ANSI/ASHRAE/IES Addenda cd, ck, cn, cq, ct, and cv to ANSI/ASHRAE/IESNA Standard 90.1-2007

ASHRAE ADDENDA

Energy Standard for Buildings Except Low-Rise Residential Buildings

Approved by the ASHRAE Standards Committee on June 20, 2010; by the ASHRAE Board of Directors on July 23, 2010; by the IES Board of Directors on July 24, 2010; and by the American National Standards Institute on July 26, 2010.

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FOREWORD

These additions 1) strengthen the language to actually require exterior control rather than just require the control capability; 2) add bi-level control for general all-night applications such as parking lots to reduce lighting when not needed; 3) add control for façade and landscaping lighting not needed after midnight.

The California Lighting Technology Center at the University of California at Davis has conducted studies using bi-level control strategies in parking lots owned by the University of California system. According to their studies, such control strategies reduce the lighting energy use by significant amounts during the night time hours[1]*. According to the Study at California Polytechnic State University, San Luis Obispo, the parking lot lighting operated in the low mode 68% of the time.*

Another study at the California State University Sacramento Campus shows similar savings, although the exact percentage of low level operation is not available in the report[2]

Energy Savings estimate:

According to a report by Navigant Consulting in 2002[3]*, parking lots account for 22 Twh out of a total of 57 TWh used for outdoor lighting annually nationwide. While this estimate includes all lighted parking areas, the potential for energy savings in parking areas that are part of the building are significant and should be supported by Standard 90.1.*

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Addendum cd to 90.1-2007

Revise Section 9.4.1.3 and 9.4.5 Exceptions as follows (I-P and SI units):

9.4.1.3 Exterior Lighting Control.

~~Lighting for all exterior applications not exempted in Section 9.1 shall have automatic controls capable of turning off exterior lighting when sufficient daylight is available or when the lighting is not required during nighttime hours.~~

~~Lighting not designated for dusk to dawn operation shall be controlled by either:~~

~~a. a combination of a photosensor and a time switch or~~
~~b. an astronomical time switch.~~

~~Lighting designated for dusk to dawn operation shall be controlled by an astronomical time switch or photosensor.~~

Lighting for exterior applications not exempted in section 9.1 shall meet the following requirements:

a. Lighting shall be controlled by a device that automatically turns off the lighting when sufficient daylight is available.
b. All building façade and landscape lighting shall be automatically shut off between midnight or business closing, whichever is later, and 6am or business opening, whichever comes first, or between times established by the *authority having jurisdiction*.
c. Lighting not specified in section b above, including advertising signage, shall be controlled by a device that automatically reduces the connected lighting power by at least 30% for at least one of the following conditions

   1. from 12 midnight or within one (1) hour of the end of business operations, whichever is later, until 6am or business opening, whichever is earlier; or
   2. during any period when no activity has been detected for a time of no longer than 15 minutes.

All time switches shall be capable of retaining programming and the time setting during loss of power for a period of at least ten hours.

Exception: Lighting for covered vehicle entrances or exits from buildings or parking structures where required for safety, security, or eye adaptation.

9.4.5 Exterior Building Lighting Power....

Exceptions: Lighting used for the following exterior applications is exempt when equipped with a *control device* independent of the control of the nonexempt lighting:

a. Specialized signal, directional, and marker lighting associated with transportation.
b. Advertising signage or directional signage.
c. Lighting integral to *equipment* or instrumentation and installed by its *manufacturer.*
d. Lighting for theatrical purposes, including performance, stage, film production, and video production.
e. Lighting for athletic playing areas.
f. Temporary lighting.
g. Lighting for industrial production, material handling, transportation sites, and associated storage areas.
h. Theme elements in theme/amusement parks.
i. Lighting used to highlight features of public monuments and registered *historic* landmark structures or *buildings.*
j. Lighting for hazardous locations.
k. Lighting for swimming pools and water features.
l. Searchlights.

[1] See the PIER Program Case Study "Bi-level Street and Parking Area Lighting, California Polytechnic State University, San Luis Obispo, CA"

[2] Keith Graeber of CLTC in the "research matters" article in LD+A Magazine, November 2008. U.S.

[3] Lighting Market Characterization, Volume I: National Lighting Inventory and Energy Consumption Estimate, Navigant Consulting Inc., Sept 2002. Available for purchase at http://www.ntis.gov – electronic copy is available for $35.

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FOREWORD

According to ASHRAE 62.1, Section 6.2.7, optional ventilation system controls may be used to reset outdoor air intake flow in response to either or both:

- *Variations in zone population (zone demand-controlled ventilation)*
- *Variations in ventilation efficiency in a VAV system due to changes in airflow (ventilation reset).*

The first reset mechanism, for variations in zone population in high occupancy areas, is currently covered by 6.4.3.9 in the mandatory section of the standard. These requirements clearly apply to single-zone systems and to zones within 100% outdoor air systems, wherein outdoor air intake flow can be adjusted directly, but they may be inadequate for zones within multiple-zone systems, wherein zone outdoor airflow depends on both central outdoor air intake flow and recirculation of unused outdoor air from over-ventilated zones.

One could make the argument that zone-level reset, i.e. with CO_2 and/or occupancy sensors and/or schedule, is ineffective unless the system ventilation efficiency and system outdoor air intake flow is changed as a result.

This addendum expands zone-level demand controlled ventilation to include various forms of system level strategies. It is being added to the prescriptive section, so that it could be traded off using the ECB method.

At the system level, the outdoor air intake flow can be adjusted continuously, in response to the worst-case (i.e. "critical") zone outdoor airflow requirement, as well as the outdoor airflow and discharge airflow currently required in all other zones. Responding to current outdoor airflow requirements (Vou) and the current system ventilation efficiency (Ev) can dramatically reduce the outdoor air heating or cooling requirement. However, it's more than just the critical zone that determines Evz and Vot, it is also determined by the ventilation efficiency of the entire system. If other zones are overventilated, then the recirculated return air will thereby provide some "fresh" air to the zones on its second time around,.

This concept is true for single- and dual-path systems without zone-level recirculated plenum return air. However, since it is much more difficult to determine the zone ventilation effectiveness for dual-path locally recirculating systems, they should be treated differently. In this addendum dual-path systems are exempted from the requirement.

Savings from this change vary by climate zone. For office buildings the energy savings vary from 1.4% in Climate Zone 1 to 12.4% in Climate Zone 8.

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Addendum ck to 90.1-2007

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

6.5.3 Air System Design and Control. Each HVAC system having a total fan system motor nameplate hp exceeding 5 hp shall meet the provisions of Sections 6.5.3.1 through ~~6.5.3.2~~.6.5.3.3.

6.5.3.3 Multiple-zone VAV System Ventilation Optimization Control. Multiple-zone VAV systems with DDC of individual zone boxes reporting to a central control panel shall include means to automatically reduce outdoor air intake flow below design rates in response to changes in *system ventilation efficiency* as defined by ASHRAE Standard 62.1, Appendix A.

Exceptions:

a. VAV systems with zonal transfer fans that recirculate air from other zones without directly mixing it with outdoor air, dual-duct dual-fan VAV systems, and VAV systems with fan-powered terminal units.

b. Systems required to have Exhaust Air Energy Recovery complying with Section 6.5.6.1.

c. Systems where total design exhaust airflow is more than 70% of total design outdoor air intake flow requirements.

Modify the following reference in Section 12:

ANSI/ASHRAE Standard 62.1-~~2004~~2007 Ventilation for Acceptable Indoor Air Quality

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FOREWORD

This change adds two versions of a combined advanced control to the control incentives table. These control system combinations involve personal workstation control and workstation-specific occupancy sensors for open office applications. The control incentive will apply only to the particular controls when they are applied in open office areas. This advanced new technology is not yet widely used, but it's inclusion in the incentive table will encourage this advanced control use and its energy savings in open office areas. Occupancy type control is very effective but also very difficult to apply in open office areas. This control makes that possible in specific workstation arrangements. A study for BC Hydro Energy Smart Office installation, "Energy Saving Lighting Control Systems for Open-Plan Offices: A Field Study (Galasiu, Newsham, Suvagau, Sander) published in Leukos July 2007 broke down the energy savings by individual control strategies for this type of workstation-specific lighting system. The conclusions showed a savings of 46% made up of 11% for individual dimming if used alone, and a saving of 35% for individual occupancy sensors if used alone.

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Addendum cn to 90.1-2007

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

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.)

	Space Type				
Additional Control Method (in addition to mandatory requirements).	Open office ~~Private 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*[1]	0.10	0
Programmable multi-level dimming control using programmable time scheduling	0.05		0.10*[1]	0.10	0.10
Multi-level occupancy sensors	0.05		0.05	0	0
Occupancy sensors controlling the downlight component of workstation specific luminaires with continuous dimming to off capabilities.	0.25[2]	0	0	0	0
Occupancy sensors controlling the downlight component of workstation specific luminaires with continuous dimming to off operation, in combination with personal continuous dimming control of downlight illumination by workstation occupant.	0.30[2,3]	0	0	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 1000 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 1000 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 1000 sq.ft.			0.10		
Automatic *continuous daylight dimming* in *secondary sidelighted area*s 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 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 sq.ft. and when *skylight effective aperture* is greater than 0.01			0.10		

*[1] These control factors may only be used if the requirements of section 9.4.1.2 are met using an *occupancy sensor.*

[2] Control factor is limited to the wattage of workstation-specific luminaires in partitioned single occupant workspaces contained within an open office environment (i.e. direct-indirect luminaires with separately controlled downlight and uplight components, with the downward component providing illumination to a single occupant in an open plan workstation). Within 30 minutes of the occupant leaving the space, the downward component shall continuously dim to off over a minimum of 2 minutes. Upon the occupant entering the space, the downward component shall turn on at the minimum level and continuously raise the illumination to a preset level over a minimum of 30 seconds. The uplight component of workstation specific luminaire shall comply with section 9.4.1.1 (automatic shutoff).

[3] In addition to the requirements described in footnote 2, the control shall allow the occupant to select their preferred light level via a personal computer, handheld device, or similarly accessible device located within the workstation.

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FOREWORD

This section of the standard has not been revised since 1999. This addendum is based on economic analysis using the current scalar value. The detailed analysis divided ducts into many categories of duct type and location; however analyzing the results showed that nearly all categories were economically justified at seal class A, which allowed eliminating two tables while reducing energy use.

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Addendum cq to 90.1-2007

Revise the Standard as follows (I-P and SI units).

3.2 Definitions

ductwork: a system of ducts for distribution and extraction of air.

seal class A: A *ductwork* sealing category that requires sealing all transverse joints, longitudinal seams, and duct wall penetrations. Duct wall penetrations are openings made by pipes, holes, conduit, tie rods, or wires. Longitudinal seams are joints oriented in the direction of airflow. Transverse joints are connections of two duct sections oriented perpendicular to airflow.

Modify Section 6.3.2k as follows:

k. Ductwork and plenums shall be insulated in accordance with Tables 6.8.2A and 6.8.2B and shall be sealed in accordance with ~~Table 6.4.4.2A.~~Section 6.4.4.2.1

Modify Section 6 as follows:

6.4.4.2 Ductwork and Plenum Leakage

6.4.4.2.1 Duct Sealing. Ductwork and all plenums with pressure class ratings shall be constructed to *seal class A* ~~sealed in accordance with Table 6.4.4.2A (Table 6.4.4.2B provides definitions of seal levels)~~ , as required to meet the requirements of Section 6.4.4.2.2, and with standard industry practice (see Informative Appendix E). Openings for rotating shafts shall be sealed with bushings or other devices that seal off air leakage. Pressure-sensitive tape shall not be used as the primary sealant, unless it has been certified to comply with UL-181A or UL-181B by an independent testing laboratory and the tape is used in accordance with that certification. All connections shall be sealed, including but not limited to spin-ins, taps, other branch connections, access doors, access panels, and duct connections to equipment. Sealing that would void product listings is not required. Spiral lock seams need not be sealed. All duct pressure class ratings shall be designated in the design documents.

6.4.4.2.2 Duct Leakage Tests. *Ductwork* that is designed to operate at static pressures in excess of 3 in. w.c. and all *ductwork* located outdoors shall be leak-tested according to industry-accepted test procedures (see Informative Appendix E). Representative sections totaling no less than 25% of the total installed duct area for the designated pressure class shall be tested. All sections shall be selected by the building owner or the designated representative of the building owner. ~~Duct systems with pressure ratings in excess of 3 in. w.c. shall be identified on the drawings.~~ Positive pressure leakage testing is acceptable for negative pressure ductwork.The maximum permitted duct leakage shall be

$$L_{max} = C_L P^{0.65},$$

where

L_{max} = maximum permitted leakage ~~in~~ cfm/100 ft^2 duct surface area;

C_L = 4, duct leakage class, cfm/100 ft^2 duct surface area at 1 in. w.c.;
~~6 for rectangular sheet metal, rectangular fibrous, and round flexible ducts,~~
~~3 for round/flat oval sheet metal or fibrous glass ducts;~~ and

P = test pressure, which shall be equal to the design duct pressure class rating, in. w.c.

~~TABLE 6.4.4.2A Minimum Duct Seal Level[a]~~

~~Duct Location~~	~~Duct Type~~			
	~~Supply~~		~~Exhaust~~	~~Return~~
	~~≤2 in. w.c.[b]~~	~~>2 in. w.c.[b]~~		
~~Outdoor~~	~~A~~	~~A~~	~~C~~	~~A~~
~~Unconditioned spaces~~	~~B~~	~~A~~	~~C~~	~~B~~
~~Conditioned spaces[c]~~	~~C~~	~~B~~	~~B~~	~~C~~

~~[a] See Table 6.4.4.2B description of seal level.~~
~~[b] Duct design static pressure classification.~~
~~[c] Includes indirectly conditioned spaces such as return air plenums.~~

~~**TABLE 6.4.4.2B Duct Seal Levels**~~

~~Seal Level~~	~~Sealing Requirements[a]~~
~~A~~	~~All transverse joints, longitudinal seams, and duct wall penetrations. Pressure-sensitive tape shall not be used as the primary sealant, unless it has been certified to comply with UL-181A or UL-181B by an independent testing laboratory and the tape is used in accordance with that certification.~~
~~B~~	~~All transverse joints, longitudinal seams. Pressure-sensitive tape shall not be used as the primary sealant, unless it has been certified to comply with UL-181A or UL-181B by an independent testing laboratory and the tape is used in accordance with that certification.~~
~~C~~	~~Transverse joints only.~~

~~[a] Longitudinal seasm are joints oriented in te direction of airflow. Transverse joints are connections of two duct sections orietned perpendicular to airflow. Duct wall penetrations are openings made by any screw fastener, pipe, ord, or wire. Spiral lock seams in a round or flat oval duct need not be sealed. All other connections are consideredtransverse joints, including but not limited to spin ins, taps, and other branch connections, access door frames and jambs, duct connections to equipment, etc.~~

Modify Appendix E as follows:

Section No.	Reference	Title/Source
6.4.4.2.1	SMACNA Duct Construction Standards - ~~1995~~2005	HVAC Duct Construction Standards
6.4.4.2.2	SMACNA Duct Leakage Test Procedures -1985	HVAC Air Duct Leakage Test Manual Sections 3, 5, and 6

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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 1,000 sqft.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 299 sq ft. The 2010 standard will require occupancy sensor control in office spaces up to 250 sq ft. Therefore to cover all office environments where energy savings is available, the committee is proposing a slightly aggressive 250 threshold for daylighting.

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Addendum ct to 90.1-2007

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

9.4.1.3 **Automatic Daylighting Controls for *Primary Sidelighted Areas*.** When the combined *primary sidelighted area* in an *enclosed space* equals or exceeds ~~1,000~~ 250 ft^2 (~~93~~ 23 m^2), the lamps for *general lighting* over the *primary sidelighted area* shall be separately controlled by at least one multi-level photocontrol (including continuous dimming devices) having the following characteristics:

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.)

	Space Type			
Additional Control Method (in addition to mandatory requirements).	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~~ 250 sq.ft. (23 m^2)	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~~ 250 sq.ft. (23 m^2)	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~~ 250 sq.ft. (23 m^2)	0.10			
Automatic *continuous daylight dimming* in *secondary sidelighted area*s 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 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 sq.ft. and when *skylight effective aperture* is greater than 0.01	0.10			

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FOREWORD

A Continuous Maintenance Proposal was submitted that indicated there is substantial energy waste in many service water booster systems.

Service water (aka domestic water) booster pump systems can waste substantial energy in three ways:

1. *It is common to boost pressure beyond the pressure needed under most conditions and then to reduce that pressure with one or more pressure reducing valves.*
2. *Even relatively efficient systems incorporating variable speed drives may be controlled in ways that require the pumps to run even when there is no service water flow.*
3. *The pressure maintained may be more than needed during low flow conditions when there is less piping pressure loss to account for.*

Locating the pressure sensor near the critical fixture (usually at the highest floor of the building) conserves energy by minimizing the setpoint during non-peak conditions. The same requirement exists in the fan power and cooling pump energy requirements. In booster systems, however, the economics are somewhat different because of the high lift pressure even when flow rates are low.

Economic analysis:

1. *Mounting the pressure sensor remotely showed net LCC improvements with a scalar of 7 (acceptable for a 14 year life) for the minimum pump size covered when compared to a simple fixed-pressure discharge setpoint. The scalar, however was not met when compared to systems with a discharge sensor and even simple pressure reset logic.*
2. *Having the pump turn off when there is no demand is a standard feature on most units, provided that the startup procedures are followed; so there is no need for cost justification.*
3. *Eliminating the PRV potentially increases first cost because one or more of the following features will be used in lieu of the PRV to provide adequate control of the system pressure:*

    1. *Variable speed drives*
    2. *Multiple smaller pumps*
    3. *Larger pressure tanks*

Research of actual costs however showed that the least expensive option is often the variable speed driven design without a PRV. The cost of the VFD is offset by eliminating the PRV and reducing the size of the bladder tank. Therefore, economic analysis was not required for this provision.

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 cv to 90.1-2007

Add the following Section to the Standard (SI and I-P units).

10.4.2 Service Water Pressure Booster Systems. Service water pressure booster systems shall be designed such that:

a. One or more pressure sensors shall be used to vary pump speed and/or start and stop pumps. The sensor(s) shall either be located near the critical fixture(s) that determine the pressure required, or logic shall be employed that adjusts the setpoint to simulate operation of remote sensor(s).

b. No device(s) shall be installed for the purpose of reducing the pressure of all of the water supplied by any booster system pump or booster system, except for safety devices.

c. No booster system pumps shall operate when there is no service water flow.

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.