reason: This proposal requires that existing ductwork serving new equipment in additions and alterations is tested. In an alteration, all ductwork serving new equipment will need to be tested. In additions, the ductwork serving the addition, both existing and new ductwork, will need to be tested if it increases the total volume of the ductwork serving the addition by more than 20%. The proposal does not include a performance criterion for the testing; the testing is informational.

The requirements for duct construction and sealing in the IECC have developed substantially over recent code cycles. Fiberboard materials, cloth tape, un-sealed duct joints, cavity plenum returns and other materials and approaches that can lead to very leaky ducts were once commonplace but are not now allowed by the IECC. The result is that the ductwork in many existing buildings fall far below modern standards.

States and local jurisdiction around the country including the states of WA and CO and cities like New York, Boston, Washington DC, and St Louis have adopted Building Performance Standards (BPS). These policies set performance requirements that subject existing buildings need to meet. Many more cities are considering this policy tool as they come to realize that meeting their climate goals will require achieving significant energy and/or carbon improvements in existing buildings. This creates a need for the IECC to be much more pro-active in tailoring requirements specifically for existing buildings. Building energy retrofits that are implemented as part of alterations, additions and changes in occupancy are far more cost-effective than stand-alone retrofit projects implemented only to meet a BPS. By incorporating reasonable and cost-effective retrofits into typical existing building projects, the IECC will both provide additional energy, carbon and cost savings to building owners and tenants and help ensure that more building retrofits are undertaken at opportune and cost-effective times.

Duct tightening can be a very cost-effective energy retrofit. The replacement of equipment or substantial expansion of existing ductwork present prime opportunities to undertake this testing and will provide project teams and building owners important information about the relative need and savings opportunity that could come from duct tightening projects. It will also give project teams important information for configuring new equipment and ductwork to ensure the whole system performs effectively.

Cost Impact: The code change proposal will increase the cost of construction.
The cost of the proposal will vary based on the size of the duct system.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Duct tightening can be a very cost-effective energy retrofit. The replacement of equipment or substantial expansion of existing ductwork present prime opportunities to undertake this testing and will provide project teams and building owners important information about the relative need and savings opportunity that could come from duct tightening projects. It will also give project teams important information for configuring new equipment and ductwork to ensure the whole system performs effectively.

Proposal # 285

CEPI-220-21

Proponents: David Collins, representing SEHPCAC (sehpcac@iccsafe.org)

2021 International Energy Conservation Code

Revise as follows:

C502.3.5 Pools and inground permanently installed spas. New pools and inground permanently installed spas shall comply with Section ~~C404.9~~ C404.8.

Reason: C404.9 references portable spas. The correct reference should be C404.8 Energy consumption of pools and permanent spas.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Neutral. Correcting reference.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason:per proponents reason statement

Proposal # 310

CEPI-221-21

Proponents: Jay Crandell, P.E., ABTG/ARES Consulting, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2021 International Energy Conservation Code

Add new definition as follows:

APPROVED SOURCE. An independent person, firm or corporation, approved by the *code official*, who is competent and experienced in the application of engineering principles to materials, methods or systems analyses.

CONSTRUCTION DOCUMENTS. Written, graphic and pictorial documents prepared or assembled for describing the design, location and physical characteristics of the elements of a project necessary for obtaining a building *permit*.

SECTION C503
ALTERATIONS

Revise as follows:

C503.1 General. *Alterations* to any *building* or structure shall comply with the requirements of Section C503. *Alterations* shall be such that the existing *building* or structure is not less conforming to the provisions of this code than the existing *building* or structure was prior to the *alteration*. *Alterations* to an existing *building*, *building* system or portion thereof shall conform to the provisions of this code as those provisions relate to new construction without requiring the unaltered portions of the existing *building* or *building* system to comply with this code. *Alterations* shall not create an unsafe or hazardous condition or overload existing *building* systems.

Exception: The following *alterations* need not comply with the requirements for new construction, provided that the energy use of the building is not increased:

1. Storm windows installed over existing *fenestration*.
2. Surface-applied window film installed on existing single-pane *fenestration* assemblies reducing solar heat gain, provided that the code does not require the glazing or *fenestration* to be replaced.
~~3. Existing ceiling, wall or floor cavities exposed during construction, provided that these cavities are filled with insulation.~~
~~4. Construction where the existing roof, wall or floor cavity is not exposed.~~
3.~~5.~~ *Roof recover*.
4. *Roof replacement* where roof assembly insulation is integral to or located below the structural roof deck.
5.~~6.~~ *Air barriers* shall not be required for *roof recover* and roof replacement where the *alterations* or renovations to the building do not include *alterations*, renovations or *repairs* to the remainder of the building envelope.
6. An existing building undergoing alterations that complies with Section C407.

C503.2 Building thermal envelope. Alterations of existing *building thermal envelope* assemblies shall comply with this section. New *building thermal envelope* assemblies that are part of the *alteration* shall comply with Section~~s C402.1 through C402.5~~ C402. An area-weighted average *U*-factor for new and altered portions of the *building thermal envelope* shall be permitted to satisfy the *U*-factor requirements in Table C402.1.4. The existing *R*-value of insulation shall not be reduced or the U-factor of a *building thermal envelope* assembly be increased as part of a *building thermal envelope* alteration except where complying with Section C407.

Exception: Where the existing building exceeds the fenestration area limitations of Section C402.4.1 prior to alteration, the building is exempt from Section C402.4.1 provided that there is no ~~not an~~ increase in fenestration area.

C503.2.1 Roof alterations ~~replacement~~. Insulation complying ~~*Roof replacements* shall comply~~ with Section C402.1 ~~C402.1.3, C402.1.4, C402.1.5 or C407~~ and Section C402.2.1, or an *approved* design that minimizes deviation from the insulation requirements, shall be provided for the following roof alterations: ~~where the existing roof assembly is part of the *building thermal envelope* and contains insulation entirely above the roof deck. In no case shall the *R*-value of the roof insulation be reduced or the *U*-factor of the roof assembly be increased as part of the *roof replacement*.~~

1. An *alteration* to roof-ceiling construction where ther is no insulation above *conditioned space*.

2. *Roof replacement* for roofs with insulation entirely above deck,

   Exception: Where compliance with Section C402.1 cannot be met due to limiting conditions on an existing roof, an *approved* design shall be submitted with the following:

   1. *Construction documents* that include a report by a *registered design professional* or other *approve source* documenting details of the limiting conditions affecting compliance with the insulation requirements.
   2. *Construction documents* that include a roof design by a *registered design professional* or other *approved source* that minimizes deviation from the insulation requirements.

3. Conversion of unconditioned attic space into *conditioned space*.
4. Replacement of ceiling finishes exposing cavities or surfaces of the roof-ceiling construction.

C503.2.2 Vertical fenestration. *(Section unchanged)*

C503.2.3 Skylight area. *(Section unchanged)*

Add new text as follows:

C503.2.4 Above-grade wall alterations. *Above-grade wall* alterations shall comply with the following:

1. Where wall cavities are exposed, the cavity shall be filled with cavity insulation complying with Section C303.1.4. New cavities created shall be insulated in accordance with Section C402.1 or an *approved* design that minimizes deviation from the insulation requirements.
2. Where exterior wall coverings and fenestration are added or replaced for the full extent of any exterior wall assembly on one or more elevations of the building, insulation shall be provided where required in accordance with one of the following:

   2.1. An R-value of *continuous insulation* not less than that designated in Table C402.1.3 for the applicable above-grade wall type and existing cavity insulation R-value, if any;

   2.2 An R-value of not less than that required to bring the *above-grade wall* into compliance with Table C402.1.4; or,

   2.3 An *approved design* that minimizes deviation from the insulation requirements of Section C402.1.

3. Where Items 1 and 2 apply, the insulation shall be provided in accordance with Section C402.1.

Where any of the above requirements are applicable, the *above-grade wall* alteration shall comply with Sections 1402.2 and 1404.3 of the *International Building Code*.

C503.2.5 Floor alterations. Where an alteration to a floor or floor overhang exposes cavities or surfaces to which insulation can be applied, and the floor or floor overhang is part of the *building thermal envelope*, the floor or floor overhang shall be brought into compliance with Section C402.1 or an *approved* design that minimizes deviation from the insulation requirements. This requirement applies to floor alterations where the floor cavities or surfaces are exposed and accessible prior to construction.

C503.2.6 Below-grade wall alterations. Where unconditioned below-grade space is changed to *conditioned space*, walls enclosing such conditioned space shall be insulated where required in accordance with Section C402.1. Where the below-grade space is *conditioned space* and where walls enclosing such space are altered, they shall be insulated where required in accordance with Section C402.1.

C503.2.7 Air barrier. Altered *building thermal envelope* assemblies shall be provided with an *air barrier* in accordance with Section C402.5.1. Such *air barrier* need not be continuous with unaltered portions of the *building thermal envelope*. Testing requirements of Section C402.5.1.2 shall not be required.

Reason: Existing building alterations are perhaps one of the primary opportunities to reduce national energy consumption, yet Chapter 5 misses many opportunities to effectively address this need. There are many opportunities to cost-effectively improve energy efficiency of the existing building stock by use of reasonable criteria to trigger (or avoid) requirements for alterations with flexibility in the manner or extent of compliance where needed. This proposal attempts to strike that balance in a practical and cost-effective manner for building envelope assemblies of existing building that are undergoing specific types of alterations. Consequently, this proposal will help to address the 40% of national energy use that is attributed to the existing building stock and will only apply where alterations are proposed that provide opportunity to improve the performance of the existing building stock. A similar coordinated proposal was also submitted for the IECC-R committee.
Key changes made in this proposal are summarized as follows:

1. Exceptions 3 and 4 of Section C503.1 are deleted as they are now addressed and preserved within requirements in new Section C503.2.4 for above-grade walls.

2.   New exception 4 is added to Section C503.1 for roof replacements for roof assemblies that do not have insulation entirely above deck (which is addressed separately in Section C503.2.1).

3.   A clause to prevent reduction of insulation levels in existing thermal envelope assemblies is moved from Section C503.2.1 to Section C503.2 to apply to all building thermal envelope alterations.

4.   Section C503.2.1 is revised to address multiple types of roof alterations, including roof replacements for roofs with insulation entirely above deck.

5.   A new Section C503.2.4 is provided for above-grade wall alterations which identifies conditions where it is appropriate and practical to provide insulation (if not already present). Language is also provided to ensure coordination with building code moisture control requirements which require integration with and can influence the method of complying with the insulation requirements.

6.   A new Section C503.2.5 is provided for floor alterations and takes an approach similar to that done for above-grade walls (although with fewer conditional requirements).

7.   A new Section C503.2.6 is provided for below-grade wall alterations. This captures the cases where a below-grade space is being converted to conditioned space and where below-grade wall alterations allow addition of insulation if the below grade space is already conditioned space.

8.   Finally, new Section C503.2.7 is provided to address air barrier installation in building thermal envelope assemblies that are altered within the scope of Section C503.2. However, it is made clear that continuity of the air barrier with unaltered portions of the building thermal envelope is not required. This avoids causing an alteration to extend beyond its intended scope and extent. This is also consistent with the intent behind existing exception #6 to Section C503.1 dealing with air barriers in roof replacements.

Cost Impact: The code change proposal will increase the cost of construction.
Where requirements are triggered and where upgrades in energy efficiency were not already planned for an alteration, this proposal will increase cost for a limited set of envelope alteration activities for existing buildings. Some existing requirements such as roof replacements and filling of exposed stud cavities remain unchanged. For those existing buildings with deficient insulation levels (or no insulation) and where planned alterations allow that deficiency to be addressed efficiently, the cost-benefits are expected to closely align with that for new buildings. However, it is not possible to conduct a simple cost-benefit analysis for existing buildings because of the multitude of variables involved and the flexibility provided in this proposal that make it nearly impossible to quantify with any reasonable level of certainty. Thus, we consider these proposed provisions to be cost-effective by judgment as these types of existing building thermal envelope upgrades are currently being used in the existing building/remodeling/renovation market, although not consistently or in an enforceable manner.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Provides improved clarity and application of existing building envelope alteration requirements with flexibility.

Proposal # 422

CEPI-225-21

Proponents: Marcin Pazera, representing Polyisocyanurate Insulation Manufacturers Association (mpazera@pima.org); Justin Koscher, Polyisocyanurate Insulation Manufacturers Association, representing Polyisocyanurate Insulation Manufacturers Association (jkoscher@pima.org)

2021 International Energy Conservation Code

Add new definition as follows:

APPROVED SOURCE. An independent person, firm or corporation, approved by the *building official*, who is competent and experienced in the application of engineering principles to materials, methods or systems analyses.

CONSTRUCTION DOCUMENTS. Written, graphic and pictorial documents prepared or assembled for describing the design, location and physical characteristics of the elements of a project necessary for obtaining a building *permit*.

Revise as follows:

C503.2.1 Roof replacement, insulation entirely above deck. *Roof replacements* shall comply with Section C402.1.3, C402.1.4, C402.1.5 or C407 where the existing roof assembly is part of the *building thermal envelope* and contains insulation entirely above the roof deck. ~~In no case shall the *R*-value of the roof insulation be reduced or the *U*-factor of the roof assembly be increased as part of the *roof replacement*.~~

Exception: Where compliance with Table C402.1.3, Table C402.1.4 or Table C402.1.5 cannot be met due to limiting conditions on an existing roof, the following shall be permitted to demonstrate compliance with the insulation requirements:

1. *Construction documents* that include a report by a registered design professional or other *approved source* documenting details of the limiting conditions affecting compliance with the insulation requirements.
2. *Construction documents* that include a roof design by a registered design professional or other *approved source* that minimizes deviation from the insulation requirements.

Insulation shall be installed in accordance with the requirements of Sections C402.2.1.2 through C402.2.1.5.

Reason: Low-sloped roofs comprise the largest thermal envelope surface in many non-residential buildings, which offers a significant opportunity to improve the energy efficiency of the roof and the overall building energy performance. Where an existing roof contains insulation entirely above the deck and is in need of replacement, the roof replacement must comply with the IECC's opaque thermal envelope requirements. For buildings constructed prior to the wide-spread adoption of energy codes, energy-code compliant roof replacements can significantly decrease whole building energy use and reduce associated costs and carbon emissions. This requirement for roof replacements has been part of the IECC since the energy code first regulated existing buildings. However, instances can arise on specific projects where the complexities of other rooftop features create limiting conditions that pose significant practical and cost challenges for installing a replacement roof system containing increased levels of above deck roof insulation in order to comply with the IECC's opaque thermal envelope requirements.
This code change proposal allows for these unique roof replacement projects to, on case-by-case basis, use alternative designs that minimize deviations from the code required insulation levels while also presenting a practical roof replacement solution under the limiting conditions that prevent full compliance. In order to qualify for the exception, the limiting conditions must be documented in construction documents, and report prepared by the approved source and provided to the building code official. The roof design must also be prepared by the approved source showing that deviations from the insulation requirements have been minimized in order to maintain the intent of the IECC to increase building energy efficiency during alterations. The proposal also reinforces that insulation must be installed in accordance with current requirements of applicable sections in Chapter 4 of the IECC. The proposal retains very important existing language regarding insulation R-value and roof assembly U-factor requirements in this provision, and the intent of relocating this language is to ensure that provision is applicable whether or not the exception is utilized. Finally, the proposal also adopts two definitions for "approved source" and "construction documents," Both definitions are in Chapter 2 of the IBC but are not in Chapter 2 of the IECC.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This code change proposal does not increase the cost of construction. In many instances, there may be cost savings to the building owner, since less than the code required levels of insulation may be installed in roof replacement work.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: Adds in some checks about who conducts the design and how it is documented. Clarifies the approved source for use of an expert in the subject matter

CEPI-226-21

Proponents: Darren Meyers, P.E., representing International Energy Conservation Consultants LLC (dmeyers@ieccode.com); Mark Graham, representing National Roofing Contractors Association (mgraham@nrca.net)

2021 International Energy Conservation Code

Revise as follows:

C503.2.1 Roof replacement. *A roof replacement* ~~replacements~~ shall comply with Section C402.1.3, C402.1.4, C402.1.5 or C407 where the existing roof assembly is part of the *building thermal envelope* and contains insulation entirely above the roof deck. In no case shall the *R*-value of the roof insulation be reduced or the *U*-factor of the roof assembly be increased as part of the *roof replacement*.

Reason: The italicized defined term is singular not plural.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The code change proposal will neither increase nor decrease the cost of construction.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: improve the language

Proposal # 347

CEPI-227-21

Proponents: Sean Denniston, representing New Buildings Institute (sean@newbuildings.org)

2021 International Energy Conservation Code

Add new text as follows:

C503.3.2 Controls. New heating and cooling equipment that are part of the alteration shall be provided with controls that comply with the control requirements in Section C403.4 and Section C403.5 other than the requirements of Section C403.4.3.3 and Section 403.4.4.

Exceptions:

1. Systems with *direct digital control* of individual zones reporting to a central control panel.
2. The replacement of individual components of multiple-zone VAV systems.

Reason: The IECC only requires that new portions of HVAC systems comply with the requirements for new construction. This leaves unaltered portions of the HVAC system unaffected, including controls. Controls are a vital component of effective and efficient operation of heating and cooling systems and older controls that do not meet current code requirements significantly hamper efficiency in buildings. Obsolete controls also increase the operational costs for building owners and tenants. The IECC has relied on HVAC controls as a cost-effective means of delivering energy efficiency in buildings, so this is a significant missed opportunity. Equipment replacement is an ideal time to also upgrade controls. Contractors are onsite, operation of the HVAC system is already disrupted, and the cost of controls would generally be a small line-item cost in the project.

This missed opportunity is particularly significant given the advent of Building Performance Standards (BPS). These policies set performance requirements that subject existing buildings need to meet. States and local jurisdiction around the country including the states of WA and CO and cities like New York, Boston, Washington DC, and St Louis have already adopted Building Performance Standards (BPS). Many more cities are considering this policy tool as they come to realize that meeting their climate goals will require achieving significant energy and/or carbon improvements in existing buildings. This creates a need for the IECC to be much more pro-active in tailoring requirements specifically for existing buildings. Building energy retrofits that are implemented as part of alterations, additions and changes in occupancy are far more cost-effective than stand-alone retrofit projects implemented only to meet a BPS. By incorporating reasonable and cost-effective retrofits into typical existing building projects, the IECC will both provide additional energy, carbon and cost savings to building owners and tenants and help ensure that more building retrofits are undertaken at opportune and cost-effective times.

This proposal requires that thermostatic controls be brought into compliance with current control requirements when equipment is replaced. It includes an exception for systems with complex central control systems where control upgrades would be far more involved. The proposal does not require the installation of new controls, so if the existing controls already meet current code requirements, they would already be in compliance with this new section.

Cost Impact: The code change proposal will increase the cost of construction.
Cost will vary depending on the type of control and how obsolete existing controls are. In most systems subject to this requirement, compliance would require replacing one thermostat with another. Modern, wireless thermostats can be used to control costs when existing control wiring is insufficient to support modern controls.

The modern, single-zone thermostatic controls subject to this requirement can be purchased for less than $30.[1] Thermostat swaps should easily represent only a fraction of an hour of additional labor.

[1] https://www.supplyhouse.com/Lux-P711-010-7-Day-5-2-day-Programming-or-Non-Programmable-Thermostat-Horizontal-Mount-1-Heat-1-Cool

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Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: The current IECC only requires that new portions of HVAC systems comply with the requirements for new construction. This leaves unaltered portions of the HVAC system unaffected, including controls. Controls are a vital component of effective and efficient operation of heating and cooling systems and older controls that do not meet current code requirements significantly hamper efficiency in buildings.

CEPI-228-21

Proponents: Sean Denniston, representing New Buildings Institute (sean@newbuildings.org)

2021 International Energy Conservation Code

Add new text as follows:

C503.3.2 System sizing. New heating and cooling equipment that is part of an *alteration* shall be sized in accordance with Section C403.3.1 based on the existing *building* features as modified by the *alteration.*

Exceptions:

1. Where is has been demonstrated to the *code official* that compliance with this section would result in heating or cooling equipment that is incompatible with the rest of the heating or cooling system.
2. Where it has been demonstrated to the *code official* that the additional capacity will be needed in the future.

Reason: Historically, HVAC equipment has been routinely oversized. Studies have found very high rates of equipment oversizing; for example, 60% of RTU units in CA were found to be oversized.[1] Oversized equipment results in increased energy use, decreased occupant comfort and increased wear-and-tear on equipment.[2] Oversized equipment is also less effective at dehumidification. Like-for-like equipment replacement are particularly vulnerable to oversizing. The original equipment may have been installed when code requirements for “right-sizing” equipment did not exist or was not enforced. The materials markups that are common practice among contractors disincentivize them to install smaller, right-sized equipment. Changes to building use could have occurred since the original equipment was installed, creating a mismatch between current design loads and the original equipment. The building may have modified, particularly by energy efficiency programs, altering the design loads of the building. Lighting especially stands out here. Fluorescent and LED lighting is ubiquitous, but many HVAC systems were designed to account for incandescent lamps that convert over 75% of the energy they consume into heat.

With all of these considerations, it is reasonable to assume that the existing equipment sizing is more likely to be wrong than right, yet many equipment replacements use existing system sizing to size new equipment. This proposal explicitly requires that new equipment installed as part of an alteration be sized based on current building characteristics and loads, using current sizing standards. The resulting installations will be more efficient and more effective and many will be less costly to install as owners stop paying for more equipment than they need.

Savings will vary based on the amount that existing equipment is oversized. “Right-sizing” has been found to result in about 0.2% energy savings for every 1% reduction in oversizing.[3]
[1] D.R. Felts, P. Bailey, The State of Affairs – Packaged Cooling Equipment in California, 2000.

[2] Ery Djunaedy, Kevin van den Wymelenberg, Brad Acker, Harshana Thimmana, *Oversizing of HVAC system: Signatures and penalties.* “Energy and Buildings,” Volume 43, Issues 2–3, 2011,

[3] H.McLain,D.Goldberg. “Benefits of Replacing Residential Central Air Conditioning Systems.” American Council for an Energy-Efficient Economy, WashingtonDC, USA, 1984.

Cost Impact: The code change proposal will decrease the cost of construction.

As “wrong-sized” equipment is generally oversized, this proposal will generally decrease the cost of installation. Smaller, right-sized equipment will generally be less costly to install.

Bibliography:
D.R. Felts, P. Bailey, The State of Affairs – Packaged Cooling Equipment in California, 2000.

Ery Djunaedy, Kevin van den Wymelenberg, Brad Acker, Harshana Thimmana. *Oversizing of HVAC system: Signatures and penalties.* “Energy and Buildings,” Volume 43, Issues 2–3, 2011,

H.McLain,D.Goldberg, Benefits of Replacing Residential Central Air Conditioning Systems, American Council for an Energy-Efficient Economy, Washington DC, USA, 1984, pp. E226–E227.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: “Right-sizing” HVAC equipment can lead to more efficient and effective systems and reduce first costs.

CEPI-229-21

Proponents: Sean Denniston, New Buildings Institute, representing New Buildings Institute (sean@newbuildings.org)

2021 International Energy Conservation Code

Revise as follows:

C503.3 Heating and cooling systems. New heating, cooling and duct systems that are part of the *alteration* shall comply with Sections C403~~ and C408~~.

Add new text as follows:

C503.3.2 Mechanical system acceptance testing. Where an *alteration* requires compliance with Section C403 or any of its subsections, mechanical systems that serve the *alteration* shall comply with Sections C408.2.2, C408.2.3 and C408.2.5.

Exceptions:

1. *Buildings* with less than 10,000 square feet (929 m^2) and a combined heating, cooling, and service water-heating capacity of less than 960,000 Btu/h (280 kW).
2. Systems included in Section C403.5 that serve individual *dwelling units* and *sleeping units*.

Revise as follows:

C503.4 Service hot water systems. New service hot water systems that are part of the *alteration* shall comply with Sections C404~~ and C408~~.

Add new text as follows:

C503.4.1 Service hot water system acceptance testing. Where an *alteration* requires compliance with Section C404 or any of its subsections, service hot water systems that serve the *alteration* shall comply with Sections C408.2.3 and C408.2.5.

Exceptions:

1. *Buildings* with less than 10,000 square feet (929 m^2) and a combined heating, cooling, and service water-heating capacity of less than 960,000 Btu/h (280 kW).
2. Systems included in Section C403.5 that serve individual dwelling units and sleeping units.

Revise as follows:

C503.5 Lighting systems. New lighting systems that are part of the *alteration* shall comply with Sections C405 ~~and C408~~.

Exception: *Alterations* that replace less than 10 percent of the luminaires in a space, provided that such *alterations* do not increase the installed interior lighting power.

Add new text as follows:

C503.5.1 Lighting acceptance testing. Where an *alteration* requires compliance with Section C405 or any of its subsections, lighting systems that serve the *alteration* shall comply with Section C408.3.

Reason: The IECC requires that new mechanical, hot water and lighting systems comply with the acceptance testing requirements of C408. However, the IECC commentary for C503 states that unaltered portions of systems do not have to be brought into compliance with the code. This means that the requirements of C408 only apply to the new portions of existing systems. However, the whole purpose of C408 is to ensure that building systems meet and document a minimum level of system configuration. Even when only part of a system is replaced, there is still the need to ensure this minimum level of system configuration for the whole building. Even in like-for-like replacements, new equipment can have different operating characteristics. It is therefore important to ensure that the whole system is operating appropriately after new components are installed, not just the new components.

Additionally, all systems see their performance degrade over time as components wear, operational parameters change and modifications accumulate. The installation of new portions of equipment also presents the most reasonable and cost-effective opportunity to recalibration the system based on current operations. Therefore, this proposal requires that the whole system meet relevant C408 requirements, rather than just the new components. The proposal is tailored to focus on the parts of C408 that are relevant to existing buildings rather than just a blanket reference to C408 and includes specific references to the appropriate commissioning /acceptance testing requirements:

- The balancing (C408.2.2), functional testing (C408.2.3) and documentation (C408.2.5) requirements for HVAC systems.
- The functional testing (C408.2.3) and documentation (C408.2.5) requirements for water heating systems

· The functional testing, documentation and reporting requirements for lighting (C408.3).·

It repeats the system-size thresholds in the charging language in C408. In this way, it has the same scope as the requirements for new construction.The proposal does not include references to the commissioning plan requirement (C408.2.1) for HVAC and SHW equipment (C408.2.4) since these requirements are most appropriate for new construction.

Retro-commissioning and building re-tuning is generally accepted as one of the most cost-effecting energy efficiency measures for existing buildings. Average savings for building re-tuning is 12%, and studies have found savings as high as 52%.[1]·[2]

[1] "Improving Commercial Building Operations through Building Re-tuning: Meta-Analysis." Pacific Northwest National Laboratory, S. Katipamula and N. Fernandez. 2020.

[2] "The Cost-Effectiveness of Commercial Buildings Commissioning." Lawrence Berkeley National Laboratory, Mills, E., H. Friedman, T. Powell, N. Bourassa, D. Claridge, T. Haasl, and M.A. Piette. 2004

Cost Impact: The code change proposal will increase the cost of construction.

According to "Improving Commercial Building Operations through Building Re-tuning: Meta-Analysis," the median costs for building re-tuning was $0.16/sf.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: This CCP ensures that the unaltered portions of mechanical, hot water and lighting systems in existing buildings, where a portion of the system is altered, are subject to C408 acceptance testing requirements. The CCP was revised to align with CEPI-215 and to remove C503 references to C408 for clarity.

CEPI-232-21

Proponents: David Collins, representing SEHPCAC (sehpcac@iccsafe.org)

2021 International Energy Conservation Code

Add new definition as follows:

ENERGY USE INTENSITY (EUI). The metric indicating the total amount of energy consumed by a building in one year divided by the gross floor area of the building.

Revise as follows:

C505.1 General. Spaces undergoing a change in occupancy ~~that would result in an increase in demand for either fossil fuel or electrical energy shall comply with this code. Where the use in a space changes from one use in Table C405.3.2(1) or C405.3.2(2) to another use in Table C405.3.2(1) or C405.3.2(2), the installed lighting wattage shall comply with Section C405.3. Where the space undergoing a change in occupancy or use is in a building with a fenestration area that exceeds the limitations of Section C402.4.1, the space is exempt from Section C402.4.1 provided that there is not an increase in fenestration area.~~ from F, H, S or U occupancy classification shall comply with Section C503. Buildings or portions of buildings undergoing a change of occupancy without alterations shall comply with Section C502.2.

~~Exceptions~~ Exception:

~~1. Where the component performance alternative in Section C402.1.5 is used to comply with this section, the proposed UA shall not be greater than 110 percent of the target UA.~~

~~2.~~ Where the total building performance option in Section C407 is used to comply with this section, the annual energy cost of the proposed design shall not be greater than 110 percent of the annual energy cost otherwise permitted by Section C407.3.

Add new text as follows:

C505.1.1 Alterations and change of occupancy. . Alterations made concurrently with any change of occupancy shall be in accordance with Section C503.

C505.1.2 Portions of buildings. . Where changes in occupancy and use are made to portions of an existing building, only those portions of the building shall comply with Section C505.2.

C505.2 Energy Use Intensitie. Building envelope, space heating, cooling, ventilation, lighting and service water heating shall comply with Sections C505.2.1 through C505.2.4.

Exceptions:

1. Where it is demonstrated by analysis approved by the code official that the change will not increase energy use intensity.
2. Where the occupancy or use change is less than 5,000 square feet in area.

C505.2.1 Building Envelope. . Where a change of occupancy or use is made to a whole building that the results in fenestration area greater than the maximum fenestration area allowed by Section C402.4.1, the building shall comply with Section C402.1.5, with a proposed UA that shall not be greater than 110 percent of the target UA.

Exception: Where the change of occupancy or use is made to a portion of the building, the new occupancy is exempt from Section C402.4.1 provided that there is not an increase in fenestration area.

C505.2.2 Building Mechanical Systems. Where a change of occupancy or use results in the same or increased energy use intensity rank as specified in Table C505.2.2, the systems serving the building or space undergoing the change shall comply with Section C403.C505.2.3 Service Water Heating. Where a change of occupancy or use results in the same or increased energy use intensity rank as specified in Table C505.2.3, the service water heating systems serving the building or space undergoing the change shall comply with Section C404.

TABLE C505.2.2 BUILDING MECHANICAL

Energy Use Intensity Rank	International Building Code Occupancy Classification and Use
1. High	A-2, B-Laboratories, I-2
2. Medium	A-1, A-3[a], A-4, A-5, B[b], E, I-1, I-3, I-4, M, R-4
3. Low	A-3 Places of Religious Worship, R-1, R-2, R-3[c], S-1, S-2

a. Excluding places of religious worship.

b. Excluding laboratories.

c. Buildings three stories or less in height above grade plane shall comply with Section R505.

C505.2.3 Service Water Heating. Where a change of occupancy or use results in the same or increased energy use intensity rank as specified in Table C505.2.3, the service water heating systems serving the building or space undergoing the change shall comply with Section C404.

TABLE C505.2.3 Service Water Heating

Energy Use Intensity Rank	**International Building Code Occupancy Classification and Use**
1. High	A-2, I-1, I-2, R-1
2. Low	All other occupancies and uses

C505.2.4 Lighting. Where a change of occupancy or use results in the same or increased energy use intensity rank as specified in Table C505.2.4, the lighting systems serving the building or space undergoing the change shall comply with Section C405 except for Sections C405.2.6 and C405.4.

TABLE C505.2.4 LIGHTING

Energy Use Intensity Rank	International Building Code Occupancy Classification and Use
1. High	B-Laboratories, B-Outpatient Healthcare, I-2, M
2. Medium	A-2, A-3, Courtrooms, B[a], I-1, I-3, I-4, R-1, R-2, R-3[b], R-4, S-1, S-2
3. Low	A-1, A-3[c], A-4, E

a. Excluding laboratories and outpatient healthcare.

b. Buildings three stories or less in height above grade plane shall comply with Section R505.

c. Excluding courtrooms.

Reason: The IECC 2018 change of occupancy requirement (C505.1) begins with this statement:

"Spaces undergoing a change in occupancy that would result in an increase in demand for either fossil fuel or electrical energy shall comply with this code."

Field research and surveys of building officials demonstrate that this requirement is difficult to enforce (Clinton et al, 2016). One reason for this is that while it is a clear performance requirement, there is no simple compliance evaluation method other than energy modeling, which is beyond the capabilities of most change-of-occupancy permit applicants. As depicted in the referenced survey findings and community-based pilot research, building officials often require energy efficiency equipment upgrades, such as lighting or HVAC, in buildings undergoing a change of occupancy. This proposal seeks to provide clarity to that approach by providing a simple breakdown of energy use intensity (EUI) by building occupancy type and system type.

The proposed code change draws on a tradition of rehabilitation "smart codes" use-based lookup tables, is more consistent with the intent of the IECC, presents no cost increase, and incorporates extensive research and stakeholder input.

This proposal advances the Energy Use Intensity (EUI) as the metric for energy demand and the trigger for code compliance. Historic energy intensity per square foot is recorded for commercial buildings in the Commercial Buildings Energy Consumption Survey (CBECS). The CBECS data make it possible to rank building occupancies in the order of the energy intensities. Note that the ranking of occupancies to trigger specific code requirements has been a feature of the International Existing Building Code (IEBC) since its earliest editions (see IEBC 2009 Section 912, Change of Occupancy Classification, Tables 912.4, 912.5 and 912.6), and thus is familiar to building code officials.

Energy intensity data in CBECS is further broken down by various end uses (space conditioning, service water heating and lighting) which makes it possible to identify when it is appropriate to trigger code compliance of specific sections of the IECC. For each of these end uses, an increase in intensity triggers compliance with the correlating code provisions related to new construction in Chapter 4. Only an increase in energy intensities in all three of the end uses triggers full compliance with the code.

There are two exceptions that apply to all four end uses, indicated in Section C505.2:

1. Where it is demonstrated by analysis approved by the code official that the change will not increase energy use intensity.

2. Where the occupancy or use change is less than 5,000 square feet in area.

A matrix has been developed for each system end use that groups building occupancy classifications into HIGH, MEDIUM and LOW energy use intensities, measured in annual kBTU/sf. Data for this analysis came from the U.S. Department of Energy's 2012 CBECS. When occupancy classification or use is being changed from one energy intensity rank to a higher energy use intensity rank (or remains within the same energy use intensity rank), this proposal requires that specific system end-use to comply with the code.

Occupancy classifications F, H and U are typically not designed primarily for occupant comfort, and are generally classified as low energy use intensity buildings. Thus any change from one of these groups to any other should be required to comply with the provisions under Section C503 Alterations, even if no physical alteration is planned.

Section C505.2.1 Building Envelope is included as a building system, although with different criteria than EUI Intensity. The requirement and exception exist in the 2018 language; they are simply relocated in this proposal.

This code change proposal has been developed with support from the Consortium for Building Energy Innovation (CBEI), a project of the U. S. Department of Energy, and research conducted by Rutgers University Center for Green Building.

Change of Occupancy Scale - Space Heating, Cooling and Ventilation

EUI Rank	CBECS Building Type	EUI Range kBTU/sq.ft.	IBC Occupancy Classification
1. High	Food Service, Laboratories, Health Care (Inpatient)	> 55	A-2, B-Laboratories, I-2
2. Medium	Public Assembly, Public Order and Safety, Office, Service, Health Care (Outpatient), Education, Retail, Residential Care/Assisted Living	27 - 55	A-1, A-3, A-4, A-5, B, E, I-1, I-3, I-4, M, R-4
3. Low	Religious Worship, Apartments, Warehouse and Storage	<27	A-3 Places of Worship, R-1, R-2, R-3, S-1, S-2

Change of Occupancy Scale - Service Water Heating

EUI Rank	CBECS Building Type	EUI Range kBTU/sq.ft.	IBC Occupancy Classification
1. High	Food Service, Health Care (Inpatient), Residential Care/Assisted Living, Lodging	> 15	A-2, I-1, I-2, R-1
2. Low	All the rest	< 15	All the rest

Change of Occupancy Scale- Lighting

EUI Rank	CBECS Building Type	EUI Range kBTU/sq.ft.	IBC Occupancy Classification
1. High	Laboratories, Health Care (Outpatient), Health Care (Inpatient), Retail	> 11	B-Laboratories, B-Healthcare (Outpatient), I-2, M
2. Medium	Food Service, Office, Health Care (Outpatient), Service, Public Order and Safety, Residential Care/Assisted Living, Lodging, Apartments, Warehouse and Storage	6.5 - 11	A-2, A-3-Courtrooms, B, I-1, I-3, I-4, R-1, R-2, R-3, R-4, S-1, S-2
3. Low	Public Assembly, Religious Worship, Education	< 6.5	A-1, A-3, A-4, E

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.

The code change proposal will not increase or decrease the cost of construction

The current code requirements trigger full compliance with the code when there is an increase in energy demand. The proposed code change offers the metric of energy use intensity per square foot per year for measuring energy demand by occupancy. It applies this metric separately to three energy end uses: space conditioning, lighting, and water heating. Therefore, compliance with the code is triggered only for the end uses for which energy intensity is increased.

In most cases, the proposed change triggers partial code compliance, and only rarely will it trigger full code compliance.

Bibliography: Clinton J. Andrews, David Hattis, David Listokin, Jennifer A. Senick, Gabriel B. Sherman & Jennifer Souder (2016): Energy –Efficient Reuse of Existing Commercial Buildings, Journal of the American Planning Association. doi.10.1080/01944363.2015.1134275

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: This proposal ensures that spaces that undergo a change from F, H, S or U occupancies to a more energy intensive occupancy comply with C503, if alterations are included, or C502.2 if not.

CEPI-254-21

Proponents: Lisa Rosenow, representing Self (lrosenow@evergreen-tech.net); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Revise as follows:

TABLE C405.3.2(1) INTERIOR LIGHTING POWER ALLOWANCES: BUILDING AREA METHOD

BUILDING AREA TYPE	LPD (w/ft^2)
Automotive facility	0.75
Convention center	0.64
Courthouse	0.79
Dining: bar lounge/leisure	0.80
Dining: cafeteria/fast food	0.76
Dining: family	0.71
Dormitory[a, b]	0.53
Exercise center	0.72
Fire station[a]	0.56
Gymnasium	0.76
Health care clinic	0.81
Hospital[a]	0.96
Hotel/Motel[a, b]	0.56
Library	0.83
Manufacturing facility	0.82
Motion picture theater	0.44
Multiple-family[c]	0.45
Museum	0.55
Office	0.64
Parking garage	0.18
Penitentiary	0.69
Performing arts theater	0.84
Police station	0.66
Post office	0.65
Religious building	0.67
Retail	0.84
School/university	0.72
Sports arena	0.76
Town hall	0.69
Transportation	0.50
Warehouse	0.45
Workshop	0.91

For SI: 1 watt per square foot = 10.76 ~~w/m^2~~ watts per square meter.

a. Where sleeping units are excluded from lighting power calculations by application of Section R404.1, neither the area of the sleeping units nor the wattage of lighting in the sleeping units is counted.

b. Where dwelling units are excluded from lighting power calculations by application of Section R404.1, neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.

c. Dwelling units are excluded. Neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.

TABLE C405.3.2(2) INTERIOR LIGHTING POWER ALLOWANCES: SPACE-BY-SPACE METHOD

COMMON SPACE TYPES[a]	LPD (watts/ft²)
Atrium	
Less than 40 feet in height	0.48
Greater than 40 feet in height	0.60
Audience seating area	
In an auditorium	0.61
In a gymnasium	0.23
In a motion picture theater	0.27
In a penitentiary	0.67
In a performing arts theater	1.16
In a religious building	0.72
In a sports arena	0.33
Otherwise	0.33
Banking activity area	0.61
Breakroom (See Lounge/breakroom)	
Classroom/lecture hall/training room	
In a penitentiary	0.89
Otherwise	0.71
Computer room, data center	0.94
Conference/meeting/multipurpose room	0.97
Copy/print room	0.31
Corridor	
In a facility for the visually impaired (and not used primarily by the staff)[b]	0.71
In a hospital	0.71
Otherwise	0.41
Courtroom	1.20
Dining area	
In bar/lounge or leisure dining	0.86
In cafeteria or fast food dining	0.40
In a facility for the visually impaired (and not used primarily by the staff)[b]	1.27
In family dining	0.60
In a penitentiary	0.42
Otherwise	0.43
Electrical/mechanical room	0.43
Emergency vehicle garage	0.52
Food preparation area	1.09
Guestroom[c, d]	0.41
Laboratory	
In or as a classroom	1.11
Otherwise	1.33
Laundry/washing area	0.53
Loading dock, interior	0.88
Lobby	
For an elevator	0.65
In a facility for the visually impaired (and not used primarily by the staff)[b]	1.69

COMMON SPACE TYPES	LPD (watts/ft^2)
In a hotel	0.51
In a motion picture theater	0.23
In a performing arts theater	1.25
Otherwise	0.84
Locker room	0.52
Lounge/breakroom	
In a healthcare facility	0.42
Otherwise	0.59
Office	
Enclosed	0.74
Open plan	0.61
Parking area, interior	0.15
Pharmacy area	1.66
Restroom	
In a facility for the visually impaired (and not used primarily by the staff[b]	1.26
Otherwise	0.63
Sales area	1.05
Seating area, general	0.23
Stairwell	0.49
Storage room	0.38
Vehicular maintenance area	0.60
Workshop	1.26
BUILDING TYPE SPECIFIC SPACE TYPES[a]	**LPD (watts/ft^2)**
Automotive (see Vehicular maintenance area)	
Convention Center—exhibit space	0.61
Dormitory—living quarters[c, d]	0.50
Facility for the visually impaired[b]	
In a chapel (and not used primarily by the staff)	0.70
In a recreation room (and not used primarily by the staff)	1.77
Fire Station—sleeping quarters[c]	0.23
Gymnasium/fitness center	
In an exercise area	0.90
In a playing area	0.85
Healthcare facility	
In an exam/treatment room	1.40
In an imaging room	0.94
In a medical supply room	0.62
In a nursery	0.92
In a nurse's station	1.17
In an operating room	2.26
In a patient room[c]	0.68
In a physical therapy room	0.91
In a recovery room	1.25
Library	
In a reading area	0.96
In the stacks	1.18
Manufacturing facility	

COMMON SPACE TYPES	LPD (watts/ft²)
In a detailed manufacturing area	0.80
In an equipment room	0.76
In an extra-high-bay area (greater than 50 feet floor-to-ceiling height)	1.42
In a high-bay area (25–50 feet floor-to-ceiling height)	1.24
In a low-bay area (less than 25 feet floor-to-ceiling height)	0.86
Museum	
In a general exhibition area	0.31
In a restoration room	1.10
Performing arts theater—dressing room	0.41
Post office—sorting area	0.76
Religious buildings	
In a fellowship hall	0.54
In a worship/pulpit/choir area	0.85
Retail facilities	
In a dressing/fitting room	0.51
In a mall concourse	0.82
Sports arena—playing area	
For a Class I facility[e]	2.94
For a Class II facility[f]	2.01
For a Class III facility[g]	1.30
For a Class IV facility[h]	0.86
Transportation facility	
At a terminal ticket counter	0.51
In a baggage/carousel area	0.39
In an airport concourse	0.25
Warehouse—storage area	
For medium to bulky, palletized items	0.33
For smaller, hand-carried items	0.69

For SI: 1 foot = 304.8 mm, 1 watt per square foot = 10.76 ~~w/m²~~ watts per square meter.

a. In cases where both a common space type and a building area specific space type are listed, the building area specific space type shall apply.

b. A ‘Facility for the Visually Impaired’ is a facility that is licensed or will be licensed by local or state authorities for senior long-term care, adult daycare, senior support or people with special visual needs.

c. Where sleeping units are excluded from lighting power calculations by application of Section R404.1, neither the area of the sleeping units nor the wattage of lighting in the sleeping units is counted.

d. Where dwelling units are excluded from lighting power calculations by application of Section R404.1, neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.

e. Class I facilities consist of professional facilities; and semiprofessional, collegiate, or club facilities with seating for 5,000 or more spectators.

f. Class II facilities consist of collegiate and semiprofessional facilities with seating for fewer than 5,000 spectators; club facilities with seating for between 2,000 and 5,000 spectators; and amateur league and high school facilities with seating for more than 2,000 spectators.

g. Class III facilities consist of club, amateur league and high school facilities with seating for 2,000 or fewer spectators.

h. Class IV facilities consist of elementary school and recreational facilities; and amateur league and high school facilities without provision for spectators.

TABLE C405.5.2(2) LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS

	LIGHTING ZONES			
	Zone 1	**Zone 2**	**Zone 3**	**Zone 4**
Base Site Allowance	350 W	400 W	500 W	900 W
Uncovered Parking Areas				
Parking areas and drives	0.03 W/ft^2	0.04 W/ft^2	0.06 W/ft^2	0.08 W/ft^2
Building Grounds				
Walkways and ramps less than 10 feet wide	0.50 W/linear foot	0.50 W/linear foot	0.60 W/linear foot	0.70 W/linear foot
Walkways and ramps 10 feet wide or greater, plaza areas, special feature areas	0.10 W/ft^2	0.10 W/ft^2	0.11 W/ft^2	0.14 W/ft^2
Dining areas	0.65 W/ft^2	0.65 W/ft^2	0.75 W/ft^2	0.95 W/ft^2
Stairways	0.60 W/ft^2	0.70 W/ft^2	0.70 W/ft^2	0.70 W/ft^2
Pedestrian tunnels	0.12 W/ft^2	0.12 W/ft^2	0.14 W/ft^2	0.21 W/ft^2
Landscaping	0.03 W/ft^2	0.04 W/ft^2	0.04 W/ft^2	0.04 W/ft^2
Building Entrances and Exits				
Pedestrian and vehicular entrances and exits	14 W/linear foot of opening	14 W/linear foot of opening	21 W/linear foot of opening	21 W/linear foot of opening
Entry canopies	0.20 W/ft^2	0.25 W/ft^2	0.40 W/ft^2	0.40 W/ft^2
Loading docks	0.35 W/ft^2	0.35 W/ft^2	0.35 W/ft^2	0.35 W/ft^2
Sales Canopies				
Free-standing and attached	0.40 W/ft^2	0.40 W/ft^2	0.60 W/ft^2	0.70 W/ft^2
Outdoor Sales				
Open areas (including vehicle sales lots)	0.20 W/ft^2	0.20 W/ft^2	0.35 W/ft^2	0.50 W/ft^2
Street frontage for vehicle sales lots in addition to “open area” allowance	No allowance	7 W/linear foot	7 W/linear foot	21 W/linear foot

For SI: 1 foot = 304.8 mm, 1 watt per square foot = ~~W/0.0929 m^2~~ 10.76 watts per square meter.

W = watts.

TABLE C405.5.2(3) INDIVIDUAL LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS

LIGHTING ZONES				
	Zone 1	**Zone 2**	**Zone 3**	**Zone 4**
Building facades	No allowance	0.075 W/ft^2 of gross above-grade wall area	0.113 W/ft^2 of gross above-grade wall area	0.15 W/ft^2 of gross above-grade wall area
Automated teller machines (ATM) and night depositories	135 W per location plus 45 W per additional ATM per location			
Uncovered entrances and gatehouse inspection stations at guarded facilities	0.50 W/ft^2 of area			
Uncovered loading areas for law enforcement, fire, ambulance and other emergency service vehicles	0.35 W/ft^2 of area			
Drive-up windows and doors	200 W per drive through			
Parking near 24-hour retail entrances.	400 W per main entry			

For SI: For SI: 1 watt per square foot = ~~W/0.0929 m^2~~ 10.76 watts per square meter.

W = watts.

Reason: Correct SI conversion errors and present footnote information consistently for all LPA tables.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Editorial corrections only.

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Submitted

Commercial Energy Committee Reason: consistency in unit conversions

Proposal # 525

CEPI-257-21

Proponents: Duane Jonlin, representing City of Seattle (duane.jonlin@seattle.gov)

2021 International Energy Conservation Code

Add new text as follows:

APPENDIX X
THE GLIDE PATH

X.1 Prescriptive compliance. Where compliance is demonstrated using the Prescriptive Compliance option, the number of additional efficiency credits required by Section C406.1 shall be XX, rather than 10. [NOTE: This number of credits to be finalized when the energy use reduction of the 2024 IECC base code can be estimated, so that it results in a net 10% energy cost reduction compared with the 2021 IECC.]

X.2 Total Building Performance compliance. Where compliance is demonstrated using the Total Building Performance option, Item 2 in Section C407.2 shall require the *proposed design* energy cost to be XX percent rather than 80 percent of the *standard reference design* energy cost. [NOTE: This percentage to be finalized when the energy use reduction of the 2024 IECC base code can be estimated, so that it results in roughly a net 10% energy cost reduction compared with the 2021 IECC.]

X.3 Renewable energy. In addition to any renewable energy required or provided to comply with other sections of this code, 2.4 watts of on-site renewable energy per square foot of conditioned space, and 0.8 watts of on-site renewable energy per square foot of semi-heated or unconditioned space, shall be provided.

X3.1 Site-recovered energy. Waste energy recovered on site is permitted to substitute for all or part of the renewable energy required by Section X.3. Waste energy consists of thermal energy that would otherwise be lost to the ground, atmosphere, or sewer.

X.4 Off-site renewable energy. Off-site renewable energy is permitted to be substituted where the off-site renewable energy production is 1.25 times the required amount of on-site renewable energy production and the renewable energy is located in the same US EPA eGRID subregion as the project.

X.4.1 Documentation requirements for off-site renewable energy systems.. Off-site renewable energy delivered or credited to the building project shall be subject to a legally binding contract to procure qualifying off-site renewable energy. Qualifying off-site renewable energy shall meet the following requirements:

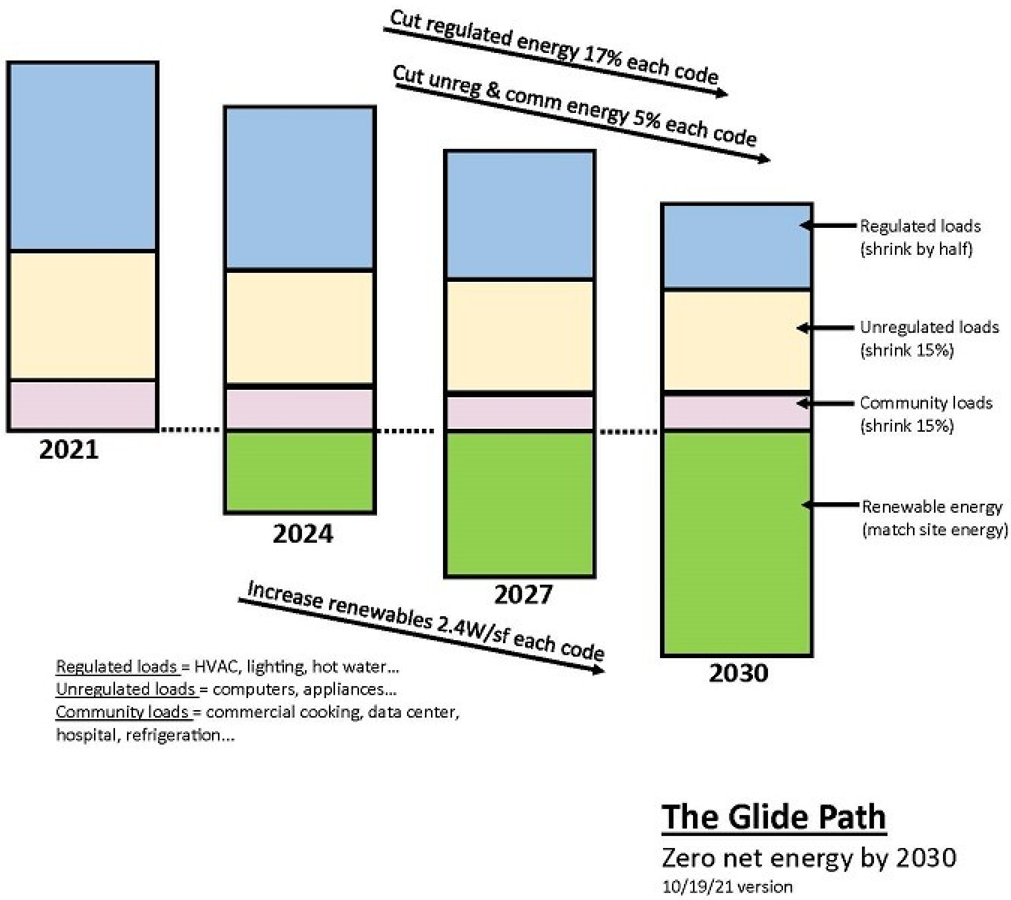
1. Documentation of off-site renewable energy procurement shall be submitted to the code official.
2. The purchase contract shall have a duration of not less than 15 years. The contract shall be structured to survive a partial or full transfer of ownership of the building property.
3. Records on renewable power purchased by the building owner from the off-site renewable energy generator that specifically assign the RECs to the building owner shall be retained or retired by the building owner on behalf of the entity demonstrating financial or operational control over the building seeking compliance to this standard and made available for inspection by the code official upon request.
4. Where multiple buildings in a building project are allocated energy procured by a contract subject to this section, the owner shall allocate for not less than 15 years the energy procured by the contract to the buildings in the building project. A plan on operation shall be developed which shall indicate how renewable energy produced from on-site or off-site systems that is not allocated before issuance of the certificate of occupancy will be allocated to new or existing buildings included in the building project.
5. The plan shall include provisions to use a REC tracking system that meets the requirements of Section V.B of the Green-e Framework for Renewable Energy Certification. The plan shall describe how the building owner will procure alternative qualifying renewable energy in the case that the renewable energy producer ceases operation.

Reason: This appendix is intended to be adopted by jurisdictions that will require new construction to operate at net zero energy by the year 2030. It reduces the net annual energy use of buildings by approximately one-third in comparison with buildings constructed in compliance with the 2021 IECC, assuming that the 2027 and 2030 editions will also reduce energy use by one-third each.
It is estimated that *regulated* energy uses in buildings can be cut by 50% from current levels by 2030, but that unregulated loads and large community process loads will only diminish about 15% in the same time period. If regulated loads comprise 60% of building energy use, and unregulated loads (not counting large process loads) comprise the remaining 40%, halving the regulated loads would result in a 30% reduction in energy use, or 10% for each of the three Glide Path steps. Reducing unregulated and process loads by 15% over this decade would result in an additional 9% overall building energy use reduction by 2030, or 3% reduction per code cycle. Some of this 13% reduction (10% regulated and 3% unregulated/process) will occur in the base code development, and the remainder is required by this appendix.

For the 2030 ZNE target, renewable or site-recovered energy will be required to compensate for the remaining half of regulated energy use, plus the typical unregulated building energy use, and an additional amount to cover a proportionate share of community process energy.

Rather than burdening those buildings that contain large process loads (restaurant, grocery, hospital, data center, laboratory, etc.) with a requirement to provide renewable energy to cover their entire operating energy use, this Appendix requires an additional amount of renewable energy for *all* new building square footage in recognition of the fact that those large process loads serve the entire community with essential services. It is estimated that such community process loads equal approximately 20% of all other building energy loads.

If 39% of a building's net energy use reduction can be covered with efficiency and technology improvements, the remaining 61% of the *net* energy use reduction will be accomplished with acquisition of renewable energy resources, also in three roughly equal steps. Assuming typical PV production to be 1.5 kWh/year/watt, this would result in a requirement for 7 W/sf of conditioned floor area for 2030, or roughly 2.4 W/sf for 2024. For semi-heated or unconditioned space, the requirement will be 1/3 of this amount, or 0.8 W/sf for 2024.



Cost Impact: The code change proposal will increase the cost of construction.
The installed cost of rooftop PV arrays will be something like $2.00 per watt during the active period of this code edition, although additional price decreases may continue to occur. The savings will vary greatly, depending on climate zone and utility rates.

The number of additional efficiency credits required for those pursuing the prescriptive compliance paths will vary depending on how much efficiency progress is made in the base code - the more the base code advances, the lower the cost of compliance.

Attached Files

- **Glide Path diagram.pdf**
  https://energy.cdpaccess.com/proposal/541/850/files/download/234/

Workgroup Recommendation

Commercial Energy Committee Committee Action: As Modified

Commercial Energy Committee Reason: This proposed appendix establishes a pathway to net-zero energy consumption by 2030.