

CE229-19

IECC: C202, C406.1, TABLE C406.1(1) (New), TABLE C406.1(2) (New), TABLE C406.1(3) (New), TABLE C406.1(4) (New), TABLE C406.1(5) (New), C406.1.1, C406.2, C406.2.1 (New), C406.2.3 (New), C406.2.4 (New), C406.4, C406.5, C406.5.1 (New), C406.5.2 (New), C406.7, C406.7.1 (New), C406.7.1, C406.7.3 (New), C406.7.4 (New)

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2018 International Energy Conservation Code

SECTION C202 GENERAL DEFINITIONS

Add new definition as follows:

LUMEN MAINTENANCE CONTROLS: A lighting control strategy that adjusts luminaire power over time to maintain constant light output as luminaires age, dirt accumulates or both. This strategy allows for energy savings in the life of the system then increases power as the system ages.

HIGH END TRIM: A lighting control strategy that sets the required maximum light level for each space.

SECTION C406 ADDITIONAL EFFICIENCY PACKAGE OPTIONS REQUIREMENTS

C406.1 Requirements. Buildings shall comply 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. 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. Alternatively, credits shall be as calculated in accordance the relevant subsection of Section C406. 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

Add new text as follows:

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

Sub-section / Climate Zone:	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6 A	6 B	7	8
C406.2.1: 5% Heating Eff Imprv.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	1	1	NA	1
C406.2.2: 5% Cooling Eff Imprv.	6	6	5	5	4	4	3	3	3	2	2	2	1	2	2	2	1

C406.2.3: 10 % Heating Eff Imprv.	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	2	1	1	2	2	NA	1
C406.2.4: 10 % Cooling Eff Imprv.	11	12	10	9	7	7	6	5	6	4	4	5	3	4	3	3	3
C406.3: Reduced Light Power	9	8	9	9	9	9	10	8	9	9	7	8	8	6	7	7	6
C406.4: Enh. Digital Light Ctrl	4	4	4	4	4	4	4	3	4	4	3	3	4	3	3	3	3
C406.5.1: On-site Renewable Egy.	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
C406.6 : Dedicated OA Sys (DOAS)	4	4	4	4	4	3	2	5	3	2	5	3	2	7	4	5	3
C406.7.2: Recovered/Renew SWH	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.3: Eff fossil fuel SWH	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.4: Heat Pump SWH	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.8: Enhanced Envelope Perf	1	4	2	4	4	3	NA	7	4	5	10	7	6	11	10	14	16
C406.9: Reduced Air Infiltration	2	1	1	2	4	1	NA	8	2	3	11	4	1	15	8	11	6

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

Sub-section / Climate Zone:	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6 A	6 B	7	8
C406 .2.1: 5% Heating Eff Imprv.	NA	NA	NA	NA	1	NA	NA	1	NA	1	1	1	1	2	1	2	2
C406 .2.2: 5% Cooling Eff Imprv.	3	3	2	2	1	1	1	1	1	NA	1	1	NA	1	1	1	NA
C406 .2.3: 10 % Heating Eff Imprv.	NA	NA	NA	NA	1	NA	NA	1	1	1	2	2	1	3	2	3	4
C406 .2.4: 10 % Cooling Eff Imprv.	5	5	4	3	2	3	1	2	2	1	1	1	1	1	1	1	1
C406 .3: Reduced Light Power	2	2	2	2	2	2	3	2	2	2	2	2	2	2	2	2	2
C406 .4: Enh. Digital Light Ctrl	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406 .5.1: On-site Renewable Egy.	8	8	8	8	7	8	8	7	7	7	7	7	7	7	7	7	7
C406 .6 : Dedicated OA Sys (DOAS)	3	4	3	3	4	2	NA	6	3	4	8	5	5	10	7	11	12
C406 .7.2: Recovered/Renew SWH	10	9	11	10	13	12	15	14	14	15	14	14	16	14	15	15	15
C406 .7.3: Eff fossil fuel SWH	5	5	6	6	8	7	8	8	8	9	9	9	10	10	9	10	11
C406 .7.4: Heat Pump SWH	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
C406 .8: Enhanced Envelope Perf	3	6	3	5	4	4	1	4	3	3	4	5	3	5	4	6	6
C406 .9: Reduced Air Infiltration	6	5	3	11	6	4	NA	7	3	3	9	5	1	13	6	8	3

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

Sub-section / Climate Zone:	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6 A	6 B	7	8
C406.2.1: 5% Heating Eff Imprv.	NA	NA	NA	NA	1	1	1	1	1	2	1	2	1	2	2	3	4
C406.2.2: 5% Cooling Eff Imprv.	4	4	3	3	2	2	2	2	1	1	1	1	NA	1	1	1	NA
C406.2.3: 10 % Heating Eff Imprv.	NA	NA	NA	1	1	1	1	2	3	4	3	4	3	4	3	5	7
C406.2.4: 10 % Cooling Eff Imprv.	7	8	7	6	5	4	3	4	3	1	2	2	1	2	2	2	1
C406.3: Reduced Light Power	8	8	8	9	8	9	9	8	9	9	8	9	8	7	8	7	7
C406.4: Enh. Digital Light Ctrl	3	4	3	4	3	4	3	4	5	4	4	5	3	4	4	3	2
C406.5.1: On-site Renewable Egy.	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	5	5
C406.6 : Dedicated OA Sys (DOAS)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

C406.7.2: Recovered/Renew SWH ^a	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
C406 .7.3: Eff fossil fuel SWH ^a	NA	1	1	1	1	1	1	2	2	3	2	3	2	3	3	3	5
C406 .7.4: Heat Pump SWH ^a	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	1	1	NA	1	1	1	1
C406.8: Enhanced Envelope Perf	3	7	3	4	2	4	1	1	3	1	2	3	NA	4	3	6	9
C406.9: Reduced Air Infiltration	1	1	1	2	NA	NA	NA	NA	NA	NA	1	NA	NA	4	1	4	3

a. For schools with showers or full service kitchens

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

Sub-section / Climate Zone:	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6 A	6 B	7	8
C406 .2.1: 5% Heating Eff Imprv.	NA	NA	NA	NA	1	1	NA	1	1	2	2	2	2	3	2	3	4
C406 .2.2: 5% Cooling Eff Imprv.	5	6	4	4	3	3	1	2	2	1	1	2	NA	1	1	1	NA
C406 .2.3: 10 % Heating Eff Imprv.	NA	NA	NA	1	1	1	1	2	2	4	3	4	5	5	3	6	8
C406 .2.4: 10 % Cooling Eff Imprv.	9	12	9	8	6	6	3	4	4	1	2	3	NA	2	2	2	1
C406 .3: Reduced Light Power	13	13	15	14	16	14	17	15	15	14	12	14	14	16	16	14	12
C406 .4: Enh. Digital Light Ctrl	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406 .5.1: On-site Renewable Egy.	8	8	8	8	8	8	8	8	8	7	7	7	7	7	7	7	6
C406 .6 : Dedicated OA Sys (DOAS)	3	4	3	3	3	3	1	3	2	2	2	3	2	4	3	4	4
C406 .7.2: Recovered/Renew SWH	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406 .7.3: Eff fossil fuel SWH	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406 .7.4: Heat Pump SWH	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406 .8: Enhanced Envelope Perf	4	6	3	4	3	3	1	6	4	4	4	5	4	6	5	8	9
C406 .9: Reduced Air Infiltration	1	1	1	2	1	1	NA	3	1	1	3	2	1	7	3	6	3

**C406.1(5)
TABLE Additional Energy Efficiency Credits for Other^a Occupancies**

Sub-section / Climate Zone:	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6 A	6 B	7	8
C406.2.1: 5% Heating Eff Imprv.	NA	NA	NA	NA	1	1	1	1	1	2	1	2	1	2	2	3	3
C406.2.2: 5% Cooling Eff Imprv.	5	5	4	4	3	3	2	2	2	1	1	2	1	1	1	1	1
C406.2.3: 10 % Heating Eff Imprv.	NA	NA	NA	1	1	1	1	2	2	3	3	3	3	4	3	5	5
C406.2.4: 10 % Cooling Eff Imprv.	8	9	8	7	5	5	3	4	4	2	2	3	2	2	2	2	2
C406.3: Reduced Light Power	8	8	9	9	9	9	10	8	9	9	7	8	8	8	8	7	7
C406.4: Enh. Digital Light Ctrl	4	4	4	4	4	4	4	4	5	4	4	4	4	4	4	3	3
C406.5.1: On-site Renewable Egy.	8	8	8	8	8	8	8	8	8	7	7	7	7	7	7	7	7
C406.6 : Dedicated OA Sys (DOAS)	3	4	3	3	4	3	2	5	3	3	5	4	3	7	5	7	6
C406.7.2: Recovered/Renew SWH ^b	10	9	11	10	13	12	15	14	14	15	14	14	16	14	15	15	15
C406.7.3: Eff fossil fuel SWH ^b	5	5	6	6	8	7	8	8	8	9	9	9	10	10	9	10	11
C406.7.4: Heat Pump SWH ^b	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
C406.8: Enhanced Envelope Perf	3	6	3	4	3	4	1	5	4	3	5	5	4	7	6	9	10

C406.9: Reduced Air Infiltration	<u>3</u>	<u>2</u>	<u>2</u>	<u>4</u>	<u>4</u>	<u>2</u>	<u>NA</u>	<u>6</u>	<u>2</u>	<u>2</u>	<u>6</u>	<u>4</u>	<u>1</u>	<u>10</u>	<u>5</u>	<u>7</u>	<u>4</u>
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a. Other occupancy groups include all Groups except for Groups B, R, I, E, and M.

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

C406.1.1 Tenant spaces. Tenant spaces shall comply with sufficient options form Tables C406 .1(1) through C406 .1(5) to achieve a minimum number of 5 credits, where credits are selected from Section C406.2, C406.3, C406.4, C406.6 or C406.7. Alternatively, tenant spaces shall Where the entire building complies using credits from Section C406.5, C406.8 or C406.9 tenant spaces within the buildings shall be deemed to comply with Section C406.5 where the entire building is in compliance.

Exception: Previously occupied tenant spaces that comply with this code in accordance with Section C501.

C406.2 More efficient HVAC equipment performance. Equipment shall exceed the minimum efficiency requirements listed in Tables C403.3.2(1) through C403.3.2(7) ~~by 10 percent, in addition to the requirements of Section C403. Where multiple performance requirements are provided, the equipment shall exceed all requirements by 10 percent.~~ 9) and Variable refrigerant flow systems shall exceed listed in the energy efficiency provisions of ANSI/ASHRAE/IESNA 90.1 by 10 percent. in accordance with Section C406.2.1, C406.2.2, C406.2.3 or C406.2.4. Equipment shall also meet applicable requirements of Section C403. Energy efficiency credits for heating shall be selected from Section C406.2.1 or C406.2.3 and energy efficiency credits for cooling shall be selected from Section C406.2.2 or C406.2.4. Selected credits shall include a heating or cooling energy efficiency credit or both. . Equipment not listed in Tables C403.3.2(1) through C403.3.2(7) 9) and Variable refrigerant flow systems not listed in the energy efficiency provisions of ANSI/ASHRAE/IES 90 .1 shall be limited to 10 percent of the total building system capacity. capacity for heating equipment where selecting Section C406.2.1 or C406.2.3 and cooling equipment where selecting Section C406.2.2 or C406.2.4.

Add new text as follows:

C406.2.1 Five percent heating efficiency improvement Equipment shall exceed the minimum heating efficiency requirements by 5 percent.

C406.2.2 Five percent cooling efficiency improvement Equipment shall exceed the minimum cooling and heat rejection efficiency requirements by 5 percent. Where multiple cooling performance requirements are provided, the equipment shall exceed the annual energy requirement, including IEER, SEER, and IPLV.

C406.2.3 Ten percent heating efficiency improvement Equipment shall exceed the minimum heating efficiency requirements by 10 percent.

C406.2.4 Ten percent cooling efficiency improvement Equipment shall exceed the minimum cooling and heat rejection efficiency requirements by 10 percent. Where multiple cooling performance requirements are provided, the equipment shall exceed the annual energy requirement, including IEER, SEER, and IPLV.

Revise as follows:

C406.4 Enhanced digital lighting controls. ~~Interior lighting in~~ At least 90 percent of the building floor area shall have interior lighting with the following enhanced lighting controls for luminaires providing general lighting, that shall be located, scheduled and operated in accordance with Section ~~C405.2.2. C405.2.~~

1. Luminaires shall be configured for continuous dimming.
2. Luminaires shall be addressed individually. Where individual addressability is not available for the luminaire class type, a controlled group of not more than four luminaries shall be allowed.

3. Not more than eight luminaires shall be controlled together in a *daylight zone*.
4. Fixtures shall be controlled through a digital control system that includes the following function:
 - 4.1. Control reconfiguration based on digital addressability.
 - 4.2. Load shedding.
 - 4.3. Individual user control of overhead general illumination in open offices.
 - 4.4. Occupancy sensors shall be capable of being reconfigured through the digital control system.
5. Construction documents shall include submittal of a Sequence of Operations, including a specification outlining each of the functions in Item 4.
6. Functional testing of lighting controls shall comply with Section C408. High end trim controls shall be enabled and configured to limit the initial maximum output or maximum power draw of the controlled lighting to 85 percent or less of full light output or full power draw for both of the following:
 - 6.1 All areas that have *lumen maintenance controls*
 - 6.2 50% of the remaining floor area.

C406.5 On-site renewable energy. ~~The total minimum ratings of on-site renewable energy systems shall be one of the following:~~

- ~~1. Not less than 1.71 Btu/h per square foot (5.4 W/m²) or 0.50 watts per square foot (5.4 W/m²) of conditioned floor area.~~
 - ~~2. Not less than 3 percent of the energy used within the building for building mechanical and service water heating equipment and lighting regulated in Chapter 4.~~
- ~~Buildings shall comply with Section C406 .5.1 or C406 .5.2.~~

Add new text as follows:

C406.5.1 Basic renewable credits. The total minimum ratings of on-site renewable energy systems not including systems used for credits under Sections C406.7.2 shall be one of the following:

1. Not less than 0.86 Btu/h per square foot (2.7 W/m²) or 0.25 watts per square foot (2.7 W/m²) of conditioned floor area.
2. Not less than 2 percent of the energy used within the building for building mechanical and service water heating equipment and lighting regulated in Chapter 4.

C406.5.2 Enhanced Renewable Credits Where the total minimum ratings of on-site renewable energy systems exceeds the rating in C406.5.1(1), additional energy efficiency credits shall be determined based on Equation 4-13, rounded to the nearest whole number.

$$AEEC_{RRa} = AEEC_{2.5} \times RR_a / RR_1 \text{ (Equation 4-13)}$$

Where:

$$AEEC_{RRa} = \text{C406 .5.2 additional energy efficiency credits}$$

RR_a = actual total minimum ratings of on-site renewable energy systems in Btu/h, watts per square foot or W/m²

RR_1 = minimum ratings of on-site renewable energy systems required by C406 .5.1(1) in Btu/h, watts per square foot or W/m²

$$AEEC_{2.5} = \text{C406 .5.1 credits from Tables C406.1(1) through C406.1(5)}$$

Revise as follows:

C406.7 Reduced energy use in service water heating. Buildings shall comply with Section C406 .7.1 and Section C406.7.2, C406.7.3 or C406 .7.4. be of the following types to use this compliance method:

1. ~~Group R-1: Boarding houses, hotels or motels.~~
2. ~~Group I-2: Hospitals, psychiatric hospitals and nursing homes.~~
3. ~~Group A-2: Restaurants and banquet halls or buildings containing food preparation areas.~~
4. ~~Group F: Laundries.~~
5. ~~Group R-2.~~
6. ~~Group A-3: Health clubs and spas.~~
7. ~~Buildings showing a service hot water load of 10 percent or more of total building energy loads, as shown with an energy analysis as described in Section C407.~~

Add new text as follows:

C406.7.1 Building type. To qualify for this credit, the building shall contain one be of the following use groups and the additional energy efficiency credit shall be prorated by conditioned floor area of the portion of the building comprised of the following use groups:

1. Group R-1: Boarding houses, hotels or motels.
2. Group I-2: Hospitals, psychiatric hospitals and nursing homes.
3. Group A-2: Restaurants and banquet halls or buildings containing food preparation areas.
4. Group F: Laundries.
5. Group R-2.
6. Group A-3: Health clubs and spas.
7. Group E: Schools with full-service kitchens or locker rooms with showers
8. Buildings showing a service hot water load of 10 percent or more of total building energy loads, as shown with an energy analysis as described in Section C407.

~~C406.7.1 C406.7.2~~ **Load fraction. Recovered 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 ~~60-30~~ percent of the building's annual hot water requirements, or sized to provide ~~40-70~~ percent of the building's annual hot water requirements if the building ~~shall otherwise is required to~~ comply with Section C403.9.5:

1. Waste heat recovery from service hot water, heat-recovery chillers, building equipment, or process equipment.
2. *On-site renewable energy* water-heating systems.

Add new text as follows:

C406.7.3 Efficient fossil fuel water heater. The combined input-capacity-weighted-average equipment rating of all fossil fuel water heating equipment in the building shall be not less than 95 percent Et or 0.95 EF. This option shall receive only half the listed credits for buildings required to comply with C404.2.1.

C406.7.4 Heat pump water heater. Where electric resistance water heaters are allowed, all service hot water system heating requirements shall be met using heat pump technology with a combined input-capacity-weighted-average EF of 3.0. Air-source heat pump water heaters shall not draw conditioned air from within the building, except exhaust air that would otherwise be exhausted to the exterior.

Reason:

C406 Credits for Enhanced digital lighting controls.

This proposal builds on top of a proposal (CE218-19) that assigns energy efficiency credits to each option in Section C406. For clarity, that entire base proposal is included here. Additional provisions and table row

modifications are as follows:

- The provisions of Enhanced Digital lighting are clarified to require high end trim tuning, including definitions to support those clarifications.
- The credits in the tables are increased for enhanced digital light control based on the clarified provisions in C406.4 that are expected to produce increased savings.

Compared to the existing enhanced lighting controls in C406.4, this proposal provides for more certain savings through light level tuning with the option of lumen maintenance control.

Enhanced lighting controls (Section C406.4) can save more energy by tuning maximum light levels to just what is needed throughout the building. Making this requirement explicit and requiring documentation can actually achieve greater savings.

In the proposed code language, changes are made to allow for the following:

- Definitions are added for lumen maintenance controls and high end trim. These definitions are adapted from NEMA-LSD-64. The high end trim definition exactly matches the NEMA definition, and the lumen maintenance definition is adjusted to refer to luminaire power rather than lamp power.
- The area required with the specified controls is adjusted to 90%. Under current language, all luminaires in the building would need to meet the control requirements. This does not make sense for areas like mechanical and electrical rooms, stairwells, and restrooms, where the specified controls would not provide an energy benefit.
- The specified controls are required only for luminaires providing general lighting.
- A requirement for high end trim was added for any areas with lumen maintenance controls, plus 50% of the remaining area.

High end trim or tuning accounts for the fact that maximum lighting with full output at the lighting power allowance level typically provides more lighting than necessary, due to increments in luminaire size and limits on exact luminaire spacing. Requiring tuning that reduces light levels and power by at least 15%, along with documentation in the lighting functional testing process will reduce actual light power levels. While the original language for this type of control provides the capability to tune, without the trim requirement, there is not a strong argument for savings actually occurring. Lumen maintenance controls also start with a lower light level and adjust the lighting upward to compensate for lumen and dirt depreciation. Requiring tuning to 85% or lower will result in more savings than the savings shown for the existing requirement without this trim language. In the field, tuning down to 70% light and power levels or lower is often possible.

This proposal addresses lumen maintenance controlled luminaires, but does not require lumen maintenance controls. Lumen maintenance controls will adjust the lighting power over time to increase power as the light output reduces from lamp, dirt and room lumen depreciation. This strategy can save average energy over time, but only if the controls are tuned initially. When these controls are applied, all areas with lumen maintenance control require tuning, with half the remaining area also requiring high end trim tuning. Where lumen maintenance controls are not used, the high trim requirement applies to 50% of the lit area.

Note: Tables C406.1(1) through C406.1(5) include entries for climate zones 1A through 8. Should climate zones 0A and 0B be added to the IECC, use values for 1A in 0A and values for 1B in 0B.

Bibliography:

Hart, R., R. Nambiar, M. Tyler, M., Y. Xie, and J. Zhang. "Relative Credits for Extra Efficiency Measures: Technical Brief." Pacific Northwest National Laboratory (PNNL), Richland, WA (US), January 2019.

https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-28370Rev.1.pdf.

Cost Impact: The code change proposal will not increase or decrease the cost of construction. This proposal makes the application easier to implement on the one hand. Making the applicability only to 90% of general lighting reduces the cost. Requiring tuning appears to increase the cost; however, it is currently required by C408 in daylighting areas, so the area where tuning is already required could be equivalent to 50% of the lighting area. In all, this proposal is more a clarification and a reinforcement of tuning requirements that are already found for daylighting areas in Section C408.

Proposal # 5134

CE229-19