ANSI/ASHRAE/IES Addenda cy, co, dd, de, and df to ANSI/ASHRAE/IESNA Standard 90.1-2007

ASHRAE ADDENDA

Energy Standard for Buildings Except Low-Rise Residential Buildings

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American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
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www.ashrae.org

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FOREWORD

This addendum makes several revisions to the economizer requirements in section 6.5.1 and in section 6.3.2.

With increased envelop insulation levels and higher internal plug loads we are seeing commercial buildings operating in cooling at lower ambient temperatures. This allows for greater air and water economizers to be used instead of mechanical cooling.

Using the ASHRAE benchmark building models we have conducted a detail energy and economic analysis and have found that requirements for the use of economizers can be justified in additional zones including 2a, 3a, and 3b.

We have also found that the threshold limit on the size of the unit above which economizers are required can be decreased from 135,000 and 65,000 Btu/h to 54,000 Btu/hr.

Integrated economizers allow for the use of economizers and mechanical cooling to meet the cooling loads of the building. With advanced controls for economizers it is now possible to eliminate the exception 6.5.1.3c which exempted zones 1, 2, 3a, 4a, 5a, 5b, 6, 7 and 8 from using integrated economizers.

The results of the analysis showed a market volume weighted average cooling energy savings for the HVAC system cooling power of 24% for the small office, 22.1% for a large office, and 33% for a hospital.

As part of this change proposal we have also updated the table 6.3.2 which allows for the elimination of economizers thru the use of higher efficiency HVAC equipment. The table has been modified to reflect the new ASHRAE benchmark building models and to expanded the table to allow it to be used for any type of HVAC system and not just Unitary air cooled equipment currently covered by the table.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifi-

Addendum cy to 90.1-2007

Modify the standard as follows (I-P Units):

6.5.1 Economizers. Each cooling system that has a fan shall include either an air or water economizer meeting the requirements of Sections 6.5.1.1 through 6.5.1.4.

Exceptions: Economizers are not required for the systems listed below.

a. Individual fan-cooling units with a supply capacity less than the minimum listed in Table 6.5.1A for comfort cooling applications and table 6.5.1B for *computer room applications*.

b. Systems that include nonparticulate air treatment as required by Section 6.2.1 in Standard 62.1.

c. In hospitals and ambulatory surgery centers, where more than 75% of the air designed to be supplied by the system is to spaces that are required to be humidified above 35°F dew-point temperature to comply with applicable codes or accreditation standards. In all other buildings, where more than 25% of the air designed to be supplied by the system is to spaces that are designed to be humidified above 35°F dew-point temperature to satisfy process needs.

d. Systems that include a condenser heat recovery system ~~required by Section 6.5.6.2.~~ with a minimum capacity as defined in 6.5.6.2.2(a) or 6.5.6.2.2(b)

e. Systems that serve *residential* spaces where the system capacity is less than five times the requirement listed in Table 6.5.1.

f. Systems that serve spaces whose sensible cooling load at design conditions, excluding transmission and infiltration loads, is less than or equal to transmission and infiltration losses at an outdoor temperature of 60°F.

g. Systems expected to operate less than 20 hours per week.

h. Where the use of *outdoor air* for cooling will affect supermarket open refrigerated casework systems.

i. For comfort cooling where the cooling *efficiency* meets or exceeds the *efficiency* improvement requirements in Table 6.3.2.

TABLE 6.5.1A Minimum Fan-Cooling Unit Size for Which an Economizer is Required for Comfort Cooling

Climate Zones	Cooling Capacity for Which an Economizer is Required
1a, 1b	No economizer requirement
2a, 2b, 3a, 4a, 5a, 6a 3b, 3c, 4b, 4c, 5b, 5c, 6b, 7, 8	≥54,000 Btu/h

TABLE 6.5.1B Minimum Fan-Cooling Unit ~~System~~ Size for Which an Economizer is Required for Computer Rooms

Climate Zones	Cooling Capacity for Which an Economizer is Required
1a, 1b, 2a, 3a, 4a	No economizer requirement
2b, 5a, 6a, 7, 8	≥135,000 Btu/h
3b, 3c, 4b, 4c, 5b, 5c, 6b	≥65,000 Btu/h

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6.5.1.1 Air Economizers

6.5.1.1.1 Design Capacity. Air economizer systems shall be capable of modulating *outdoor air* and return air dampers to provide up to 100% of the design supply air quantity as *outdoor air* for cooling.

6.5.1.1.2 Control Signal. Economizer dampers shall be capable of being sequenced with the mechanical cooling equipment and shall not be controlled by only mixed air temperature.

Exception: The use of mixed air temperature limit control shall be permitted for systems controlled from space temperature (such as single-zone systems).

6.5.1.1.3 High-Limit Shutoff. All air economizers shall be capable of automatically reducing *outdoor air* intake to the design minimum *outdoor air* quantity when *outdoor air* intake will no longer reduce cooling energy usage. High-limit shutoff control types for specific climates shall be chosen from Table 6.5.1.1.3A. High-limit shutoff control settings for these control types shall be those listed in Table 6.5.1.1.3B.

6.5.1.1.4 Dampers. Both return air and *outdoor air* dampers shall meet the requirements of Section 6.4.3.3.4.

6.5.1.1.5 Relief of Excess *Outdoor Air.* Systems shall provide a means to relieve excess *outdoor air* during air economizer operation to prevent overpressurizing the building. The relief air outlet shall be located to avoid recirculation into the building.

6.5.1.2 Water Economizers

6.5.1.2.1 Design Capacity. Water economizer systems shall be capable of cooling supply air by indirect evaporation and providing up to 100% of the expected system cooling load at *outdoor air* temperatures of 50°F dry bulb/45°F wet bulb and below.

Exception: Systems in which a water economizer is used and where dehumidification requirements cannot be met using *outdoor air* temperatures of 50°F dry bulb/45°F wet bulb must satisfy 100% of the expected system cooling load at 45°F dry bulb/40°F wet bulb.

6.5.1.2.2 Maximum Pressure Drop. Precooling coils and water-to-water heat exchangers used as part of a water economizer system shall either have a water-side pressure drop of less than 15 ft of water or a secondary loop shall be created so that the coil or heat exchanger pressure drop is not seen by the circulating pumps when the system is in the normal cooling (noneconomizer) mode.

6.5.1.3 Integrated Economizer Control. Economizer systems shall be integrated with the mechanical cooling system and be capable of providing partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load.

~~**Exceptions:**~~

~~a. Direct expansion systems that include controls that reduce the quantity of *outdoor air* required to prevent coil frosting at the lowest step of compressor unloading, provided this lowest step is no greater than 25% of the total system capacity.~~

~~b. Individual direct expansion units that have a rated cooling capacity less than 65,000 Btu/h and use non-integrated economizer controls that preclude simultaneous operation of the economizer and mechanical cooling.~~

~~c. Systems in climate zones 1, 2, 3a, 4a, 5a, 5b, 6, 7, and 8.~~

6.5.1.4 Economizer Heating System Impact. HVAC system design and economizer controls shall be such that economizer operation does not increase the building heating energy use during normal operation.

Exception: Economizers on VAV systems that cause zone level heating to increase due to a reduction in supply air temperature.

TABLE 6.5.1.1.3A High-Limit Shutoff Control Options for Air Economizers

Climate Zones	Allowed Control Types	Prohibited Control Types
1b, 2b, 3b, 3c, 4b, 4c, 5b, 5c, 6b, 7, 8	Fixed dry bulb Differential dry bulb Electronic enthalpy[a] Differential enthalpy Dew-point and dry-bulb temperatures	Fixed enthalpy
1a, 2a, 3a, 4a	~~Fixed dry bulb~~ Fixed enthalpy Electronic enthalpy[a] Differential enthalpy Dew-point and dry-bulb temperatures	Fixed dry bulb Differential dry bulb
~~All other climates~~ 5a, 6a	Fixed dry bulb Differential dry bulb Fixed enthalpy Electronic enthalpy[a] Differential enthalpy Dew-point and dry-bulb temperatures	

[a]Electronic enthalpy controllers are devices that use a combination of humidity and dry-bulb temperature in their switching algorithm.

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TABLE 6.5.1.1.3B High-Limit Shutoff Control Settings for Air Economizers

Device Type	Climate	Required High Limit (Economizer Off When):	
		Equation	Description
Fixed dry bulb	1b, 2b, 3b, 3c, 4b, 4c, 5b, 5c, 6b, 7, 8 5a, 6a~~, 7a~~ ~~All other zones~~	T_{OA} > 75°F T_{OA} > 70°F ~~T_{OA} > 65°F~~	Outdoor air temperature exceeds 75°F Outdoor air temperature exceeds 70°F ~~Outdoor air temperature exceeds 65°F~~
Differential dry bulb	1b, 2b, 3b, 3c, 4b, 4c, 5a, 5b, 5c, 6a, 6b, 7, 8	$T_{OA} > T_{RA}$	Outdoor air temperature exceeds return air temperature
Fixed enthalpy	~~All~~ 2a, 3a, 4a, 5a, 6a	h_{OA} > 28 Btu/lb[a]	Outdoor air enthalpy exceeds 28 Btu/lb of dry air[a]
Electronic enthalpy	All	(T_{OA}, RH_{OA}) > A	Outdoor air temperature/RH exceeds the "A" setpoint curve[b]
Differential enthalpy	All	$h_{OA} > h_{RA}$	Outdoor air enthalpy exceeds return air enthalpy
Dew-point and dry-bulb temperatures	All	DP_{oa}>55°F or T_{oa}>75°F	Outdoor air dry bulb exceeds 75°F or outside dew point exceeds 55°F (65 gr/lb)

[a] At altitudes substantially different than sea level, the Fixed Enthalpy limit shall be set to the enthalpy value at 75°F and 50% relative humidity. As an example, at approximately 6000 ft elevation the fixed enthalpy limit is approximately 30.7 Btu/lb.
[b] Setpoint "A" corresponds to a curve on the psychrometric chart that goes through a point at approximately 75°F and 40% relative humidity and is nearly parallel to dry-bulb lines at low humidity levels and nearly parallel to enthalpy lines at high humidity levels.

6.3.2 Criteria. The HVAC *system* must meet ALL of the following criteria:

a. The *system* serves a single *HVAC zone*.

b. Cooling (if any) shall be provided by a unitary packaged or split-system air conditioner that is either air-cooled or evaporatively cooled with *efficiency* meeting the requirements shown in Table 6.8.1A (air conditioners), Table 6.8.1B (heat pumps), or Table 6.8.1D (packaged terminal and room air conditioners and heat pumps) for the applicable equipment category.

c. The *system* shall have an air economizer meeting the requirements of Section 6.5.1~~where indicated in Table 6.5.1, with controls as indicated in Tables 6.5.1.1.3A and 6.5.1.1.3B and with either barometric or powered relief sized to prevent overpressurization of the building. Where the cooling *efficiency* meets or exceeds the *efficiency* requirement in Table 6.3.2, no economizer is required. *Outdoor air* dampers for economizer use shall be provided with blade and jamb seals.~~

Replace Table 6.3.2 approved as part of addendum au to the 2007 standard with the revised table.

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TABLE 6.3.2 Alternate Compliance Path to Airside Economizers for Unitary Equipment

Unitary Equipment with Electric Resistance or No Heat covered by Table 6.8.1A

Size Category (Btu/h)	Climate Zones					
	1A, 1B, 2A, 3A, 4A	2B, 3B	6A, 6B, 8	4C, 5A, 5C	3C, 4B, 5B	7
≥65,000 and <135,000	Economizer not required	11.2 EER 12.7 IEER	11.2 EER 13.8 IEER	11.2 EER 14.9 IEER	Economizer required	Economizer not required
≥135,000 and <240,000		11.0 EER 12.4 IEER	11.0 EER 13.6 IEER	11.0 EER 14.7 IEER		
≥240,000 and <760,000		11.0 EER 11.2 IEER	11.0 EER 12.2 IEER	11.0 EER 13.2 IEER		Economizer required
≥760,000		9.7 EER 10.9 IEER	9.7 EER 11.9 IEER	9.7 EER 12.8 IEER		

Unitary Equipment with other heat covered by table 6.8.1A

Size Category (Btu/h)	Climate Zones					
	1A, 1B, 2A, 3A, 4A	2B, 3B	6A, 6B, 8	4C, 5A, 5C	3C, 4B, 5B	7
≥65,000 and <135,000	Economizer not required	11.0 EER 12.4 IEER	11.0 EER 13.6 IEER	11.0 EER 14.7 IEER	Economizer required	Economizer not required
≥135,000 and <240,000		10.8 EER 12.2 IEER	10.8 EER 13.3 IEER	10.8 EER 14.4 IEER		
≥240,000 and <760,000		9.8 EER 11.0 IEER	9.8 EER 12.0 IEER	9.8 EER 13.0 IEER		Economizer required
≥760,000		9.5 EER 10.7 IEER	9.5 EER 11.6 IEER	9.5 EER 12.6 IEER		

Unitary and Applied Heat Pumps with electric resistance heat or no heat covered by table 6.8.1B

Size Category (Btu/h)	Climate Zones					
	1A, 1B, 2A, 3A, 4A	2B, 3B	6A, 6B, 8	4C, 5A, 5C	3C, 4B, 5B	7
≥65,000 and <135,000	Economizer not required	11.0 EER 12.4 IEER	11.0 EER 13.6 IEER	11.0 EER 14.7 IEER	Economizer required	Economizer not required
≥135,000 and <240,000		10.6 EER 11.9 IEER	10.6 EER 12.9 IEER	10.6 EER 14.0 IEER		Economizer required
≥240,000		9.5 EER 10.7 IEER	9.5 EER 11.6 IEER	9.5 EER 12.6 IEER		

Unitary and Applied Heat Pumps other heat covered by table 6.8.1B

Size Category (Btu/h)	Climate Zones					
	1A, 1B, 2A, 3A, 4A	2B, 3B	6A, 6B, 8	4C, 5A, 5C	3C, 4B, 5B	7
≥65,000 and <135,000	Economizer not required	10.8 EER 12.2 IEER	10.8 EER 13.3 IEER	10.8 EER 14.4 IEER	Economizer required	Economizer not required
≥135,000 and <240,000		10.4 EER 11.7 IEER	10.4 EER 12.7 IEER	10.4 EER 13.8 IEER		Economizer required
≥240,000		9.3 EER 10.4 IEER	9.3 EER 11.4 IEER	9.3 EER 12.3 IEER		

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TABLE 6.3.2 Eliminate Required Economizer for Comfort Cooling by Increasing Cooling Efficiency

Climate Zone	Efficiency Improvement[a]
2a	17%
2b	21%
3a	27%
3b	32%
3c	65%
4a	42%
4b	49%
4c	64%
5a	49%
5b	59%
5c	74%
6a	56%
6b	65%
7	72%
8	77%

[a] If a unit is rated with an IPLV, IEER or SEER then to eliminate the required air or water economizer, the minimum cooling efficiency of the HVAC unit must be increased by the percentage shown. If the HVAC unit is only rated with a full load metric like EER or COP cooling then these must be increased by the percentage shown.

Modify the standard as follows (SI Units):

6.5.1 Economizers. Each cooling system that has a fan shall include either an air or water economizer meeting the requirements of Sections 6.5.1.1 through 6.5.1.4.

Exceptions: Economizers are not required for the systems listed below.

a. Individual fan-cooling units with a supply capacity less than the minimum listed in Table 6.5.1A for comfort cooling applications and table 6.5.1B for *computer room applications*.

b. Systems that include nonparticulate air treatment as required by Section 6.2.1 in Standard 62.1.

c. In hospitals and ambulatory surgery centers, where more than 75% of the air designed to be supplied by the system is to spaces that are required to be humidified above 2 °C dew-point temperature to comply with applicable codes or accreditation standards. In all other buildings, where more than 25% of the air designed to be supplied by the system is to spaces that are designed to be humidified above 2 °C dew-point temperature to satisfy process needs.

d. Systems that include a condenser heat recovery system ~~required by Section 6.5.6.2.~~ with a minimum capacity as defined in 6.5.6.2.2(a) or 6.5.6.2.2(b)

e. Systems that serve *residential* spaces where the system capacity is less than five times the requirement listed in Table 6.5.1.

f. Systems that serve spaces whose sensible cooling load at design conditions, excluding transmission and infiltration loads, is less than or equal to transmission and infiltration losses at an outdoor temperature of 16°C.

g. Systems expected to operate less than 20 hours per week.

h. Where the use of *outdoor air* for cooling will affect supermarket open refrigerated casework systems.

i. For comfort cooling where the cooling *efficiency* meets or exceeds the *efficiency* improvement requirements in Table 6.3.2.

6.5.1.1 Air Economizers

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TABLE 6.5.1A Minimum Fan-cooling Unit Size for Which an Economizer is Required for Comfort Cooling

Climate Zones	Cooling Capacity for Which an Economizer is Required
1a, 1b	No economizer requirement
2a, 2b, 3a, 4a, 5a, 6a 3b, 3c, 4b, 4c, 5b, 5c, 6b, 7, 8	≥16 kW

TABLE 6.5.1B Minimum Fan-Cooling Unit ~~System~~ Size for Which an Economizer is Required for Computer Rooms

Climate Zones	Cooling Capacity for Which an Economizer is Required
1a, 1b, 2a, 3a, 4a	No economizer requirement
2b, 5a, 6a, 7, 8	≥40 kW
3b, 3c, 4b, 4c, 5b, 5c, 6b	≥19 kW

6.5.1.1.1 Design Capacity. Air economizer systems shall be capable of modulating *outdoor air* and return air dampers to provide up to 100% of the design supply air quantity as *outdoor air* for cooling.

6.5.1.1.2 Control Signal. Economizer dampers shall be capable of being sequenced with the mechanical cooling equipment and shall not be controlled by only mixed air temperature.

Exception: The use of mixed air temperature limit control shall be permitted for systems controlled from space temperature (such as single-zone systems).

6.5.1.1.3 High-Limit Shutoff. All air economizers shall be capable of automatically reducing *outdoor air* intake to the design minimum *outdoor air* quantity when *outdoor air* intake will no longer reduce cooling energy usage. High-limit shutoff control types for specific climates shall be chosen from Table 6.5.1.1.3A. High-limit shutoff control settings for these control types shall be those listed in Table 6.5.1.1.3B.

6.5.1.1.4 Dampers. Both return air and *outdoor air* dampers shall meet the requirements of Section 6.4.3.3.4.

6.5.1.1.5 Relief of Excess *Outdoor Air.* Systems shall provide a means to relieve excess *outdoor air* during air economizer operation to prevent overpressurizing the building. The relief air outlet shall be located to avoid recirculation into the building.

6.5.1.2 Water Economizers

6.5.1.2.1 Design Capacity. Water economizer systems shall be capable of cooling supply air by indirect evaporation and providing up to 100% of the expected system cooling load at *outdoor air* temperatures of 10°C dry bulb/ 7°C wet bulb and below.

Exception: Systems in which a water economizer is used and where dehumidification requirements cannot be met using *outdoor air* temperatures of 10°C dry bulb/7°C wet bulb must satisfy 100% of the expected system cooling load at 7°C dry bulb/4°C wet bulb.

6.5.1.2.2 Maximum Pressure Drop. Precooling coils and water-to-water heat exchangers used as part of a water economizer system shall either have a water-side pressure drop of less than 45 kPa of water or a secondary loop shall be created so that the coil or heat exchanger pressure drop is not seen by the circulating pumps when the system is in the normal cooling (noneconomizer) mode.

6.5.1.3 Integrated Economizer Control. Economizer systems shall be integrated with the mechanical cooling system and be capable of providing partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load.

~~**Exceptions:**~~

~~a. Direct expansion systems that include controls that reduce the quantity of *outdoor air* required to prevent coil frosting at the lowest step of compressor unloading, provided this lowest step is no greater than 25% of the total system capacity.~~

~~b. Individual direct expansion units that have a rated cooling capacity less than 19 kW and use nonintegrated economizer controls that preclude simultaneous operation of the economizer and mechanical cooling.~~

~~c. Systems in climate zones 1, 2, 3a, 4a, 5a, 5b, 6, 7, and 8.~~

6.5.1.4 Economizer Heating System Impact. HVAC system design and economizer controls shall be such that economizer operation does not increase the building heating energy use during normal operation.

Exception: Economizers on VAV systems that cause zone level heating to increase due to a reduction in supply air temperature.

6.3.2 Criteria. The HVAC *system* must meet ALL of the following criteria:

a. The *system* serves a single *HVAC zone*.

b. Cooling (if any) shall be provided by a unitary packaged or split-system air conditioner that is either air-cooled or evaporatively cooled with *efficiency* meeting the requirements shown in Table 6.8.1A (air conditioners), Table 6.8.1B (heat pumps), or Table 6.8.1D (packaged terminal and room air conditioners and heat pumps) for the applicable equipment category.

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c. The *system* shall have an air economizer meeting the requirements of Section 6.5.1 ~~where indicated in Table 6.5.1, with controls as indicated in Tables 6.5.1.1.3A and 6.5.1.1.3B and with either barometric or powered relief sized to prevent over pressurization of the building. Where the cooling *efficiency* meets or exceeds the *efficiency* requirement in Table 6.3.2, no economizer is required. *Outdoor air* dampers for economizer use shall be provided with blade and jamb seals.~~

Replace Table 6.3.2 approved as part of addendum au to the 2007 standard with the revised table.

~~TABLE 6.3.2 Alternate Compliance Path to Airside Economizers for Unitary Equipment~~

~~Unitary Equipment with Electric Resistance or No Heat Covered by Table 6.8.1A~~

	~~Climate Zones~~					
~~Size Category (kW)~~	~~1A, 1B, 2A, 3A, 4A~~	~~2B, 3B~~	~~6A, 6B, 8~~	~~4C, 5A, 5C~~	~~3C, 4B, 5B~~	~~7~~
~~≥19 and <40~~	~~Economizer not required~~	~~3.28 COP 3.72 ICOP~~	~~3.28 COP 4.04 ICOP~~	~~3.28 COP 4.37 ICOP~~	~~Economizer required~~	~~Economizer not required~~
~~≥40 and <70~~		~~3.22 COP 3.63 ICOP~~	~~3.22 COP 3.99 ICOP~~	~~3.22 COP 4.31 ICOP~~		
~~≥70 and <223~~		~~3.22 COP 3.28 ICOP~~	~~3.22 COP 3.58 ICOP~~	~~3.22 COP 3.87 ICOP~~		~~Economizer required~~
~~≥223~~		~~2.84 COP 3.19 ICOP~~	~~2.84 COP 3.49 ICOP~~	~~2.84 COP 3.75 ICOP~~		

~~Unitary Equipment with Other Heat Covered by Table 6.8.1A~~

	~~Climate Zones~~					
~~Size Category (kW)~~	~~1A, 1B, 2A, 3A, 4A~~	~~2B, 3B~~	~~6A, 6B, 8~~	~~4C, 5A, 5C~~	~~3C, 4B, 5B~~	~~7~~
~~≥19 and <40~~	~~Economizer~~	~~3.22 COP 3.63 ICOP~~	~~3.22 COP 3.99 ICOP~~	~~3.22 COP 4.31 ICOP~~	~~Economizer required~~	~~Economizer not required~~
~~≥40 and <70~~		~~3.16 COP 3.58 ICOP~~	~~3.16 COP 3.90 ICOP~~	~~3.16 COP 4.22 ICOP~~		
~~≥70 and <223~~		~~2.87 COP 3.22 ICOP~~	~~2.87 COP 3.52 ICOP~~	~~2.87 COP 3.81 ICOP~~		~~Economizer required~~
~~≥223~~		~~2.78 COP 3.14 ICOP~~	~~2.78 COP 3.40 ICOP~~	~~2.78 COP 3.69 ICOP~~		

~~Unitary and Applied Heat Pumps with Electric Resistance Heat or No Heat Covered by Table 6.8.1B~~

	~~Climate Zones~~					
~~Size Category (kW)~~	~~1A, 1B, 2A, 3A, 4A~~	~~2B, 3B~~	~~6A, 6B, 8~~	~~4C, 5A, 5C~~	~~3C, 4B, 5B~~	~~7~~
~~≥19 and <40~~	~~Economizer~~	~~3.22 COP 3.63 ICOP~~	~~3.22 COP 3.99 ICOP~~	~~3.22 COP 4.31 ICOP~~	~~Economizer required~~	~~Economizer not required~~
~~≥40 and <70~~		~~3.11 COP 3.49 ICOP~~	~~3.11 COP 3.78 ICOP~~	~~3.11 COP 4.10 ICOP~~		~~Economizer required~~
~~≥70~~		~~2.78 COP 3.14 ICOP~~	~~2.78 COP 3.40 ICOP~~	~~2.78 COP 3.69 ICOP~~		

~~Unitary and Applied Heat Pumps Other Heat Covered by Table 6.8.1B~~

	~~Climate Zones~~					
~~Size Category (kW)~~	~~1A, 1B, 2A, 3A, 4A~~	~~2B, 3B~~	~~6A, 6B, 8~~	~~4C, 5A, 5C~~	~~3C, 4B, 5B~~	~~7~~
~~≥19 and <40~~	~~Economizer~~	~~3.17 COP 3.58 ICOP~~	~~3.17 COP 3.90 ICOP~~	~~3.17 COP 4.22 ICOP~~	~~Economizer required~~	~~Economizer not required~~
~~≥40 and <70~~		~~3.05 COP 3.43 ICOP~~	~~3.05 COP 3.72 ICOP~~	~~3.05 COP 4.044 ICOP~~		~~Economizer required~~
~~≥70~~		~~2.73 COP 3.05 ICOP~~	~~2.73 COP 3.34 ICOP~~	~~2.73 COP 3.60 ICOP~~		

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TABLE 6.3.2 Eliminate Required Economizer for Comfort Cooling by Increasing Cooling Efficiency

Climate Zone	Efficiency Improvement
2a	17%
2b	21%
3a	27%
3b	32%
3c	65%
4a	42%
4b	49%
4c	64%
5a	49%
5b	59%
5c	74%
6a	56%
6b	65%
7	72%
8	77%

[a] If a unit is rated with an IPLV, IEER or SEER then to eliminate the required air or water economizer, the minimum cooling efficiency of the HVAC unit must be increased by the percentage shown. If the HVAC unit is only rated with a full load metric like EER or COP cooling then these must be increased by the percentage shown.

TABLE 6.5.1.1.3A High-Limit Shutoff Control Options for Air Economizers

Climate Zones	Allowed Control Types	Prohibited Control Types
1b, 2b, 3b, 3c, 4b, 4c, 5b, 5c, 6b, 7, 8	Fixed dry bulb Differential dry bulb Electronic enthalpy[a] Differential enthalpy Dew-point and dry-bulb temperatures	Fixed enthalpy
1a, 2a, 3a, 4a	~~Fixed dry bulb~~ Fixed enthalpy Electronic enthalpy[a] Differential enthalpy Dew-point and dry-bulb temperatures	Fixed dry bulb Differential dry bulb
~~All other climates~~ 5a, 6a	Fixed dry bulb Differential dry bulb Fixed enthalpy Electronic enthalpy[a] Differential enthalpy Dew-point and dry-bulb temperatures	

[a]Electronic enthalpy controllers are devices that use a combination of humidity and dry-bulb temperature in their switching algorithm.

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TABLE 6.5.1.1.3B High-Limit Shutoff Control Settings for Air Economizers

Device Type	Climate	Required High Limit (Economizer Off When):	
		Equation	Description
Fixed dry bulb	1b, 2b, 3b, 3c, 4b, 4c, 5b, 5c, 6b, 7, 8 5a, 6a~~, 7a~~ ~~All other zones~~	T_{OA} > 24°C T_{OA} > 21°C ~~T_{OA} > 18°C~~	Outdoor air temperature exceeds 24°F Outdoor air temperature exceeds 21°F ~~Outdoor air temperature exceeds 18°F~~
Differential dry bulb	1b, 2b, 3b, 3c, 4b, 4c, 5a, 5b, 5c, 6a, 6b, 7, 8	$T_{OA} > T_{RA}$	Outdoor air temperature exceeds return air temperature
Fixed enthalpy	~~All~~ 2a, 3a, 4a, 5a, 6a	h_{OA} > 47 kJ/kg[a]	Outdoor air enthalpy exceeds 47 kJ/kg of dry air[a]
Electronic enthalpy	All	(T_{OA}, RH_{OA}) > A	Outdoor air temperature/RH exceeds the "A" setpoint curve[b]
Differential enthalpy	All	$h_{OA} > h_{RA}$	Outdoor air enthalpy exceeds return air enthalpy
Dew-point and dry-bulb temperatures	All	DP_{oa}>18°C or T_{oa}>13°C	Outdoor air dry bulb exceeds 18°C or outside dew point exceeds 13°C (~~65 gr/lb~~0.009 kg/kg)

[a] At altitudes substantially different than sea level, the Fixed Enthalpy limit shall be set to the enthalpy value at 24°C and 50% relative humidity. As an example, at approximately 1830 m ~~melva ti on~~ elevation the fixed enthalpy limit is approximately 53.5 kJ/kg.

[b] Setpoint "A" corresponds to a curve on the psychrometric chart that goes through a point at approximately 24°C and 40% relative humidity and is nearly parallel to dry-bulb lines at low humidity levels and nearly parallel to enthalpy lines at high humidity levels.

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FOREWORD

In summer 2005, ASHRAE approved amendments to Standard 90.1 (addendum g to ASHRAE 90.1-2004) which increased the minimum energy efficiency standards of commercial air-cooled air conditioners and heat pumps greater than 65,000 Btu/h. EER and COP (at 47°F) were amended, with new levels taking effect on January 1, 2010. However, Addendum g left unchanged the minimum energy efficiency standards for water and evaporatively cooled commercial air conditioners as well as air cooled, water and evaporatively cooled condensing units listed in Table 6.8.1A. In 2007, addendum s to ASHRAE 90.1-2007 replaced all part load IPLV values in Table 6.8.1A (at the exception of condensing units) with new part load IEER.

This proposal makes three major amendments to Table 6.8.1A. First, it updates EER and IEER values for all condensing units and water and evaporatively cooled air conditioners with cooling capacities greater than 65,000 Btu/h. Depending on the cooling capacity, the new EERs and IEERs are between 5 and 13% higher than the values they are replacing. Second, the proposal establishes a separate product class for evaporatively cooled air conditioners with different energy efficiency standards. While water and evaporatively cooled air conditioners have been listed in one product category with the same energy efficiency standards since 1989, differences in how the two products are rated per AHRI standard 340/360 dictate a separate product class with different minimum EERs and IEERs. A closer look at AHRI standard 340/360 shows that at cooling capacities greater than 135,000 Btu/h, cooling tower fan motor and circulating water pump motor power inputs are not taken into account in the energy efficiency calculation for water cooled air conditioners while the power input for the evaporative condenser fan and re-circulating water pump is included in the EER calculation for evaporatively cooled air conditioners. As such the new proposed EERs and IEERs for evaporatively cooled units are slightly lower than water cooled units. Third, the proposal replaces the IPLV descriptor for condensing units with the new IEER metric and amends the EERs with more stringent values.

The new EER and IEER levels will become effective on June 1, 2011.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.-

Addendum co to 90.1-2007

Revise the Standard as follows (I-P units)

Revise Tables 6.8.1 A as follows:

Remainder of table left unchanged.

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TABLE 6.8.1A Electrically Operated Unitary Air Conditioners and Condensing Units—Minimum Efficiency Requirements

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency[a]	Test Procedure[b]
Air conditioners, water ~~and evaporatively~~ cooled	<65,000 Btu/h	All	Split System and Single Package	12.1 EER 12.3 IEER	AHRI 210/240
	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.5 EER (before 6/1/2011) 12.1 EER (as of 6/1/2011) 11.7 IEER (before 6/1/2011) 12.3 IEER (as of 6/1/2011)	AHRI 340/360
		All other	Split System and Single Package	11.3 EER (before 6/1/2011) 11.9 EER (as of 6/1/2011) 11.5 IEER (before 6/1/2011) 12.1 IEER (as of 6/1/2011)	
	≥135,000 Btu/h and <240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER (before 6/1/2011) 12.5 EER (as of 6/1/2011) 11.2 IEER (before 6/1/2011) 12.7 IERR (as of 6/1/2011)	
		All other	Split System and Single Package	10.8 EER (before 6/1/2011) 12.3 EER (as of 6/1/2011) 11.0 IEER (before 6/1/2011) 12.5 IEER (as of 6/1/2011)	
	≥240,000 Btu/h and < 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER (before 6/1/2011) 12.4 EER (as of 6/1/2011) 11.1 IEER (before 6/1/2011) 12.6 IEER (as of 6/1/2011)	
		All other	Split System and Single Package	10.8 EER (before 6/1/2011) 12.2 EER (as of 6/1/2011) 10.9 IEER (before 6/1/2011) 12.4 IEER (as of 6/1/2011)	
	≥760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER (before 6/1/2011) 12.2 EER (as of 6/1/2011) 11.1 IEER (before 6/1/2011) 12.4 IEER (as of 6/1/2011)	
		All other	Split System and Single Package	10.8 EER (before 6/1/2011) 12.0 EER (as of 6/1/2011) 10.9 IEER (before 6/1/2011) 12.2 IEER (as of 6/1/2011)	
Air conditioners, evaporatively cooled	< 65,000 Btu/h	All	Split System and Single Package	12.1 EER 12.3 IEER	AHRI 210/240
	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.5 EER (before 6/1/2011) 12.1 EER (as of 6/1/2011) 11.7 IEER (before 6/1/2011) 12.3 IEER (as of 6/1/2011)	AHRI 340/360
		All other	Split System and Single Package	11.3 EER (before 6/1/2011) 11.9 EER (as of 6/1/2011) 11.5 IEER (before 6/1/2011) 12.1 IEER (as of 6/1/2011)	

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TABLE 6.8.1A Electrically Operated Unitary Air Conditioners and Condensing Units—Minimum Efficiency Requirements

Air conditioners, evaporatively cooled (cont.)	≥135,000 Btu/h and <240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER (before 6/1/2011) 12.0 EER (as of 6/1/2011) 11.2 IEER (before 6/1/2011) 12.2 IERR (as of 6/1/2011)	AHRI 340/360 (cont.)
		All other	Split System and Single Package	10.8 EER (before 6/1/2011) 11.8 EER (as of 6/1/2011) 11.0 IEER (before 6/1/2011) 12.0 IEER (as of 6/1/2011)	
	≥240,000 Btu/h and < 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER (before 6/1/2011) 11.9 EER (as of 6/1/2011) 11.1 IEER (before 6/1/2011) 12.1 IEER (as of 6/1/2011)	
		All other	Split System and Single Package	10.8 EER (before 6/1/2011) 12.2 EER (as of 6/1/2011) 10.9 IEER (before 6/1/2011) 11.9 IEER (as of 6/1/2011)	
	≥760,000 Btu/h	Electric Resistance (or None	Split System and Single Package	11.0 EER (before 6/1/2011) 11.7 EER (as of 6/1/2011) 11.1 IEER (before 6/1/2011) 11.9 IEER (as of 6/1/2011)	
		All other	Split System and Single Package	10.8 EER (before 6/1/2011) 11.5 EER (as of 6/1/2011) 10.9 IEER (before 6/1/2011) 11.7 IEER (as of 6/1/2011)	
Condensing units, air cooled	≥135,000 Btu/h	—	—	10.1 EER (before 6/1/2011) 10.5 EER (as of 6/1/2011) ~~11.2 IPLV~~ 11.4 IEER (before 6/1/2011) 11.8 IEER (as of 6/1/2011)	AHRI 365
Condensing units, water ~~or evaporatively~~ cooled	≥135,000 Btu/h	—	—	13.1 EER (before 6/1/2011) 13.5 EER (as of 6/1/2011) ~~13.1 IPLV~~ 13.6 IEER (before 6/1/2011) 14.0 IEER (as of 6/1/2011)	
Condensing units, evaporatively cooled	≥135,000 Btu/h	—	—	13.1 EER (before 6/1/2011) 13.5 EER (as of 6/1/2011) ~~13.1 IPLV~~ 13.6 IEER (before 6/1/2011) 14.0 IEER (as of 6/1/2011	

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Modify normative reference in Chapter 12 (under Air Conditioning, Heating, and Refrigeration Institute) as follows:

AHRI 340/360-2007	Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment

Revise the Standard as follows (SI units).

Revise Tables 6.8.1 A as follows:

TABLE 6.8.1A Electrically Operated Unitary Air Conditioners and Condensing Units—Minimum Efficiency Requirements

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency[a]	Test Procedure[b]
Air conditioners, water ~~and evaporatively~~ cooled	<19 kW	All	Split System and Single Package	3.54 COP 3.60 ICOP	AHRI 210/240
	≥19 kW and <40 kW	Electric Resistance (or None)	Split System and Single Package	3.37 COP (before 6/1/2011) 3.54 COP (as of 6/1/2011) 3.43 ICOP (before 6/1/2011) 3.60 ICOP (as of 6/1/2011)	AHRI 340/360
		All other	Split System and Single Package	3.31 COP (before 6/1/2011) 3.49 COP (as of 6/1/2011) 3.37 ICOP (before 6/1/2011) 3.54 ICOP (as of 6/1/2011)	
	≥40 kW and <70 kW	Electric Resistance (or None)	Split System and Single Package	3.22 COP (before 6/1/2011) 3.66 COP (as of 6/1/2011) 3.28 ICOP (before 6/1/2011) 3.72 ICOP (as of 6/1/2011)	
		All other	Split System and Single Package	3.16 COP (before 6/1/2011) 3.60 COP (as of 6/1/2011) 3.22 ICOP (before 6/1/2011) 3.66 ICOP(as of 6/1/2011)	
	≥70 kW and < 223 kW	Electric Resistance (or None)	Split System and Single Package	3.22 COP (before 6/1/2011) 3.63 COP (as of 6/1/2011) 3.25 ICOP (before 6/1/2011) 3.69 ICOP (as of 6/1/2011)	
		All other	Split System and Single Package	3.16 COP (before 6/1/2011) 3.57 COP (as of 6/1/2011) 3.19 ICOP (before 6/1/2011) 3.63 ICOP (as of 6/1/2011)	
	≥223 kW	Electric Resistance (or None)	Split System and Single Package	3.22 COP (before 6/1/2011) 3.57 COP (as of 6/1/2011) 3.25 ICOP (before 6/1/2011) 3.63 ICOP (as of 6/1/2011)	
		All other	Split System and Single Package	3.16 COP (before 6/1/2011) 3.52 COP (as of 6/1/2011) 3.19 ICOP (before 6/1/2011) 3.57 ICOP (as of 6/1/2011)	
Air conditioners, evaporatively cooled	<19 kW	All	Split System and Single Package	3.54 COP 3.60 ICOP	AHRI 210/240

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TABLE 6.8.1A Electrically Operated Unitary Air Conditioners and Condensing Units—Minimum Efficiency Requirements

Air conditioners, evaporatively cooled (cont.)	≥19 kW and <40 kW	Electric Resistance (or None)	Split System and Single Package	3.37 COP (before 6/1/2011) 3.54 COP (as of 6/1/2011) 3.43 ICOP (before 6/1/2011) 3.60 ICOP (as of 6/1/2011)	AHRI 340/360
		All other	Split System and Single Package	3.31 COP (before 6/1/2011) 3.49 COP (as of 6/1/2011) 3.37 ICOP (before 6/1/2011) 3.54 ICOP (as of 6/1/2011)	
	≥40 kW and <70 kW	Electric Resistance (or None)	Split System and Single Package	3.22 COP (before 6/1/2011) 3.52 COP (as of 6/1/2011) 3.28 ICOP (before 6/1/2011) 3.57 ICOP (as of 6/1/2011)	
		All other	Split System and Single Package	3.16 COP (before 6/1/2011) 3.46 COP (as of 6/1/2011) 3.22 ICOP (before 6/1/2011) 3.52 ICOP (as of 6/1/2011)	
	≥70 kW and < 223 kW	Electric Resistance (or None)	Split System and Single Package	3.22 COP (before 6/1/2011) 3.49 COP (as of 6/1/2011) 3.25 ICOP (before 6/1/2011) 3.54 ICOP (as of 6/1/2011)	
		All other	Split System and Single Package	3.16 COP (before 6/1/2011) 3.57 COP (as of 6/1/2011) 3.19 ICOP (before 6/1/2011) 3.49 ICOP (as of 6/1/2011)	
	≥223 kW	Electric Resistance (or None)	Split System and Single Package	3.22 COP (before 6/1/2011) 3.43 COP (as of 6/1/2011) 3.25 ICOP (before 6/1/2011) 3.49 ICOP (as of 6/1/2011)	
		All other	Split System and Single Package	3.16 COP(before 6/1/2011) 3.37 COP (as of 6/1/2011) 3.19 ICOP (before 6/1/2011) 3.43 ICOP (as of 6/1/2011)	
Condensing units, air cooled	≥40 kW	—	—	2.96 COP (before 6/1/2011) 3.08 COP (as of 6/1/2011) ~~3.28 IPLV~~ 3.34 ICOP (before 6/1/2011) 3.46 ICOP (as of 6/1/2011)	AHRI 365
Condensing units, water ~~or Evaporatively~~ cooled	≥40 kW	—	—	3.84 EER (before 6/1/2011) 3.95 COP (as of 6/1/2011) ~~3.84 IPLV~~ 3.98 ICOP (before 6/1/2011) 4.10 ICOP (as of 6/1/2011)	
Condensing units, evaporatively cooled	≥40 kW	—	—	3.84 EER (before 6/1/2011) 3.95 COP (as of 6/1/2011) ~~3.84 IPLV~~ 3.98 ICOP (before 6/1/2011) 4.10 ICOP (as of 6/1/2011	

Remainder of table left unchanged.

Modify normative reference in Chapter 12 (under Air Conditioning, Heating, and Refrigeration Institute) as follows:

AHRI 340/360-2007	Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment

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FOREWORD

The original sidelighting requirements were based on conservative analysis completed by H-M-G (Jon McHugh) which resulted in a sidelighting area of 10,000 ft^2. The analysis has been re-run with revised but still conservative up to date cost data for sensors and daylighting controls installed in smaller spaces. These results show cost-effective sidelighting at a threshold of 5,000 ft^2 when considered across climate zones 1 through 5 (climate zones 6 through 8 are exempted from the requirements due to colder temperatures and less daylight availability).

An earlier benefit cost analysis photocontrols in sidelit spaces was conducted to identify the balance point where the initial costs are paid for by the product of the annual energy cost savings and the "scalar" the discounted present worth factor for a 15 year period of analysis. The calculated scalar for a 15 year period of analysis is 8.8 present valued years.

There are two types of first costs, fixed first costs that are relatively independent of the area served and variable fixed costs that are a function of the sidelit area. For dimming controls, the variable costs are those associated with the cost of the dimming ballast – the larger the areas served the more ballasts are needed. The installed cost of the dimming controller and sensor are fixed costs as their cost does not increase as a function of area. For multi-level switching systems, the variable costs are those associated with the relays and additional wiring (at that time ASHRAE 90.1 did not yet require bi-level switching and for the prior analysis and this was an added cost).

The cost of skylights are of course a variable cost since the greater the area served, the greater the number of skylights required.

As a result of discussion with the ASHRAE 90.1 Lighting Subcommittee, the following variable and fixed costs were associated with dimming and switching controls systems. For switching control systems the additional circuiting costs associated with bi-level switching is $0.108/sf (for more information see the section entitled "Cost of Multi-Level Switching," in Section 7.1.5 Life Cycle Costing). Since that time, the Committee has adopted a bi-level switching requirement and thus this variable cost for switching systems no longer was applicable and this cost was zeroed out.

The Committee originally recommended that we use a conservatively high value of $6,100 for the costs of controls with the expectation that the minimum area being controlled would be a fairly large warehouse space. These controls were a lighting panel based type of controls with multiple circuits. In addition the cost of the controls included a cost of the bi-level wiring which added costs as described above. Over time the costs of daylighting controls has dropped and more capabilities are possible with small stand-alone controls. The revised installed cost of controls is $1,200 or approximately 1/5th that of what was used previously. For the relatively small toplit spaces

The scalar (present worth factor) for a 15 year period of analysis is 8.8.If we consider the worst case climate in climate zones 1 through 5, Boise, ID (5B) had the lowest net savings. Though Boise is relatively sunny it is the coldest of the cities considered and thus the added heating load offset the marginal increase in lighting savings From a prototypical small warehouse with ON/50%/OFF (2 level plus off) controls, the present valued energy cost savings for skylights and the switching controls is as follows:

The lighting energy savings was 1.91 kWh/yr-sf but the added skylights resulting in additional HVAC loads of 0.23 kWh/sf-yr, thus resulting a net electricity savings of 1.68/kWh/yr-sf. Adding skylights and reducing internal gains from electric lighting results in higher heating loads and thus increased natural gas consumption of 0.03 therms/yr-sf. When the electricity costs of 0.094/kWh and gas costs of $1.25/therm are applied along with the 8,8 present valued scalar, the PV net energy cost savings are:

PV Cost Savings – [(1.68 kWh/sf × yr)($0.0942/kWh)+
(-0.032/therms/yr × sf)($1.25/therm)] × 8.8 PV Years

PV Cost Savings – PV $1.041/sf

PV$1.04/sf.

The breakpoint for cost effectiveness is given by the following equation.

$$Breakpoint\ sf = \frac{Fixed\ Cost}{PV\ Unit\ Savings - Variable\ Cost}$$

Thus for the combined skylighting system (skylights and daylighting control system) to be cost-effective it needs to control lighting that is serving at least the amount of area as given in the breakpoint sf equation above. The variable cost of skylights $0.764 per sf. The cost of extra heating and cooling capacity is around $0.051/sf in Boise. Thus the total variable cost is around $0.815/sf.

The breakpoint square footage needed to result in a benefit to cost ratio greater than 1 for skylights with switching controls is

$$Breakpoint\ sf = \frac{\$1200}{\$1.041/sf - \$0.815/sf} = 5310\ \text{sf}$$

Note that if one assumed that a control was used that turns all of the lights off, the threshold breakpoint square footage is substantially less. Thus we are being relatively conservative by selecting a control that leaves 1/3 of the lights on under full daylight conditions as the basis of the threshold area. The lighting subcommittee wanted the skylighting system to be cost-effective under all allowed control types and thus selected 5,000 sf as the reasonable area threshold for required skylighting.

Given that the applicable spaces could be a small as 5,000 sf, one could have space that was only 50 feet by 100 ft in dimensions. In these spaces sidelighting would be a feasible method of daylighting half of the space. As a result exceptions

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were added to allow the use of sidelighting to meet all or part of the daylighting requirement. This provides more flexibility for the designer to choose how they daylight the space while maintaining the desired level of energy savings. When either toplighting controls or sidelighting controls are used to meet these mandatory requirements, these controls do not qualify for control credits.

A similar analysis was conducted for the minimum area that photocontrols could be required. The analysis is the same except the cost and the thermal impacts of skylights are removed from the equation. Note that the requirement for photocontrols when skylights are installed is required in climate zones 1-7, the thermal impact of skylights is given and we are just concerned with the energy impacts of controlling the lights. However we did calculate the additional cooling savings and heating energy consumption. In our worse case condition in Helena M with ON/66%/33% switching controls that do not turn all the way off, the lighting energy savings were 1.904 kWh/sf-yr, cooling energy savings 0.140 kWh/sf-yr, for a total electricity savings of 2.044 kWh/sf-yr increased heating energy consumption of 0.031 therms/sf. When the electricity costs of 0.094/kWh and gas costs of $1.25/therm are applied along with the 8,8 present valued scalar, the PV net energy cost savings are:

PV Cost Savings – [(2.044 kWh/sf × yr)($0.0942/kWh)+
(–0.031/therms/yr × sf)($1.25/therm)] × 8.8 PV Years

PV Cost Savings = PV $1.353

In this case we ignored the cost associated with sizing the heating or cooling plant and given that cooling is more expensive this is a conservative simplification

$$Breakpoint\ sf = \frac{Fixed\ Cost}{PV\ Unit\ Savings - Variable\ Cost}$$

$$Breakpoint\ sf = \frac{\$1200}{\$1.353 - \$0.0} = 886\ \text{sf}$$

The breakpoint for Fairbanks Alaska was 1,500 sf

Even though one could choose to install a control that turns the lights completely of and would have a lower threshold value, the committee thought that the controls should be cost-effective in those spaces where some lights are left on to show that the space is open for business. Thus the lighting subcommittee selected 900 sf as the threshold for daylighting controls in toplit spaces.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum dd to 90.1-2007

Modify the standard as follows (I-P and SI Units):

5.5.4.2.2 Maximum *Skylight* Fenestration Area. The total skylight area shall not exceed 5% of the gross roof area.

5.5.4.2.3 Minimum *Skylight* Fenestration Area. In any *enclosed spaces* ~~s~~ in a building that is 4 stories or less and that is:

1. ~~10,000ft^2,(900m^2)~~ 5,000 ft^2 (465 m^2) and greater and
2. directly under a roof with ceiling heights greater than 15 ft (4.6 m), and
3. one of the following space types: office, lobby, atrium, concourse, corridor, non-refrigerated warehouse or storage, gymnasium/exercise center, convention center, automotive service, manufacturing, ~~non-refrigerated warehouse~~, retail, distribution/sorting area, transportation, or workshop,

the total *daylight area under skylights* shall be a minimum of half the floor area and either:

a. provide a minimum *skylight* area to *daylight area under skylights* of 3% with a skylight VLT of at least 0.40 or
b. provide a minimum *skylight effective aperture* of at least 1%.

These skylights shall have a glazing material or diffuser with a measured haze value greater than 90% when tested according to ASTM D1003. *General lighting* in the daylight area shall be controlled as described in Section 9.4.1.4.

Exceptions to 5.5.4.2.3:

a. *Enclosed spaces* in climate zones 6 through 8,
b. *Enclosed spaces* with designed *general lighting* power densities less than 0.5 W/ft^2 (5.4 W/m^2)
c. Areas where it is documented that existing structures or natural objects block direct beam sunlight on at least half of the roof over the enclosed area for more than 1,500 daytime hours per year between 8 am and 4 pm.
d. *Enclosed spaces* where the *daylight area under rooftop monitors* is greater than 50% of the *enclosed space* floor area.
e. The required *daylight area under skylights* may be reduced by the amount of *primary sidelighted area* with a *sidelighting effective aperture* greater than 0.15 and with *general lighting* controlled as described in Section 9.4.1.3 without the use of any exceptions in Section 9.4.1.3.
f. The required *daylight area under skylights* may be reduced by the amount of *secondary sidelighted area* with a *sidelighting effective aperture* greater than 0.30 and with *general lighting* controlled by *continuous daylight dimming.*

9.4.1.4 Automatic Daylighting Controls for *Toplighting*. When the total *daylight area under skylights* plus the total *daylight area under roof top monitors* in an *enclosed space* exceeds 900 ft^2 (84 m^2) ~~371 m^2~~, the lamps for *general lighting* ~~in~~ over the daylight area shall be separately controlled by at least one multi-level photocontrol (including continuous dimming devices) having the following characteristics:

a. the light sensor for the photocontrol shall be remote from where calibration adjustments are made;
b. the calibration adjustments shall be readily accessible; and
c. the multi-level photocontrol shall reduce electric lighting in response to available daylight with at least one control

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step that is between 50% and 70% of design lighting power and another control step that is no greater than 35% of design power.

Exceptions to 9.4.1.4:

a. ~~*Daylit*~~ *Daylighted areas* under skylights where it is documented that existing adjacent structures or natural objects block direct beam sunlight for more than 1,500 daytime hours per year between 8 am and 4 pm.

b. ~~*Daylit*~~ *Daylighted areas* where the *skylight effective aperture* is less than 0.006 (0.6%).

c. Buildings in climate zone 8 with daylight areas totaling less than ~~10,000 743~~ 1,500 ft^2 (140 m^2) ~~square meters~~ in an enclosed space.

9.6.2 Additional Interior Lighting Power.

c. For space types identified in Table 9.6.2, when additional controls are used as indicated, provided that all mandatory controls are used according to section 9.4, the additional lighting power, to be used anywhere in the building, is calculated as follows:

Additional Interior Lighting Power Allowance = Lighting Power Under Control × Control Factor;

where

Lighting Power Under Control = the total wattage of all lighting fixtures that are controlled in the given space using the control method indicated

Control Factor = the value given in Table 9.6.2 for the corresponding space type and control method.

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TABLE 9.6.2 Control Factors Used in Calculating Additional Interior Lighting Power Allowance
(Only one control factor per controlled space may be used. Any manual controls must be user accessible.)

Additional Control Method (in addition to mandatory requirements)	Space Type			
	Open office, Private office	**Conference room, meeting room, Classroom (lecture/training)**	**Retail sales area**	**Lobby, Atrium, Dining area, Corridors/ stairways, Gym/pool, Mall concourse, Parking garage**
Manual, continuous dimming control or Programmable multi-level dimming control	0.05	0.10*	0.10	0
Programmable multi-level dimming control using programmable time scheduling	0.05	0.10*	0.10	0.10
Multi-level occupancy sensors	0.05	0.05	0	0
Automatic bi-level or multi-level switching in *primary sidelighted areas* when *sidelighting effective aperture* is greater than 0.15	0		0.10**	0
Automatic bi-level or multi-level switching in *primary sidelighted areas* when *sidelighting effective aperture* is greater than 0.15 and when *primary sidelighted area* is less than 1,000 sq.ft.	0.10**			
Automatic *continuous daylight dimming* in *primary sidelighted areas* when *sidelighting effective aperture* is greater than 0.15 and when *primary sidelighted area* is less than 1,000 sq.ft.	0.20**			
Automatic *continuous daylight dimming* in *primary sidelighted areas* when *sidelighting effective aperture* is greater than 0.15 and when *primary sidelighted area* is greater than 1,000 sq.ft.	0.10**			
Automatic *continuous daylight dimming* in *secondary sidelighted areas* when *sidelighting effective aperture* is greater than 0.3	0.10**			
Automatic *continuous daylight dimming* in *daylighted areas under skylights* when the total of those areas is less than ~~4,000~~ 900 sq.ft. and when *skylight effective aperture* is greater than 0.01	0.20			
Automatic *continuous daylight dimming* in *daylighted areas under skylights* when the total of those areas is greater than ~~4,000~~ 900 sq.ft. and when *skylight effective aperture* is greater than 0.01	0.10			

*These control factors may only be used if the requirements of section 9.4.1.2 are met using an *occupancy sensor*.
** Control factors may not be used if controls are used to satisfy exceptions to Section 5.5.4.2.3

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FOREWORD

This addendum splits the "generic lobby" from common elevator lobbies and LPDs were adjusted to reflect specific space needs. In addition, this removes the fitness center audience seating because it's considered a space type that was considered not used, and potentially confusing.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum de to 90.1-2007

Modify the standard as follows (I-P Units) .

These changes are shown relative to addendum "by" to 90.1-2007.

TABLE 9.6.1 Lighting Power Densities Using the Space-by-Space Method

Common Space Types	*LPD*, W/ft^2	RCR Threshold
Lobby	~~0.65~~ 0.90	4
For Elevator	0.64	6
For Performing Arts Theater	2.00	6
For Motion Picture Theater	0.52	4
Gymnasium/Fitness Center		
Fitness Area	0.72	4
~~Fitness Center Audience Seating~~	~~0.20~~	~~4~~

Modify the standard as follows (SI units).

These changes are shown relative to addendum "by" to 90.1-2007.

TABLE 9.6.1 Lighting Power Densities Using the Space-by-Space Method

Common Space Types	*LPD*, W/m^2	RCR Threshold
Lobby	~~7.0~~ 9.675	4
For Elevator	6.88	6
For Performing Arts Theater	21.5	6
For Motion Picture Theater	5.6	4
Gymnasium/Fitness Center		
Fitness Area	7.8	4
~~Fitness Center Audience Seating~~	~~2.2~~	~~4~~

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FOREWORD

ACEEE and the European E4 committee estimate elevator energy to be in the range of 2-5% of building electric consumption. Elevators waste energy in several ways:

- *Ventilation fans often run 24/7 regardless of load or occupancy*
- *Cab lighting often operates 24/7 regardless of occupancy*
- *The energy consumption of the elevator moving apparatus varies over a range of around 5:1 between the least and most efficient units.*

This addendum takes a first step in addressing the first two sources of inefficiency listed above.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum df to 90.1-2007

Revise the Standard as follows (SI units):

Add the following:

10.4.3 Elevators. Elevator systems shall comply with the requirements of this section:

10.4.3.1 Lighting. All cab lighting systems shall have efficacy of not less than 35 lumens per Watt.

10.4.3.2 Ventilation Power Limitation. Cab ventilation fans for elevators without air-conditioning shall not consume over 0.7 W*s/L at maximum speed.

10.4.3.3 Standby Mode. When stopped and unoccupied with doors closed for over 15 minutes, cab interior lighting and ventilation shall be de-energized until required for operation.

Revise the Standard as follows (I-P units):

Add the following:

10.4.3 Elevators. Elevator systems shall comply with the requirements of this section:

10.4.3.1 Lighting. All cab lighting systems shall have efficacy of not less than 35 lumens per Watt.

10.4.3.2 Ventilation Power Limitation. Cab ventilation fans for elevators without air-conditioning shall not consume over 0.33 Watts per cfm at maximum speed.

10.4.3.3 Standby Mode. When stopped and unoccupied with doors closed for over 15 minutes, cab interior lighting and ventilation shall be de-energized until required for operation.

POLICY STATEMENT DEFINING ASHRAE'S CONCERN FOR THE ENVIRONMENTAL IMPACT OF ITS ACTIVITIES

ASHRAE is concerned with the impact of its members' activities on both the indoor and outdoor environment. ASHRAE's members will strive to minimize any possible deleterious effect on the indoor and outdoor environment of the systems and components in their responsibility while maximizing the beneficial effects these systems provide, consistent with accepted standards and the practical state of the art.

ASHRAE's short-range goal is to ensure that the systems and components within its scope do not impact the indoor and outdoor environment to a greater extent than specified by the standards and guidelines as established by itself and other responsible bodies.

As an ongoing goal, ASHRAE will, through its Standards Committee and extensive technical committee structure, continue to generate up-to-date standards and guidelines where appropriate and adopt, recommend, and promote those new and revised standards developed by other responsible organizations.

Through its *Handbook*, appropriate chapters will contain up-to-date standards and design considerations as the material is systematically revised.

ASHRAE will take the lead with respect to dissemination of environmental information of its primary interest and will seek out and disseminate information from other responsible organizations that is pertinent, as guides to updating standards and guidelines.

The effects of the design and selection of equipment and systems will be considered within the scope of the system's intended use and expected misuse. The disposal of hazardous materials, if any, will also be considered.

ASHRAE's primary concern for environmental impact will be at the site where equipment within ASHRAE's scope operates. However, energy source selection and the possible environmental impact due to the energy source and energy transportation will be considered where possible. Recommendations concerning energy source selection should be made by its members.