

July 11, 2019

To the Washington State Building Code Council,

We respectfully request your acceptance of our public testimony in reference to the proposed rules for the 2018 WSEC commercial provisions.

Evergreen Technology Consulting provides technical support and training for the commercial WSEC for the design, construction and jurisdictional community of WA State.

As a member of the WSEC Technical Advisory Committee, we participated in the TAG process and submitted several code change proposals that were intended to improve code language clarity to support the efforts of the jurisdictional community and improve energy code compliance.

We conducted a thorough review of the proposed rules in comparison with the TAG amended and approved code change proposals that we submitted. The document attached are our observations. We noted errors, omissions and language inconsistent with the intent of the language that was vetted and approved by the TAG. Our comments do not include recommendations for changes in stringency.

This exercise reveals the importance of affording the TAG the opportunity to complete their work by going through a final QA/QC review of the code change recommendations that they submitted. The extended code adoption schedule provides the time needed to complete this level of quality control.

The negative impact of errors, omissions and ambiguous language in the code to the design, construction and jurisdictional community cannot be understated.

We respectfully request that the SBCC executive committee consider moving submitted public comment to the Energy Code TAG for their review and recommendations prior to adopting the proposed rules for the 2018 WSEC.

Sincerely,

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Public Testimony for the 2018 WSEC

Document includes Pages 2-15

ETC Comment for Section C402.1.1.1 – As a minor editorial correction, in Item 3 add “Reserved.”

ETC Comment for Section C402.1.1.2 – Proposed edits highlighted in yellow below adds specific details pertaining to a semi-heated space directly into the section versus pointing to a definition. Improves code language clarity. No change in requirements.

C402.1.1.2 Semi-heated buildings and spaces. The building envelope of semi-heated buildings, or portions thereof, shall comply with the same requirements as that for conditioned spaces in Section C402, except as modified by this section. **The total installed output capacity of mechanical space conditioning space heating systems serving a semi-heated building or space shall be no greater than 8 Btu/(h-ft²) and mechanical cooling is not allowed in accordance with Section C202.** Building envelope assemblies separating conditioned space from semi-heated space shall comply with exterior envelope insulation requirements. Semi-heated spaces heated by mechanical systems that do not include electric resistance heating equipment are not required to comply with the opaque wall insulation provisions of Section C402.2.3 for walls that separate semi-heated spaces from the exterior or low energy spaces. Semi-heated spaces shall be calculated separately from other conditioned spaces for compliance purposes. Opaque walls in semi-heated spaces shall be calculated as fully code compliant opaque walls for both the target and proposed for the Target UA calculations for Component Performance compliance per Section C402.1.5, and for the Standard Reference Design for Total Building Performance compliance per Section C407. The capacity of heat trace temperature maintenance systems complying with Section C404.7.2 that are provided for freeze protection of piping and equipment only shall not be included in the total installed output capacity of mechanical space conditioning systems.

EXCEPTION: **A semi-heated building or space may comply as semi-heated with this section when served by one or more of the following mechanical system alternatives provided the total installed heating output capacity does not exceed that which is allowed for semi-heated:**

1. Electric infrared heating equipment for localized heating applications.
2. Heat pumps with cooling capacity permanently disabled, as pre-approved by the jurisdiction.

ETC Comment for Section C402.1.1.3 – Proposed edits highlighted in yellow below correct a section reference error and add a missing table. Refer to TAG amended language in **ENV013-2018**.

C402.1.1.3 Greenhouses. Greenhouse structures or areas 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 C402.4.4.
EXCEPTION: Low energy greenhouses that comply with Section C402.1.1.1.
2. Interior partition building thermal envelope assemblies that separate the greenhouse from conditioned space complying with Sections C402.2, C402.4.3 and C402.4.4.
3. Nonopaque envelope assemblies complying with the thermal envelope requirements in Table **C402.1.1.3**. The U-factor for the nonopaque roof shall be for the roof assembly or a roof that includes the assembly and an internal curtain system.
EXCEPTION: Unheated greenhouses.
4. No mechanical cooling is provided.
5. For heated greenhouses, heating is provided by a radiant heating system, a condensing natural gas-fired or condensing propane-fired heating system, or a heat pump with cooling capacity permanently disabled as preapproved by the jurisdiction.

Table C402.1.1.3 - Non-Opaque Thermal Envelope Maximum Requirements	
Component U-factor (BTU/h-ft²-°F)	Climate Zone 5 and Marine 4
Non-Opaque Roof	0.5
Non-Opaque SEW Wall	0.7
Non-Opaque N Wall	0.6

ETC Comment for Section C406.1.1 – Proposed edits highlighted in yellow below correct inconsistencies and language omissions associated with the blending of TAG amended language per **EO126-2018 and EO125-2018**. The intent is to require a building constructed in two phases (shell and core followed by an initial tenant improvement) to collectively be required to comply with a total of six credits, in the same manner as required for a building constructed in a single phase. This intent is not clear in the current language.

C406.1.1 Tenant spaces. Initial tenant improvement shall comply with sufficient packages from Table C406.1 so as to achieve a minimum number of ~~three~~ **six** credits, ~~from Section C406.2, C406.3, C406.4, C406.6 or C406.7, where applicable.~~ In buildings with multiple tenant spaces, each tenant space is permitted to comply individually. ~~Where an entire building complies with Section C406.5, C406.10 or C406.11, tenant spaces within the building shall be deemed to comply with this section.~~ **When a whole building complies with a credit from Table C406.1 under the initial shell and core permit, the approved credit may be used to demonstrate compliance with this section.**

EXCEPTION: Previously occupied tenant spaces in existing buildings that comply with this code in accordance with Section C501.

ETC Comment for Section C406.2 – Proposed edits highlighted in yellow below correct a section reference error. Referenced section and topic do not exist.

C406.2 More efficient HVAC equipment and fan performance. No less than 90 percent of the total HVAC capacity serving the total conditioned floor area of the entire building, building addition, ~~shell and core area in accordance with Section C406.1.1~~ or tenant space in accordance with Section **C406.1.1** shall comply with Sections C406.2.1 through C406.2.3. For systems required to comply with Section C403.1.1, HVAC total system performance ratio, exceed the minimum requirement by 10 percent.

EXCEPTION: In low energy spaces complying with Section C402.1.1 and semi-heated spaces complying with Section C402.1.1.2, 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. Stand-alone supply, return and exhaust fans shall comply with Section C406.2.3.

ETC Comment for Section C406.2.2 – As a minor editorial correction, in Item 2 “Equipment **that complies** with the exception to Section C406.2.1 is not required to comply with the minimum equipment efficiency requirement.”

ETC Comment for Section C406.4 – Proposed edits highlighted in yellow add approved code change content that was inadvertently omitted. Without this language, this option is not allowed to be applied in the same manner as all the other options, which was not the intent. The intent is to allow this option to be applied to the whole building or a portion of a building. In addition, approved changes in Section C406.4.1 provides important clarifications about how to demonstrate compliance. Refer to TAG amended language in **EO126-2018**.

C406.4 Enhanced digital lighting controls. Interior lighting shall be located, scheduled and operated in accordance with Section C405.2 and ~~No~~ less than 90 percent of the total installed interior lighting power within the whole building, building addition or tenant space shall be configured with the following enhanced control functions **comply with Section C406.4.1.**

C406.4.1 Lighting controls function. Interior lighting shall be located, scheduled and operated in accordance with Section C405.2, and shall be configured with the following enhanced control function:

1. Luminaires shall be configured for continuous dimming.
2. Each luminaire shall be individually addressed.... etc

ETC Comment for Section C406.4 – Proposed edits highlighted in yellow aligns with the intent of the other DOAS option to allow this option to be applied to the whole building or a portion of a building. In addition, the intent of this option is to be an enhanced version of C406.6 and the language noted does not make this clear, which will lead to difficulties in enforcement.

C406.7 High performance dedicated outdoor air system (DOAS). Buildings A whole building, building addition or tenant space which includes a DOAS complying with Section ~~C403.3.5~~ of C406.6 shall also provide minimum sensible effectiveness of heat recovery of 80 percent and DOAS total combined fan power less than 0.5 W/cfm of outdoor air. For the purpose of this section, total combined fan power includes all supply, exhaust, recirculation and other fans utilized for the purpose of ventilation.

ETC Comment for Section C202, C501.4.1, C501.4.2 – Proposed edits highlighted in yellow correct a term that is inconsistent with the rest of the code. Also highlighted are omissions in C501.4.2 compared to the approved TAG amended language in **E160-2018**.

RETROFIT ALTERATION, BUILDING ENVELOPE. Includes building envelope alterations and building envelope upgrades including those required for an area undergoing a change in space conditioning or a change in occupancy.

C501.4.1 U-factor requirements for retrofits alterations. For existing building projects where an addition or building envelope retrofit alteration area is combined with existing-to-remain building areas to demonstrate compliance with this code as a whole building, the U-factors applied to existing-to-remain envelope assemblies shall be in accordance with record documents.

EXCEPTIONS:

1. If accurate record documents are not available, U-factors for the existing envelope assemblies may be in accordance with the edition of the Washington State Energy Code that was in effect at the time the building was permitted.
2. U-factors for the existing envelope assemblies as approved by the *code official*.

C501.4.2 Calculations of mechanical heating and cooling loads for retrofits alterations. For the installation of new or replacement mechanical equipment that serves existing building areas, design loads associated with heating, cooling and ventilation of the existing building areas served shall be determined in accordance with Section C403.1.1. R-values and U-factors used to determine existing thermal envelope performance for the purpose of calculating design loads shall be in accordance with record documents or existing conditions.

EXCEPTIONS:

1. If accurate record documents are not available, R-values and U-factors for the existing envelope assemblies used to determine existing building thermal envelope performance may be in accordance with the edition of the Washington State Energy Code that was in effect at the time the building was permitted.
2. R-values and U-factors for the existing envelope assemblies as approved by the *code official*.

ETC Comment for Section C502.2.2 – Proposed edit highlighted in yellow corrects an error. Vertical fenestration alternates are not applicable to skylights. Refer to TAG amended language in **E161-2018**.

C502.2.2 Skylight area. Additions with skylights that result in a total building skylight area less than or equal to that specified in Section C402.4.1 shall comply with Section C402.4. Additions with skylights that result in a total building skylight area greater than that specified in Section C402.4.1 shall comply with one of the following:

Vertical fenestration alternate per Section C402.4.1.1 or C402.4.1.3 for the addition area of the building only.

1. Component performance alternative with target area adjustment per Section C402.1.5 for the addition area of the building only.
2. Existing building and addition area are combined to demonstrate compliance with the component performance alternative for the whole building.
3. Total building performance in accordance with Section C407 for the addition area of the building only.
4. Total building performance for the whole building.

ETC Comment for Section C503.1 – Proposed edit highlighted in yellow provides clarification that an initial tenant improvement is considered new construction and not an alteration and thus is not allowed to utilize the allowances available for alterations.

C503.1 General. Alterations to any building or structure shall comply with the requirements of Section C503 and the code for new construction. Alterations do not include the initial tenant improvement of a shell and core space.

ETC Comment for Section C503.2 and C505.1 – Proposed edits highlighted in yellow below removes language duplication that is the result of blending TAG amended language per E161-2018 and E162-2018. Also, extraneous language is removed from C505.1 that is not applicable to this code section topic and could cause confusion.

C503.2 Change in space conditioning. Any low energy space in accordance with Section C402.1.1.1 that is altered to become conditioned space or semi-heated space shall be brought into full compliance with this code. Any semi-heated space in accordance with Section C402.1.1.2 that is altered to become conditioned space shall be required to be brought into full compliance with this code. For buildings with more than one space conditioning category, the interior partition walls, ceilings, floors and fenestration that separate space conditioning areas shall comply with the thermal envelope requirements per the area with the highest level of space conditioning. A change in space conditioning project shall be deemed to comply with this code if the project area alone complies or if the existing building and the project area combined comply with this code as a whole building.

EXCEPTIONS:

1. Where the component performance building alternative in Section C402.1.5 is used to demonstrate compliance with this Section, the Proposed Total UA is allowed to be up to 110 percent of the Allowable Total Envelope UA.
2. Where total building performance in Section C407 is used to demonstrate compliance with this section, the annual carbon emissions from energy consumption of the proposed design is allowed to be up to 110 percent of the annual carbon emissions from energy consumption allowed by Section C407.3. This exception may be applied to the project area alone, or to the existing building and project area combined as a whole building.

EXCEPTIONS: Buildings or spaces that were permitted prior to the 2009 Washington State Energy Code, or were originally permitted as unconditioned, may comply with this section as follows:

1. Where the component performance alternative in Section C402.1.5 is used to demonstrate compliance with this Section, the Proposed Total Envelope UA is allowed to be up to 110 percent of the Allowable Total Envelope UA. This exception may be applied to the project area alone, or to the existing building and project area combined as a whole building.
2. Where total building performance in accordance with Section C407 is used to demonstrate compliance with this Section, the total annual carbon emissions from energy consumption of the proposed design is allowed to be up to 110 percent of the annual carbon emissions from energy consumption allowed by Section C407.3. This exception may be applied to the project area alone, or to the existing building and project area combined as a whole building.

C505.1 General. Spaces undergoing a change in occupancy shall be brought up to full compliance with this code in the following cases:

1. Any space that is converted from an F, S or U occupancy to an occupancy other than F, S or U.
2. Any space that is converted to a Group R dwelling unit or portion thereof, from another use or occupancy.
3. Any Group R dwelling unit or portion thereof permitted prior to July 1, 2002, that is converted to a commercial use or occupancy.

A change in occupancy project shall be deemed to comply with this code if the project area alone complies or if the existing building and the project area combined comply with this code as a whole building.

EXCEPTIONS:

1. Where the component performance building alternative in Section C402.1.5 is used to demonstrate compliance with this Section, the Proposed Total UA is allowed to be up to 110 percent of the Allowable Total Envelope UA. This exception may be applied to the project area alone, or to the existing building and project area combined as a whole building.
2. Where total building performance in Section C407 is used to demonstrate compliance with this section, the annual carbon emissions from energy consumption of the proposed design is allowed to be up to 110 percent of the annual carbon emissions from energy consumption allowed by Section C407.3. This exception may be applied to the project area alone, or to the existing building and project area combined as a whole building.

EXCEPTIONS: Buildings or spaces that were permitted prior to the 2009 Washington State Energy Code, or were originally permitted as unconditioned, may comply with this section as follows:

1. Where the component performance alternative in Section C402.1.5 is used to demonstrate compliance with this Section, the Proposed Total Envelope UA is allowed to be up to 110 percent of the Allowable Total Envelope UA. This exception may be applied to the project area alone, or to the existing building and project area combined as a whole building.
2. Where total building performance in accordance with Section C407 is used to demonstrate compliance with this Section, the total annual carbon emissions from energy consumption of the proposed design is allowed to be up to 110 percent of the annual carbon emissions from energy consumption allowed by Section C407.3. This exception may be applied to the project area alone, or to the existing building and project area combined as a whole building.

Where the use in a space changes from one use in Table C405.4.2 (1) or (2) to another use in Table C405.4.2 (1) or (2), the installed lighting wattage shall comply with Section C405.4.

ETC Comment for Section C503.3.2 and C503.3.3. – Proposed edits highlighted in yellow add approved code change content that was inadvertently omitted in C503.3.2. The omission of this language changes the intent and scope of this code section. Refer to TAG amended language per **E161-2018**. In addition, it is recommended to move the exception language into the applicable location in the body of this section to improve code language clarity. This does not change the intent or stringency.

C503.3.2 Vertical fenestration. The addition of *vertical fenestration* that results in a total building vertical fenestration area less than or equal to that specified in Section C402.4.1 shall comply with Section C402.4. ~~Alterations~~ **The addition of vertical fenestration** that results in a total building vertical fenestration area greater than specified in Section C402.4.1 shall comply with one of the following:

1. Vertical fenestration alternate in accordance with Section C402.1.3 for the new vertical fenestration added.
2. Vertical fenestration alternate in accordance with Section C402.4.1.1 for the area adjacent to the new vertical fenestration added.
3. Existing building and alteration area are combined to demonstrate compliance with the component performance alternate ~~with target area adjustment~~ in accordance with Section C402.1.5 for the whole building. **The Proposed Total Envelope UA is allowed to be up to 110 percent of the Allowed Total Envelope UA.**
4. Total building performance ~~alternative in accordance with~~ Section C407 for the whole building. **The annual carbon emissions from energy consumption of the proposed design is allowed to be up to 110 percent of the annual carbon emissions from energy consumption allowed in accordance with Section C407.3.**

EXCEPTIONS:

1. Additional envelope upgrades are included in the project so the addition of vertical fenestration does not cause a reduction in overall building energy efficiency, as approved by the *code official*.
2. ~~Where the component performance alternative for the whole building is used to demonstrate compliance with this section, the Proposed Total UA is allowed to be up to 110 percent of the Allowed Total UA.~~
3. ~~Where total building performance for the whole building is used to demonstrate compliance with this section, the annual carbon emissions from energy consumption of the proposed design is allowed to be up to 110 percent of the annual carbon emissions from energy consumption allowed in Section C407.3.~~

C503.3.3 Skylight area. The addition of skylights that results in a total building skylight area less than or equal to that specified in Section C402.4.1 shall comply with Section C402.4. The addition of skylights that results in a total building skylight area greater than that specified in Section C402.4.1 shall comply with one of the following:

1. Existing building and alteration area are combined to demonstrate compliance with the component performance alternative with target area adjustment in accordance with Section C402.1.5 for the whole building. The Proposed Total Envelope UA is allowed to be up to 110 percent of the Allowed Total Envelope UA.
2. Total building performance in accordance with Section C407 for the whole building. The annual carbon emissions from energy consumption of the proposed design is allowed to be up to 110 percent of the annual carbon emissions from energy consumption allowed in accordance with Section C407.3.

EXCEPTIONS:

1. Additional envelope upgrades are included in the project so the addition of skylights does not cause a reduction in overall building energy efficiency, as approved by the *code official*.
2. ~~Where the component performance alternative for the whole building is used to demonstrate compliance with this section, the Proposed Total UA is allowed to be up to 110 percent of the Allowed Total UA.~~
3. ~~Where total building performance for the whole building is used to demonstrate compliance with this section, the annual carbon emissions from energy consumption of the proposed design is allowed to be up to 110 percent of the annual carbon emissions from energy consumption allowed in Section C407.3.~~

ETC Comment for Sections C402.4.1.1, C402.4.1.1.1 and C402.4.1.1.2 – Proposed edits highlighted in yellow below adds language that was inadvertently omitted as the result of blending TAG amended language per **ENV039-2018** and **ENV041-2018**. Also highlighted are minor improvements to section titles that was also approved by the TAG.

C402.4.1.1 Vertical fenestration maximum area with high performance alternates. For buildings that comply with Section C402.4.1.1.1 or C402.4.1.1.2, the total building vertical fenestration area is permitted to exceed 30 percent but shall not exceed 40 percent of the gross above grade wall area for the purpose of prescriptive compliance with Section C402.1.4. When determining compliance using the component performance alternative in **accordance with** Section C402.1.5, the total building vertical fenestration area allowed in Equation 4-2 is 40 percent of the above grade wall area for buildings that comply with the vertical fenestration alternates described in this section. These alternates are not permitted to be used for total building performance compliance using Section C407.

C402.4.1.1.1 Optimized daylighting. All of the following requirements shall be met:

1. Not less than 50 percent of the total conditioned floor area in the building is within a daylight zone that includes daylight responsive controls complying with Section C405.2.4.1.
2. Visible transmittance (VT) of all vertical fenestration in the building is greater than or equal to 1.1 times **the required** solar heat gain coefficient (SHGC) **in accordance with Section C402.4**, or 0.50, whichever is greater.

EXCEPTION: Fenestration that is outside the scope of NFRC 200 is not required to comply with Item 2.

C402.4.1.1.2 ~~Increased vertical fenestration area with~~ High-performance fenestration.

All of the following requirements shall be met:

1. All *vertical fenestration* in the building shall comply with the following U-factors:
 - a. U-factor for Class AW windows rated in accordance with AAMA/CSA101/I.S.2/A440, vertical curtain walls and site-built fenestration products (fixed) = 0.34
 - b. U-factor for Class AW windows rated in accordance with AAMA/CSA101/I.S.2/A440, vertical curtainwalls and site-built fenestration products (operable) = 0.36
 - c. Entrance doors = 0.60
 - d. U-factor for all other vertical fenestration = 0.28
2. The SHGC of the vertical fenestration shall be less than or equal to 0.35, adjusted for projection factor in compliance with C402.4.3.

An area-weighted average shall be permitted to satisfy the U-factor requirement for each fenestration product category listed in Item 1 of this section. Individual fenestration products from different fenestration product categories shall not be combined in calculating the area-weighted average U-factor.

ETC Comment for C503.4 – Proposed edits highlighted in yellow below address public comment stating that the language as presented is unclear and may cause issues with interpretation and enforcement. These proposed edits do not change the intent or stringency. Also noted are incorrect section references in footnotes. Refer to TAG amended language per E169-2018.

**TABLE C503.4
ECONOMIZER COMPLIANCE OPTIONS FOR MECHANICAL ALTERATIONS**

Unit Type	Option A	Option B (alternate to A)	Option C (alternate to A)	Option D (alternate to A)
	Any alteration with new or replacement equipment	Replacement unit of the same type with the same or smaller output capacity	Replacement unit of the same type with a larger output capacity	New equipment added to existing system or replacement unit of a different type
1. Packaged Units	Efficiency: min. ^a Economizer: C403.5 ^b	Efficiency: min. ^a Economizer: C403.5 ^b	Efficiency: min. ^a Economizer: C403.5 ^b	Efficiency: min. ^a Economizer: C403.5 ^b
2. Split Systems	Efficiency: min. ^a Economizer: C403.5 ^b	For units ≤ 60,000 Btuh, comply with two of two measures: (1) Efficiency: + 10% ^c (2) Economizer: shall not decrease existing economizer capability Otherwise For all other capacities: Efficiency: min. ^a Economizer: C403.5 ^b	For units ≤ 60,000 Btuh replacing unit installed prior to 1991, comply with at least one of two measures : (1) Efficiency: + 10% ^c (2) Economizer: 50% ^f Otherwise For all other capacities: Efficiency: min. ^a Economizer: C403.5 ^b	Efficiency: min. ^a Economizer: C403.5 ^b
3. Water Source Heat Pump	Efficiency: min. ^a Economizer: C403.5 ^b	For units < 72,000 Btuh, comply with at least two of three measures : (1) Efficiency: + 10% ^c for units < 72,000 Btuh (2) Flow control valve ^g (3) Economizer: 50% ^f Otherwise For all other capacities: Efficiency: min. ^a Economizer: C403.5 ^b	For units < 72,000 Btuh, comply with three of three measures : (1) Efficiency: + 10% ^c for units < 72,000 Btuh (2) Flow control valve ^g (3) Economizer: 50% ^f (except for certain pre-1991 systems ^q) Otherwise For all other capacities: Efficiency: min. ^a Economizer: C403.5 ^b	Efficiency: min. ^a Economizer: C403.5 ^b (except for certain pre-1991 systems ^q)
4. Water Economizer using Air-Cooled Heat Rejection Equipment (Dry Cooler)	Efficiency: min. ^a Economizer: C403.5 ^b	Efficiency: + 5% ^d Economizer: shall not decrease existing economizer capacity	Efficiency: min. ^a Economizer: C403.5 ^b	Efficiency: min. ^a Economizer: C403.5 ^b

Unit Type	Option A	Option B (alternate to A)	Option C (alternate to A)	Option D (alternate to A)
	Any alteration with new or replacement equipment	Replacement unit of the same type with the same or smaller output capacity	Replacement unit of the same type with a larger output capacity	New equipment added to existing system or replacement unit of a different type
5. Air-Handling Unit (including fan coil units) where the system has an air-cooled chiller	Efficiency: min. ^a Economizer: C403.5 ^b	Economizer: shall not decrease existing economizer capacity	Efficiency: min. ^a Economizer: C403.5 ^b (except for certain pre-1991 systems ^d)	Efficiency: min. ^a Economizer: C403.5 ^b (except for certain pre-1991 systems ^d)
6. Air- Handling Unit (including fan coil units) and Water-cooled Process Equipment, where the system has a water-cooled chiller ¹⁰	Efficiency: min. ^a Economizer: C403.5 ^b	Economizer: shall not decrease existing economizer capacity	Efficiency: min. ^a Economizer: C403.5 ^b (except for certain pre-1991 systems ^d and certain 1991-2016 systems ⁱ)	Efficiency: min. ^a Economizer: C403.5 ^b (except for certain pre-1991 systems ^d and certain 1991-2016 systems ⁱ)
7. Cooling Tower	Efficiency: min. ^a Economizer: C403.5 ^b	No requirements	Efficiency: min. ^a Economizer: C403.5 ^b	Efficiency: min. ^a Economizer: C403.5 ^b
8. Air-Cooled Chiller	Efficiency: min. ^a Economizer: C403.5 ^b	Efficiency: + 10% ^k Economizer: shall not decrease existing economizer capacity	Efficiency: 1 Comply with two of two measures : (1) + 10% ^{k,l} and (2) multistage compressor(s) Economizer: shall not decrease existing economizer capacity	Efficiency: min. ^a Economizer: C403.5 ^b
9. Water-Cooled Chiller	Efficiency: min. ^a Economizer: C403.5 ^b	Efficiency: 1 Comply with at least one of two measures } : (1) Part load IPLV +15% ⁿ or (2) plate frame heat exchanger ° Economizer: shall not decrease existing economizer capacity	Efficiency: 1 Comply with two of two measures } : (1) Part load IPLV +15% ⁿ or (2) plate frame heat exchanger ° Economizer: shall not decrease existing economizer capacity	Efficiency: min. ^a Economizer: C403.5 ^b

a Minimum equipment efficiency shall comply with Section C403.3.2 and Tables C403.3.2(1) through C403.3.3.2(12).

b All separate new equipment and replacement equipment shall have air economizer complying with Section C403.5, including both the individual unit size limits and the total building capacity limits on units without economizer. It is acceptable to comply using one of the exceptions to Section C403.5.

c Reserved.

d Equipment shall have a capacity-weighted average cooling system efficiency that is 5% better than the requirements in Tables C403.3.2(1) and C403.3.2(2) (1.05 x values in Tables C403.3.2(1) and C403.3.2(2)).

e Equipment shall have a capacity-weighted average cooling system efficiency that is 10% better than the requirements in Tables C403.3.2(1)A and C403.3.2(2) (1.10 x values in Tables C403.3.2(1)A and C403.3.2(2)).

f Minimum of 50% air economizer that is ducted in a fully enclosed path directly to every heat pump unit in each zone, except that ducts may

terminate within 12 inches of the intake to an HVAC unit provided that they are physically fastened so that the outside air duct is directed into the unit intake. If this is an increase in the amount of outside air supplied to this unit, the outside air supply system shall be configured to provide this additional outside air and be equipped with economizer control.

g Water-source heat pump systems shall have a flow control valve to eliminate flow through the heat pumps that are not in operation and variable speed pumping control complying with Section C403.4.23 for that heat pump.

- When the total capacity of all units with flow control valves exceeds 15% of the total system capacity, a variable frequency drive shall be installed on the main loop pump.

- As an alternate to this requirement, the capacity-weighted average cooling system efficiency shall be 5% better than the requirements in footnote e for water-source heat pumps (i.e. 15% greater than the requirements in Table C403.3.2(2)).

h Water economizer equipment shall have a capacity-weighted average cooling system efficiency that is 10% better than the requirements in Tables C403.3.2(8) and C403.3.2(9) (1.10 x values in Tables C403.3.2(8) and C403.3.2(9)).

I Air economizer is not required for systems installed with water economizer plate and frame heat exchanger complying with previous codes between 1991 and June 2016, provided that the total fan coil load does not exceed the existing or added capacity of the heat exchangers.

J For water-cooled process equipment where the manufacturers specifications require colder temperatures than available with waterside economizer, that portion of the load is exempt from the economizer requirements.

K The air-cooled chiller shall have an IPLV efficiency that is a minimum of 10% greater than the IPLV requirements in EER in Table C403.3.2(7) (1.10 x IPLV values in EER in Table C403.3.2(7)).

l The air-cooled chiller shall be multistage with a minimum of two compressors.

m The water-cooled chiller shall have full load and part load IPLV efficiency that is a minimum of 5% greater than the IPLV requirements in Table C403.2.3(7).

n The water-cooled chiller shall have an IPLV value that is a minimum of 15% lower than the IPLV requirements in Table C403.2.3(7) (1.15 x IPLV values in Table C403.2.3(7)). Water-cooled centrifugal chillers designed for nonstandard conditions shall have an NPLV value that is at least 15% lower than the adjusted maximum NPLV rating in kW per ton defined in Section C403.3.2.1 (1.15 x NPLV).

o Economizer cooling shall be provided by adding a plate-frame heat exchanger on the waterside with a capacity that is a minimum of 20% of the chiller capacity at standard AHRI rating conditions.

p Reserved.

q Systems installed prior to 1991 without fully utilized capacity are allowed to comply with Option B, provided that the individual unit cooling capacity does not exceed 90,000 Btuh.