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# **ANSI/ASHRAE/IES Standard 90.1-2013 Determination of Energy Savings: Qualitative Analysis**

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August 2014



**Pacific Northwest**  
NATIONAL LABORATORY

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# Executive Summary

Section 304(b) of the Energy Conservation and Production Act (ECPA), as amended, requires the Secretary of Energy to make a determination each time a revised version of ASHRAE Standard 90.1 is published with respect to whether the revised standard would improve energy efficiency in commercial buildings. When the U.S. Department of Energy (DOE) issues an affirmative determination on Standard 90.1, states are statutorily required to certify within two years that they have reviewed and updated the commercial provisions of their building energy code, with respect to energy efficiency, to meet or exceed the revised standard.

To meet these statutory requirements, the DOE Building Energy Codes Program (BECP) and Pacific Northwest National Laboratory (PNNL) conduct two types of analysis in a determination of energy savings for a revised Standard 90.1:

- **Qualitative Analysis:** This is a detailed textual analysis that identifies all the changes made to the previous edition of Standard 90.1 and categorizes the changes as having a positive, negative, or neutral impact on energy efficiency in commercial buildings. In the qualitative analysis, no attempt is made to estimate a numerical impact using whole building simulation. Three steps are typically undertaken in the qualitative analysis: identify all changes made to Standard 90.1, characterize the impact of each change on the energy efficiency of Standard 90.1, and identify those changes that can be incorporated into the subsequent quantitative analysis.
- **Quantitative Analysis:** This analysis uses the results of the qualitative analysis to identify which changes should be incorporated into the building simulation models to estimate the energy impact resulting from the changes to Standard 90.1.

This report provides the qualitative analysis of all addenda to ANSI/ASHRAE/IES<sup>1</sup> Standard 90.1-2010 (referred to as Standard 90.1-2010 or 2010 edition) that were included in ANSI/ASHRAE/IES Standard 90.1-2013 (referred to as Standard 90.1-2013 or 2013 edition). All addenda in creating Standard 90.1-2013 were evaluated for their projected impact on energy efficiency. Each addendum was characterized as having a positive, neutral, or negative impact on overall building energy efficiency.

The textual analysis indicated that 52 of a total of 110 changes have positive impact on energy efficiency, including 8 changes evaluated as having a major positive impact and 44 changes with a minor positive impact on energy efficiency. Of the remaining changes, 53 were neutral (had neither a positive or negative impact on energy efficiency). These include editorial changes, changes to reference standards, changes to alternative compliance paths, and other changes to the text of the standard that may improve the usability of the standard, but do not generally affect the energy efficiency of a building. Five changes were identified as having a minor negative impact on energy efficiency.

The eight addenda that have major positive impacts on energy efficiency are as follows:

1. Addendum 90.1-2010m – adds control requirements for lighting alterations.
2. Addendum 90.1-2010u – applies new efficiency requirements to individual fans.

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<sup>1</sup> American National Standards Institute/American Society of Heating, Refrigerating, and Air Conditioning Engineers/Illuminating Engineering Society of North America

3. Addendum 90.1-2010am – reduces energy usage for large boilers.
4. Addendum 90.1-2010aq – reduces fan energy usage and improves economizer effectiveness.
5. Addendum 90.1-2010bb – increases stringency of building envelope requirements.
6. Addendum 90.1-2010bq – adds new efficiency requirements for commercial refrigeration.
7. Addendum 90.1-2010by – requires more lighting controls in more spaces and reduces time to reduction or shutoff.
8. Addendum 90.1-2010co – decreases lighting power density in most building types.

The five addenda that have negative impacts on energy efficiency are as follows:

1. Addendum 90.1-2010j – reduces energy efficiency ratio for evaporatively cooled air conditioners.
2. Addendum 90.1-2010da – relaxes air leakage requirements for high-speed doors.
3. Addendum 90.1-2010db – relaxes the U-factor requirement for residential steel joist floors in Climate Zone 3.
4. Addendum 90.1-2010de – relaxes economizer requirements for computer rooms.
5. Addendum 90.1-2010dq – eliminates sizing requirements for pipes above 24" in diameter.

Addenda characterized as resulting in negative energy saving impacts are judged to be relatively minor, indicating no significant energy impact.

The 44 addenda that are rated as minor positives are discussed in Section 4. A comparison of the number of major positives and minor positives (a total of 52 positives) to the number of minor negatives (5) indicates that the overall impact on the standard is positive.

## Acronyms and Abbreviations

AHRI	Air Conditioning, Heating, and Refrigeration Institute
AHU	air handling unit
AMCA	Air Movement and Control Association
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ATC	acceptance test code
BECP	Building Energy Codes Program
bhp	brake horsepower
BOD	Board of Directors
Btu	British thermal unit(s)
Btu/h	British thermal unit(s) per hour
cfm	cubic feet per minute
CFR	Code of Federal Regulations
COP	coefficient of performance
CRRC	Cool Roof Rating Council
CSA	Canadian Standards Association
CTI	Cooling Tower Institute
DDC	direct digital control(s)
DOE	U.S. Department of Energy
DX	direct expansion
ECB	energy cost budget
ECPA	Energy Conservation and Production Act
EER	energy efficiency ratio
EPAct 2005	Energy Policy Act of 2005
EPCA	Energy Policy and Conservation Act
FC	filled cavity
FEG	fan efficiency grade
gpm	gallon(s) per minute
HERS	home energy rating systems
hp	horsepower
HSPF	heating season performance factor
HVAC	heating, ventilation, and air-conditioning
HVACR	heating, ventilation, air-conditioning, and refrigeration
IEC	International Electrotechnical Commission
IEER	Integrated Energy Efficiency Ratio
IES	Illuminating Engineering Society of North America
IESNA	Illuminating Engineering Society of North America
IPLV	integrated partial load value
LPD	lighting power density

LSG	light-to-solar-gain ratio
NAECA	National Appliance Energy Conservation Act
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NFRC	National Fenestration Rating Council
NR	not required
PNNL	Pacific Northwest National Laboratory
OA	outdoor air
PTAC	packaged terminal air conditioner
PTHP	packaged terminal heat pump
PUE	power utilization effectiveness
RH	relative humidity
SDHV	small duct high velocity
SEER	seasonal energy efficiency ratio
SHGC	solar heat gain coefficient
SPVAC	single package vertical air conditioner
SPVHP	single package vertical heat pump
SWH	service water heating
VAV	variable air volume
VRF	variable refrigerant flow
VSD	variable speed drive
VT	visible transmittance
WWR	window-to-wall ratio
w.c.	water column



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## 1.0 Introduction

Title III of the Energy Conservation and Production Act, as amended (ECPA), establishes requirements for the Building Energy Efficiency Standards Program (42 U.S.C. 6831 et seq.). Section 304(b), as amended, of ECPA provides that whenever the ANSI/ASHRAE/IESNA<sup>1</sup> 90.1-1989 (Standard 90.1-1989 or 1989 edition), or any successor to that code, is revised, the Secretary must make a determination, not later than 12 months after such revision, whether the revised code would improve energy efficiency in commercial buildings and must publish notice of such determination in the Federal Register (42 U.S.C. 6833 (b)(2)(A)). The Secretary may determine that the revision of Standard 90.1-1989, or any successor thereof, improves the level of energy efficiency in commercial buildings. If so, then not later than 2 years after the date of the publication of such affirmative determination, each State is required to certify that it has reviewed and updated the provisions of its commercial building code regarding energy efficiency with respect to the revised or successor code (42 U.S.C. 6833(b)(2)(B)(i)). The State must include in its certification a demonstration that the provisions of its commercial building code, regarding energy efficiency, meet or exceed the revised standard (42 U.S.C. 6833(b)(2)(B)(i)).

If the Secretary makes a determination that the revised standard will not improve energy efficiency in commercial buildings, State commercial codes shall meet or exceed the last revised standard for which the Secretary has made a positive determination (42 U.S.C. 6833(b)(2)(B)(ii)). ECPA also requires the Secretary to permit extensions of the deadlines for the State certification if a State can demonstrate that it has made a good faith effort to comply with the requirements of Section 304(c) of ECPA and that it has made significant progress in doing so (42 U.S.C. 6833(c)).

On October 9, 2011, DOE issued an affirmative determination of energy savings for Standard 90.1-2010, which concluded that Standard 90.1-2010 would achieve greater energy efficiency in buildings subject to the code, than Standard 90.1-2007. (76 FR 64904). Consequently, DOE has determined that Standard 90.1-2010 represents the baseline to which Standard 90.1-2013 requirements are compared for the purpose of a determination of energy savings for Standard 90.1-2013. To meet these statutory requirements, the DOE Building Energy Codes Program (BECP) and Pacific Northwest National Laboratory (PNNL) conduct two types of analysis in a determination of energy savings for a revised Standard 90.1<sup>2</sup>:

- **Qualitative Analysis:** This is a detailed textual analysis that identifies all the changes made to the previous edition of Standard 90.1 and categorizes the changes as having a positive, negative, or neutral impact on energy efficiency in commercial buildings. In the qualitative analysis, no attempt is made to estimate a numerical impact using whole building simulation. Three steps are typically undertaken in the qualitative analysis: identify all changes made to Standard 90.1, characterize the impact of each change on the energy efficiency of Standard 90.1, and identify those changes that can be incorporated into the subsequent quantitative analysis.
- **Quantitative Analysis:** This analysis uses the results of the qualitative analysis to identify which changes should be incorporated into the building simulation models to estimate the energy impact resulting from the changes to Standard 90.1.

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<sup>1</sup> American National Standards Institute/American Society of Heating, Refrigerating, and Air Conditioning Engineers/Illuminating Engineering Society of North America

<sup>2</sup> Standard 90.1-2010 Determination available at <http://www.energycodes.gov/regulations/determinations>

In support of the U.S. Department of Energy's (DOE's) Determination of Energy Savings for ANSI/ASHRAE/IES Standard 90.1-2013 (referred to as ASHRAE Standard 90.1-2013, Standard 90.1-2013, 90.1-2013, or 2013 edition) (ASHRAE 2013b), Pacific Northwest National Laboratory (PNNL) prepared this qualitative assessment analysis of the relative energy use for commercial buildings designed to meet requirements found in Standard 90.1-2013 compared to meeting requirements found in ANSI/ASHRAE/IES<sup>1</sup> Standard 90.1-2010 (referred to as ASHRAE Standard 90.1-2010, Standard 90.1-2010, 90.1-2010, or 2010 edition) (ASHRAE 2010b). ASHRAE processes changes to Standard 90.1 in the form of individual addenda, with each addendum representing a single change or set of changes related topically or chronologically. Addenda may range from a few words changed for clarification to complete replacement of a series of requirements tables.

The ensuing sections of this document describe the addenda to Standard 90.1-2010 that are included in Standard 90.1-2013, and impacts of the specific addenda and impacts on various sections of Standard 90.1-2013.

#### *Review Under the Information Quality Act*

This report is being disseminated by the Department of Energy. As such, the document was prepared in compliance with Section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001 (Public Law 106-554) and information quality guidelines issued by the Department of Energy. Though this report does not constitute "influential" information, as that term is defined in DOE's information quality guidelines or the Office of Management and Budget's Information Quality Bulletin for Peer Review (Bulletin), the current report builds upon methods of analysis that have been subjected to peer review and public dissemination. In addition, this work has been subject to internal peer review, and external review through the public comment process as part of the DOE Determination for Standard 90.1-2013.

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<sup>1</sup> American National Standards Institute/American Society of Heating, Refrigerating, and Air Conditioning Engineers/Illuminating Engineering Society of North America

## 2.0 Addenda Included in Standard 90.1-2013

Standard 90.1-2013 incorporates ASHRAE Standard 90.1-2010 and all approved addenda. Table 2.1 lists all 110 addenda processed by ASHRAE for inclusion in Standard 90.1-2013. All addenda were applied to Standard 90.1-2010 to create the 2013 edition. The addenda included in Standard 90.1-2013 may also be found in the published supplements to Standard 90.1-2010 on the ASHRAE website (ASHRAE 2012, ASHRAE 2013a).

The following list is taken from Appendix F to ASHRAE Standard 90.1-2013. Table 2.1 lists each addendum and describes the way in which the text is affected by the change, as well as ASHRAE, IES, and ANSI approval dates. Table 2.1 is a copy of Appendix F to Standard 90.1-2013 with minor edits to define some of the acronyms used in Appendix F and to make the format of the descriptions the same. The description of addendum 90.1-2010j was also modified in this table, as it was a repeat of the description of addendum 90.1-2010k. The section affected for addendum 90.1-2010bo was also modified to indicate that this addendum is associated with the Service Water Heating section and not Heating, Ventilating, and Air-Conditioning section.

The table numbers called out in Table 2.1 refer to Standard 90.1-2010. In Standard 90.1-2013, tables have been renumbered from a format of “Table (Section Number)(Letter)” to “Table(Section Number)-(Number).” Thus, for example, Table 6.8.1A in Standard 90.1-2010 is now Table 6.8.1-1 in Standard 90.1-2013. These table numbers have been corrected in Sections 4 and 5 in this document to match the table numbers in the 2013 edition of Standard 90.1.

The first eight addenda listed in Table 2.1 were originally developed as addenda to Standard 90.1-2007 and are listed prior to addenda that were developed solely to Standard 90.1-2010. In later tables in this document, addenda are listed strictly in order of their addendum designation.

**Table 2.1.** Complete List of Addenda Processed for ASHRAE Standard 90.1-2013

Addendum	Section(s) Affected	Description of Changes	ASHRAE Standards Committee Approval	ASHRAE BOD Approval	IES BOD Approval	ANSI Approval
bb (formerly addendum bb to 90.1-2007)	5. Building Envelope, Appendix A	This addendum modifies the building envelope requirements for opaque assemblies and fenestration in tables 5.5.1 through 5.5.8 and the associated text in section 5.5.4.5. It also updates the National Fenestration Rating Council (NFRC) 301 reference and modifies two metal building roof assemblies in Table A2.3.	3/23/2012	4/4/2012	3/23/2012	5/11/2012
bz (formerly addendum bz to 90.1-2007))	6. Heating, Ventilating, and Air-Conditioning	This addendum adds a Section 8.4.2 which specifies requirements for installation of basic electrical metering of major end uses (total electrical energy, HVAC systems, interior lighting, exterior lighting and receptacle circuits) to provide basic reporting of energy consumption data to building occupant.	1/21/2012	1/23/2012	1/18/2012	1/26/2012
cg (formerly addendum cg to 90.1-2007))	11. Energy Cost Budget and Appendix G	This addendum modifies the simulation requirements for modeling mandatory automatic daylighting controls as well as automatic lighting controls. It also modifies the simulation requirements for automatic lighting controls in the proposed design, beyond the minimum mandatory requirements. Table G3.2, which provided power adjustment percentages for automatic lighting controls, has been deleted and savings through automatic control devices are now required to be modeled in building simulation through schedule adjustments for the proposed design.	1/21/2012	1/23/2012	1/18/2012	1/26/2012
ci (formerly addendum ci to 90.1-2007))	3. Definitions, 11. Energy Cost Budget and Appendix G	This addendum modifies requirements for the cooling tower in Chapter 11, from two-speed to variable speed. A formula has been specified to calculate the condenser water design supply temperature. Similar revisions have been made to Appendix G for the cooling tower requirements. Definitions for cooling design wet-bulb temperature and heating design wet-bulb temperature have been added to Chapter 3.	1/21/2012	1/23/2012	1/18/2012	1/26/2012
cj (formerly addendum cj to 90.1-2007))	Appendix G	Creates modeling rules for computer rooms in Appendix G	6/26/2012	41086	6/28/2013	7/24/2013
cm (formerly addendum cm to 90.1-2007)	5. Building Envelope	The proposed text clarifies how to interpret the use of dynamic glazing products given the requirements in Addendum bb (envelope requirements).	7/20/2010	7/23/2010	7/24/2010	7/26/2010
dm (previously from 2007)	5. Building Envelope	This addendum modifies Section 5.4.3.4 for vestibules. It adds a size limit for large buildings, exemptions for semiheated spaces and elevator lobbies in parking garages	01/26/13	1/29/2013	2/11/2013	2/12/2013

**Table 2.1 (continued)**

Addendum	Section(s) Affected	Description of Changes	ASHRAE Standards Committee Approval	ASHRAE BOD Approval	IES BOD Approval	ANSI Approval
ds (formerly addendums to 90.1-2007)	5.Building Envelope	This addendum corrects the definitions of primary sidelighted area, secondary sidelighted area, and sidelighting effective area to use the term “vertical fenestration” instead of “window” to clarify that glazed doors and other fenestration products are included as well as windows. Additionally, the definition of daylight area under rooftop monitors is corrected to include the spread of light beyond the width of the rooftop monitor glazing.	1/21/2012	1/23/2012	1/18/2012	1/26/2012
a	10.Other Equipment and 12.Normative References	This addendum specifies that nominal efficiencies for motors are required to be established in accordance with 10 CFR 431 instead of National Electrical Manufacturers Association (NEMA) Standards. It modifies the footnotes to Tables 10.8A, 10.8B, 10.8 C. The corresponding reference for 10 CFR 431 has also been added.	1/21/2012	1/23/2012	1/18/2012	1/26/2012
b	10.Other Equipment and 12.Normative References	This addendum requires escalators and moving walks to automatically slow when not conveying passengers. The corresponding reference to American Society of Mechanical Engineers (ASME) A17.1/ Canadian Standards Association (CSA) B44 has also been added to the Normative References.	6/25/2011	6/29/2011	6/30/2011	6/30/2011
c	Appendix G	This addendum adds requirements for laboratory exhaust fans to Section G3.1.1, Baseline HVAC System Type and Definition. Lab exhaust fans are required to be modeled as constant horsepower, reflecting constant volume stack discharge with outside air bypass.	6/25/2011	6/29/2011	6/30/2011	6/30/2011
e	Appendix G	This addendum updates language in Section G3.1, part 5 'Building Envelope', to require that existing buildings use the same envelope baseline as new buildings with the exception of fenestration area.	6/27/2012	6/27/2012	6/18/2012	7/26/2012
f	Appendix G	This addendum modifies Section G.3.1, Building Envelope. It specifies the vertical fenestration area for calculating baseline building performance for new buildings and additions.	6/26/2013	6/26/2013	6/28/2013	7/24/2013
g	6. Heating, Ventilating, and Air-Conditioning and 12.Normative References	This addendum adds efficiency requirements for commercial refrigerators, freezers and refrigeration equipment. Table 6.8.1L and Table 6.8.1M have been added which specify the energy use limits for refrigerators and freezers. The corresponding references have also been added in Chapter 12.	6/25/2011	6/29/2011	6/30/2011	6/30/2011
h	6. Heating, Ventilating, and Air-Conditioning.	This addendum modifies the minimum efficiency standards for water to air heat pumps (water loop, ground water and ground loop). The proposed cooling energy efficiency ratios (EERs) and heating coefficients of performance (COPs) are more stringent than the present values. This addendum also removes the small duct high velocity product class from Table 6.8.1B.	6/25/2011	6/29/2011	6/30/2011	6/30/2011

**Table 2.1 (continued)**

Addendum	Section(s) Affected	Description of Changes	ASHRAE Standards Committee Approval	ASHRAE BOD Approval	IES BOD Approval	ANSI Approval
i	6. Heating, Ventilating, and Air-Conditioning.	This addendum increases the minimum efficiency standards for single package vertical air conditioners (SPVAC) and single package vertical heat pumps (SPVHP). It also creates a new product class for SPVAC and SPVHP used in space constrained applications. This new product class only applies to non-weatherized products with cooling capacities <36,000 Btu/h and intended to replace an existing AC.	01/26/13	1/29/2013	2/11/2013	2/12/2013
j	6. Heating, Ventilating, and Air-Conditioning.	Modifies the minimum efficiency requirements of evaporatively cooled units, of size category 240,000 Btu/h to 760,000 Btu/h and heating type-other, in Table 6.8.1A (now Table 6.8.1-1 in Standard 90.1-2013). The value is reduced to account for increased pressure drop in such system types. The product class, small duct high velocity, has been eliminated.	6/25/2011	6/29/2011	6/30/2011	6/30/2011
k	8. Power and 12. Normative References	This addendum modifies notes to Table 8.1 and specifies that nominal efficiencies would be established in accordance with the 10 CFR 431 test procedure for low-voltage dry-type transformers. The corresponding references have also been added in Chapter 12.	6/25/2011	6/29/2011	6/30/2011	6/30/2011
l	6. Heating, Ventilating, and Air-Conditioning.	This addendum fixes the mistake with 90.1-2010 fan power limitations, which required the user to perform calculations for fan brake horsepower (bhp) even if the simplified nameplate hp option was being used.	6/27/2012	6/27/2012	6/18/2012	6/28/2012
m	9.Lighting	This addendum adds some control requirements for lighting alterations, for interior and exterior applications. It adds a section for submittals and includes loading docks as a tradable surface. It modifies the provisions for additional interior lighting power, which would now be calculated on the basis of controlled wattage.	6/27/2012	6/27/2012	6/18/2012	6/28/2012
n	10.Other Equipment	This addendum clarifies that the total lumens/watt for the entire elevator cab is required to meet the efficiency requirement and it is not required for each individual light source.	6/27/2012	6/27/2012	6/18/2012	6/28/2012
o	5.Building Envelope and 3.Definitions	This addendum adds the definition for sectional garage doors. It also modifies Section 5.4.3.2 (d), fenestration air leakage provisions for doors, to include requirements for glazed sectional garage doors.	1/21/2012	1/23/2012	1/18/2012	1/26/2012
p	5.Building Envelope and 12.Normative References	This addendum modifies Section 5.5.3.1 and requires roof solar reflectance and thermal emittance testing to be in accordance with Cool Roof Rating Council (CRRC)-1 Standard. It also modifies Section 12 by adding the reference for CRRC.	1/21/2012	1/23/2012	1/18/2012	1/26/2012



**Table 2.1 (continued)**

Addendum	Section(s) Affected	Description of Changes	ASHRAE Standards Committee Approval	ASHRAE BOD Approval	IES BOD Approval	ANSI Approval
q	5. Building Envelope, 3.Definitions and 12.Normative References	This addendum modifies Section 5.8.2.2, by clarifying the requirements for labeling of fenestration and door products. The corresponding references to NFRC in Chapter 12 have also been updated.	6/27/2012	6/27/2012	6/18/2012	6/28/2012
r	Appendix G and 12.Normative References	This addendum clarifies the requirements related to temperature and humidity control in Appendix G and relocates all related wording to the Schedules section of Table 3.1. Additionally, clarity is provided for modeling systems that provide occupant thermal comfort via means other than other than directly controlling the air dry-bulb and wet-bulb temperature (i.e. radiant cooling/heating, elevated air speed, etc.). It permits the use of ASHRAE Standard 55 for calculation of PMV-PPD. This addendum also updates the Normative References by including a reference to ASHRAE Standard 55-2010.	7/26/2013	7/30/2013	7/29/2013	7/31/2013
s	6. Heating, Ventilating, and Air-Conditioning.	This addendum modifies the requirement for the static pressure sensor location and the control requirements for set point reset for systems with direct digital control (DDC) of individual zones. Ensures that savings from previously required static pressure reset will be realized.	1/21/2012	1/23/2012	1/18/2012	1/26/2012
u	6. Heating, Ventilating, and Air-Conditioning.	This addendum adds new definition as Fan Efficiency Grade (FEG) and requires each fan has a FEG of 67 or higher as defined by Air Movement and Control Association (AMCA) 205-10 (Energy Efficiency Classification for Fans)	01/26/13	1/29/2013	2/11/2013	2/12/2013
v	8.Power	This addendum clarifies the requirement for controlled receptacles in open offices. It also requires the automatically controlled receptacles to be appropriately identified for the users benefit.	01/26/13	1/29/2013	2/11/2013	2/28/2013
w	3.Definitions, 11.Energy Cost Budget Method and Appendix G.	This addendum adds definitions for on-site renewable energy and purchased energy. It clarifies the process for accounting for on-site renewable energy and purchased energy as well as calculating the annual energy costs in the energy cost budget (ECB) approach and Appendix G.	6/26/2013	6/26/2013	6/28/2013	7/24/2013
y	3.Definitions and 10.Other Equipment	This addendum revises the definitions of general purpose electric motors (subtype I &II) based on information from NEMA. It also updates the standard to include the new federal energy efficiency standards used in HVAC equipment, to be in effect from 2015. It adds Table 10.8D, which specifies minimum average full-load efficiency for Polyphase Small Electric Motors; and Table 10.8E, which specifies minimum average full-load efficiency for Capacitor-Start Capacitor-Run and Capacitor-Start Induction-Run Small Electric Motors.	1/21/2012	1/23/2012	1/18/2012	1/26/2012

**Table 2.1 (continued)**

Addendum	Section(s) Affected	Description of Changes	ASHRAE Standards Committee Approval	ASHRAE BOD Approval	IES BOD Approval	ANSI Approval
z	6. Heating, Ventilating, and Air-Conditioning.	This addendum relocates the requirements for water economizers into the main economizer section, Section 6.5.1.5.	1/21/2012	1/23/2012	1/18/2012	1/26/2012
aa	6. Heating, Ventilating, and Air-Conditioning.	Prior to this addendum certain controls requirements were only required when the controls were provided by a DDC system. This addendum eliminates that contingency for set point overlap restrictions, humidification and dehumidification controls, variable air volume (VAV) fan control set point reset, multiple-zone VAV system ventilation optimization control, hydronic system design and control, and instead specifies how the system must perform. This will in effect require DDC for systems where these controls are needed.	7/26/2013	7/30/2013	7/29/2013	7/31/2013
ad	12.Normative References	Adds reference to specific addenda to Air Conditioning, Heating, and Refrigeration Institute (AHRI) standards 340/360 and 1230 being referenced	6/27/2012	6/27/2012	6/18/2012	6/28/2012
ae	12.Normative References	Adds reference to specific addenda to AHRI standards 210/240 and 550/590 being referenced	7/26/2013	7/30/2013	7/29/2013	8/28/2013
af	6. Heating, Ventilating, and Air-Conditioning	Modifies heat rejection equipment (cooling tower) requirements to require variable speed drives (VSDs) on fans, operate all fans at the same speed instead of sequencing them, and require that systems with multiple condenser water pumps operate those pumps in parallel at reduced flow.	6/26/2013	6/26/2013	6/28/2013	7/1/2013
ag	Appendix G	Establishes a method for gaining credit in Appendix G for buildings that undergo whole building air leakage testing to demonstrate that they have an air-tight building.	7/26/2013	7/30/2013	7/29/2013	8/28/2013
ah	Appendix G	Sets system sizing requirements in appendix G for humid climates based on humidity ratio instead of Supply Air Temperature Differential. Sets baseline system dehumidification requirements.	6/27/2012	6/27/2012	6/18/2012	6/28/2012
ai	Appendix G	Modifies Appendix G to account for 3 prescriptive addenda that were incorporated in to standard 90.1-2010, but did not make it into Appendix G in time for publication. Updates economizer requirements to match addendum cy, establishes baseline transformer efficiency requirements to match addendum o, and establishes path A for centrifugal chiller baselines from addendum m.	6/27/2012	6/27/2012	6/18/2012	6/28/2012
aj	6. Heating, Ventilating, and Air-Conditioning	Requires fractional horsepower motors $\geq$ 1/22 hp to EC motors or minimum 70% efficient in accordance with 10 CFR 431. Also requires adjustable speed or other method to balance airflow.	6/26/2013	6/26/2013	6/28/2013	7/1/2013
al	Appendix G	Establishes a consistent fuel source for space heating for baseline systems based on climate zone. Establishes a consistent fuel source for service water heating based on building type.	6/26/2013	6/26/2013	6/28/2013	7/24/2013

**Table 2.1 (continued)**

Addendum	Section(s) Affected	Description of Changes	ASHRAE Standards Committee Approval	ASHRAE BOD Approval	IES BOD Approval	ANSI Approval
am	6. Heating, Ventilating, and Air-Conditioning	Establishes minimum turndown for boilers and boiler plants with of at least 1,000,000 Btu/h.	6/26/2013	6/26/2013	6/28/2013	7/1/2013
an	Appendix C	Rewrites entire Appendix C to use a simulation based approach for envelope trade-offs.	7/26/2013	7/30/2013	7/29/2013	8/28/2013
ap	6. Heating, Ventilating, and Air-Conditioning	Adds Power Utilization Effectiveness (PUE) as an alternative compliance methodology for data centers.	1/26/2013	1/29/2013	2/11/2013	5/3/2013
aq	6. Heating, Ventilating, and Air-Conditioning and 11. Energy Cost Budget	This addendum makes changes to the requirements for fan control for both constant volume and VAV units including extending the fan part load power requirements down to ¼ hp. In addition it defines the requirements for integrated economizer control and defines direct expansion (DX) unit capacity staging requirements	6/26/2013	6/26/2013	6/28/2013	7/1/2013
ar	6. Heating, Ventilating, and Air-Conditioning	Adds mandatory and prescriptive requirements for walk-in coolers and freezers and refrigerated display cases.	6/26/2013	6/26/2013	6/28/2013	7/1/2013
as	6. Heating, Ventilating, and Air-Conditioning	Avoidance of simultaneous heating and cooling at air handling unit (AHU). Requires humidifiers mounted in the airstream to have an automatic control valve shutting off preheat when humidification is not required, and insulation on the humidification system dispersion tube surface.	6/27/2012	6/27/2012	6/18/2012	6/28/2012
at	3. Definitions, 5. Building Envelope, and 9. Lighting	Deletes the term clerestory and instead adds roof monitor and clarifies the definition. Changes the references in Chapters 5 and 9 from clerestory to roof monitor.	6/27/2012	6/27/2012	6/18/2012	6/28/2012
au	6. Heating, Ventilating, and Air-Conditioning	This addendum modifies Table 6.5.3.1.1B which addresses fan power limitation pressure drop adjustment credits. Deductions are added for systems without any central heating or cooling as well as systems with electric resistance heating. Sound attenuation credit is modified to be available only when there are background noise criteria requirements.	01/26/13	1/29/2013	2/11/2013	2/12/2013
av	6. Heating, Ventilating, and Air-Conditioning	This addendum modifies Section 6.5.1, exception k, applicable to Tier IV data centers, in an attempt to make economizer exceptions more strict and in agreement with ASHRAE TC 9.9	6/26/2013	6/26/2013	6/28/2013	7/24/2013

**Table 2.1 (continued)**

Addendum	Section(s) Affected	Description of Changes	ASHRAE Standards Committee Approval	ASHRAE BOD Approval	IES BOD Approval	ANSI Approval
aw	11. Energy Cost Budget and Appendix G	This addendum updates the reference year for ASHRAE Standard 140 and exempts software used for ECB and Appendix G compliance from having to meet certain sections of ASHRAE Standard 140	01/26/13	1/29/2013	2/11/2013	2/12/2013
ax	Appendix G	Table G3.1, Part 14 of Appendix G is modified to exclude the condition that permits a building surface, shaded by an adjacent structure, to be simulated as north facing if the simulation program is incapable of simulating shading by adjacent structures.	6/26/2013	6/26/2013	6/28/2013	7/1/2013
ay	3. Definitions, 9. Lighting	This addendum modifies daylighting requirements. It modifies definitions for daylight area under skylights, daylight area under roof monitors, primary sidelight area, and secondary sidelight area. It modifies the thresholds for applying automatic daylighting control for sidelighting and toplighting, to a wattage basis and provides characteristics for the required photo controls. It modifies Table 9.6.2 to include continuous dimming in secondary sidelighted areas, which is now based on a W level rather than area of the space. It eliminates the need for effective aperture calculation.	6/26/2013	6/26/2013	6/28/2013	7/1/2013
az	6. Heating, Ventilating, and Air-Conditioning	This addendum increases the minimum efficiency of open circuit axial fan cooling towers. An additional requirement has been added which states that the minimum efficiency requirements for all types of cooling towers also applies to accessories that affect the thermal performance of the unit. An additional footnote clarifies that the certification requirements do not apply to field erected cooling towers.	01/26/13	1/29/2013	2/11/2013	2/12/2013
ba	6. Heating, Ventilating, and Air-Conditioning	Adds requirements for door switches to disable or reset mechanical heating or cooling when doors are left open.	7/26/2013	7/30/2013	7/29/2013	8/28/2013
bc	9. Lighting	Modifies requirements for automatic lighting control for guestroom type spaces. Exceptions to this requirement are lighting and switched receptacles controlled by captive key systems.	6/26/2013	6/26/2013	6/28/2013	7/24/2013
bd	9. Lighting	This addenda adds more specific requirements for the functional testing of lighting controls, specifically, occupancy sensors, automatic time switches and daylight controls.	6/26/2013	6/26/2013	6/28/2013	7/1/2013
be	9. Lighting	Minor revisions to Section 9.7.2.2, which addresses the scope of the operating and maintenance manuals required for lighting equipment and controls.	01/26/13	1/29/2013	2/11/2013	2/12/2013
bf	8. Power	This addendum addresses Section 8.4.2 on automatic receptacle control and increases the spaces where plug shutoff control is required. It also clarifies the application of this requirement for furniture systems, states a labeling requirement to distinguish controlled and uncontrolled receptacles and restricts the use of plug-in devices to comply with this requirement.	7/26/2013	7/30/2013	7/29/2013	8/28/2013

**Table 2.1 (continued)**

Addendum	Section(s) Affected	Description of Changes	ASHRAE Standards Committee Approval	ASHRAE BOD Approval	IES BOD Approval	ANSI Approval
bg	5. Building Envelope	Requirements for low-E storm window retrofits.	6/26/2013	6/26/2013	6/28/2013	7/1/2013
bh	9. Lighting	Modifies Table 9.6.1 Space-By-Space Lighting Power Density allowance	7/26/2013	7/30/2013	8/12/2013	9/4/13
bi	6. Heating, Ventilating, and Air-Conditioning	Increase seasonal energy efficiency ratio (SEER) and heating season performance factor (HSPF) for air-cooled commercial air conditioners and heat pumps below 65,000 Btu/h. Effective 1/1/2015	6/26/2013	6/26/2013	6/28/2013	7/1/2013
bj	6. Heating, Ventilating, and Air-Conditioning.	Re-establishes the product class for Small Duct High Velocity (SDHV) air conditioners and heat pumps. Adds efficiency requirements for systems at <65,000 Btu/h.	6/26/2013	6/26/2013	6/28/2013	7/1/2013
bk	6. Heating, Ventilating, and Air-Conditioning	Increases cooling efficiency for packaged terminal air conditioners (PTACs)	01/26/13	1/29/2013	2/11/2013	2/12/2013
bl	11. Energy Cost Budget and Appendix G	Provide rules for removing fan energy from efficiency metrics when modeling in ECB or Appendix G.	7/26/2013	7/30/2013	7/29/2013	7/31/2013
bn	8. Power and 10. Other Equipment	Establishes electric and fuel metering requirements	7/26/2013	7/30/2013	7/29/13	9/4/13
bo	7. Service Water Heating	Requires buildings with service water heating (SWH) capacity $\geq$ 1 million Btu/h to have average efficiency of at least 90%. Updates Table 7.8 to reflect federal requirements for electric water heaters. Updates the reference standard for swimming pool water heaters to ASHRAE Standard 146.	7/26/2013	7/30/2013	7/29/13	9/4/13
bp	6. Heating, Ventilating, and Air-Conditioning	Adds efficiency requirements (Btu/h-hp) to Table 6.8.1G for evaporative condensers with ammonia refrigerants	7/26/2013	7/30/2013	7/29/2013	7/31/2013
bq	6. Heating, Ventilating, and Air-Conditioning	Improve efficiency of commercial refrigeration systems	01/26/13	1/29/2013	2/11/2013	2/12/2013
br	10. Other Equipment	Updates motor efficiency tables	6/26/2013	6/26/2013	6/28/2013	7/1/2013

**Table 2.1 (continued)**

Addendum	Section(s) Affected	Description of Changes	ASHRAE Standards Committee Approval	ASHRAE BOD Approval	IES BOD Approval	ANSI Approval
bs	6. Heating, Ventilating, and Air-Conditioning	Reduce occupancy threshold for demand controlled ventilation from greater than 40 people per 1000 ft <sup>2</sup> to equal to or greater than 25 people per 1000 ft <sup>2</sup> with exemptions for certain occupancies.	7/26/2013	7/30/2013	7/29/2013	7/31/2013
bt	6. Heating, Ventilating, and Air-Conditioning	Reduces the threshold at which energy recovery is required. Relaxed in some climate zones.	6/26/2013	6/26/2013	6/28/2013	7/24/2013
bv	9. Lighting	Reduces the threshold at which skylights and daylighting controls are required for high bay spaces.	6/26/2013	6/26/2013	6/28/2013	7/1/2013
bw	5. Building Envelope	Modifies orientation requirements and adds solar heat gain coefficient (SHGC) tradeoff	7/26/2013	7/30/2013	7/29/2013	8/28/2013
bx	9. Lighting	Clarification of exceptions to occupancy sensor requirements	01/26/13	1/29/2013	2/11/2013	2/12/2013
by	9. Lighting	Improves and enhances lighting controls requirements. Establishes table of lighting controls applicable to each space type. Corrects daylighting threshold.	7/26/2013	7/30/2013	7/29/2013	8/28/2013
ca	5. Building Envelope	Adds control requirements for heating systems in vestibules	6/26/2013	6/26/2013	6/28/2013	7/1/2013
cb	6. Heating, Ventilating, and Air-Conditioning	This addendum requires night setback 10°F heating and 5°F cooling and removes exception for systems less than 10,000 cfm min for optimum start	7/26/2013	7/30/2013	7/29/2013	8/28/2013
cc	6. Heating, Ventilating, and Air-Conditioning	Adds efficiency requirements (Btu/h-hp) to Table 6.8.1G for evaporative condensers with R-507A	6/26/2013	6/26/2013	6/28/2013	7/1/2013
cd	6. Heating, Ventilating, and Air-Conditioning	Provides definition for piping to include all accessories in series with pipe such as pumps, valves, strainers, air separators, etc. This is meant to clarify that these accessories need to be insulated.	7/26/2013	7/30/2013	7/29/2013	8/28/2013
ce	Appendix G	Establishes a baseline system type for retail occupancies less than 3 stories in Appendix G	6/26/2013	6/26/2013	6/28/2013	7/1/2013
cf	Appendix G	Establishes baseline window-to-wall ratio (WWR) in Appendix G for strip malls.	7/26/2013	7/30/2013	7/29/2013	8/28/2013
ch	6. Heating, Ventilating, and Air-Conditioning	Improved air and water cooled chiller efficiencies in Table 6.8.1C. Exempts water cooled positive displacement chillers with leaving condenser temperature ≥ 115°F (typically heat reclaim chillers).	6/26/2013	6/26/2013	6/28/2013	7/1/2013

**Table 2.1 (continued)**

Addendum	Section(s) Affected	Description of Changes	ASHRAE Standards Committee Approval	ASHRAE BOD Approval	IES BOD Approval	ANSI Approval
ck	6. Heating, Ventilating, and Air-Conditioning	Requires VAV dual maximum damper position when DDC system is present	6/26/2013	6/26/2013	6/28/2013	7/1/2013
cl	6. Heating, Ventilating, and Air-Conditioning	Table 6.8.1A and B. Improves integrated energy efficiency ratio (IEER) requirements for air-cooled air conditioners and heat pumps and EER requirements for water and evaporatively cooled air conditioners and heat pumps.	7/26/2013	7/30/2013	7/29/2013	7/31/2013
cn	Appendix G	Establishes modeling rules for laboratories with 100% outdoor air (OA) in Appendix G	6/26/2013	6/26/2013	6/28/2013	7/1/2013
co	9.Lighting	Comprehensive update of lighting power densities (LPDs) in Table 9.5.1 - Building Area Method	7/26/2013	7/30/2013	7/29/2013	7/31/2013
cp	5.Building Envelope	Corrects non-residential U-factor and R-value requirements for steel joist floors in CZ3	6/26/2013	6/26/2013	6/28/2013	7/1/2013
cr	9.Lighting	Makes a number of adjustments to Table 9.6.1 Space-by-space LPD	7/26/2013	7/30/2013	7/29/2013	7/31/2013
ct	Appendix G	Identifies heated only storage systems 9 and 10 in Appendix G as being assigned one system per thermal zone.	7/26/2013	7/30/2013	7/29/2013	7/31/2013
cv	Appendix G	Establishes baseline system types in Appendix G for Assembly occupancies.	7/26/2013	7/30/2013	7/29/2013	7/31/2013
cy	6. Heating, Ventilating, and Air-Conditioning	More stringent energy recovery for 24/7 occupancies	7/26/2013	7/30/2013	7/29/2013	7/31/2013
cz	6. Heating, Ventilating, and Air-Conditioning	Increases boiler efficiency for residential sized (National Appliance Energy Conservation Act (NAECA) covered) equipment, <3,000 Btu/h	7/26/2013	7/30/2013	7/29/2013	7/31/2013
da	5.Building Envelope	Relaxes air leakage requirements for high-speed doors for vehicle access and material transport	7/26/2013	7/30/2013	7/29/2013	8/28/2013
db	5.Building Envelope	Corrects residential U-factor and R-value requirements for steel joist floors in CZ3	7/26/2013	7/30/2013	7/29/2013	7/31/2013
dc	9. Lighting	Clarifies automatic lighting and switched receptacle control in guest rooms as applied to individual spaces.	7/26/2013	7/30/2013	7/29/2013	7/31/2013
dd	5.Building Envelope	Clarifies roof insulation requirements, differentiating between roof recovering (on top of existing roof covering) and replacement of roof covering.	7/26/2013	7/30/2013	7/29/2013	7/31/2013

**Table 2.1 (continued)**

Addendum	Section(s) Affected	Description of Changes	ASHRAE Standards Committee Approval	ASHRAE BOD Approval	IES BOD Approval	ANSI Approval
de	6. Heating, Ventilating, and Air-Conditioning	Relaxes design requirements for waterside economizers for computer rooms	7/26/2013	7/30/2013	7/29/2013	7/31/2013
dg	5.Building Envelope	Updates reference to ANSI/CRRC-1 Standard 2012 (cool roof ratings)	7/26/2013	7/30/2013	7/29/2013	7/31/2013
di	6. Heating, Ventilating, and Air-Conditioning	Establishes limits on using electric or fossil fuel to humidify or dehumidify between 30% and 60% relative humidity (RH) except certain applications. Requires deadband on humidity controls.	7/26/2013	7/30/2013	7/29/2013	7/31/2013
dj	9.Lighting	Additional lighting power allowance for electrical/mechanical rooms provided there is separate control for additional lighting.	7/26/2013	7/30/2013	7/29/2013	7/31/2013
dk	9.Lighting	Eliminates the exemption for wattage used in spaces where lighting is specifically designed for those with age-related eye conditions or other medical conditions related to the eye, where special lighting or light levels might be needed.	7/26/2013	7/30/2013	7/29/2013	8/28/2013
dl	9.Lighting	Modifies hotel and motel guest room lighting power density.	7/26/2013	7/30/2013	7/29/2013	8/28/2013
dn	6. Heating, Ventilating, and Air-Conditioning	Reduces the limits on hot gas bypass as a means of cooling capacity control.	7/26/2013	7/30/2013	7/29/2013	7/31/2013
do	6. Heating, Ventilating, and Air-Conditioning	Update references to AHRI 550, AMCA 500, ANSI Z21.10.3 & Z21.47, ASHRAE 90.1 & 62.1, NEMA MG 1, & National Fire Protection Association (NFPA) 70 &96	7/26/2013	7/30/2013	7/29/2013	7/31/2013
dp	6. Heating, Ventilating and Air Conditioning	Corrects the definition of walk-in-cooler to be consistent with federal requirements.	7/26/2013	7/30/2013	7/29/2013	7/31/2013
dq	6. Heating, Ventilating, and Air-Conditioning	Deletes sizing requirements for pipes >24"	7/26/2013	7/30/2013	7/29/2013	7/31/2013
dr	5.Building Envelope	Clarifies definition of building entrances to exclude electrical room, mechanical rooms, and other utility service entrances.	7/26/2013	7/30/2013	7/29/2013	7/31/2013
dt	9.Lighting	Added exceptions for control of exterior lighting integral to signage. Requires certain types of exterior lighting exempt from LPD requirements to be separately controlled.	7/26/2013	7/30/2013	7/29/2013	7/31/2013



**Table 2.1 (continued)**

Addendum	Section(s) Affected	Description of Changes	ASHRAE Standards Committee Approval	ASHRAE BOD Approval	IES BOD Approval	ANSI Approval
dv	6. Heating, Ventilating, and Air- Conditioning	Establishes chiller and boiler fluid flow isolation requirements so there is no flow through the equipment when not in use.	7/26/2013	7/30/2013	7/29/2013	7/31/2013
dw	6. Heating, Ventilating, and Air- Conditioning	Revises high limit shutoff for air economizers. Add sensor accuracy requirements.	7/26/2013	7/30/2013	7/29/2013	7/31/2013



### 3.0 Impacts of Addenda in Standard 90.1-2013

Each addendum in Table 2.1 was examined to subjectively evaluate its impact on overall building energy efficiency. Many of the addenda are editorial, clarification of the text, or related to alternative compliance paths of Standard 90.1, and have been determined to have no direct impact on energy efficiency. Other addenda have been determined to have significant positive or negative impacts on energy efficiency. The most common type of positive impact on energy efficiency occurs when a requirement is changed to a higher level of performance. The reverse change, from a higher level of performance to a lower level, is less common. However, there are addenda where exceptions are introduced for various requirements, and the addition of an exception or expansion of an exception could be considered a negative impact on energy efficiency.

Table 3.1 assesses the energy efficiency impact of each addendum. Addenda are ranked in terms of impact on building energy efficiency as follows: “major +” (significant positive impact), “minor +” (minor positive impact), “neutral” (no impact), “major –” (significant negative impact), or “minor –” (minor negative impact). A rationale for the ranking is provided for each addendum as well. Each rating considers the addendum’s impact on all compliance paths where the addendum has an effect. The addenda are listed in alphabetical order in Table 3.1.

There are five addenda in Table 3.1 that are listed as “neutral – adopts Federal standards” or “neutral – implements Federal standards”. These addenda are Addenda 90.1-2010g, 90.1-2010y, 90.1-2010ar, 90.1-2010br, and 90.1-2010cz. Both Standard 90.1-2010 and Standard 90.1-2013 contain specific tables of HVAC, motors, transformers, and service water heating equipment efficiency requirements. Standard 90.1-2013 added efficiency tables for commercial refrigerators and freezers and prescriptive requirements for walk-in coolers and freezers. Most, but not all, of these equipment classes have minimum federal efficiency standards applied to them.

The overlap between federal efficiency standards and the requirements shown in ASHRAE Standard 90.1 as a model standard result in specific complications for an analysis used to inform a DOE determination of energy savings. In some instances, a revised edition of Standard 90.1 will adopt an existing federal efficiency standard into its tabulated efficiency requirement, typically with the same effective date as provided by the federal standard. Because that mandated equipment efficiency will be enforced as a manufacturing standard regardless of whether it is represented in Standard 90.1, the inclusion of the requirement in the ASHRAE standard is assumed to have no real energy impact. To address this issue, such addenda are listed as neutral in PNNL’s qualitative analysis.

**Table 3.1. Impact Assessment of Addenda for ASHRAE Standard 90.1-2013**

Number	Addendum Letter	Full Name of Addendum	Section Affected in 90.1-2010	Description of Changes	Impact on Energy Efficiency (justification)
1	a	90.1-2010a	10. Other Equipment and 12. Normative References	Specifies that nominal efficiencies for motors are required to be established in accordance with 10 CFR 431 instead of NEMA Standards. Modifies the footnotes to Tables 10.8A, 10.8B, 10.8 C (now Tables 10.8-1, 10.8-2, and 10.8-3 in Standard 90.1-2013). The corresponding reference for 10 CFR 431 has also been added.	Neutral (simply specifies alternate rating standard)
2	b	90.1-2010b	10. Other Equipment and 12. Normative References	Requires escalators and moving walks to automatically slow when not conveying passengers. The corresponding reference to ASME A17.1/CSA B44 has also been added to the Normative References.	Minor + (reduces escalator and moving walkway energy usage)
3	c	90.1-2010c	Appendix G	Adds requirements for laboratory exhaust fans to section G3.1.1, Baseline HVAC System Type and Definition. Lab exhaust fans are required to be modeled as constant horsepower, reflecting constant volume stack discharge with outside air bypass.	Neutral (whole building performance tradeoff method only)
4	e	90.1-2010e	Appendix G	Updates language in Section G3.1, part 5 'Building Envelope', to require that existing buildings use the same envelope baseline as new buildings with the exception of fenestration area.	Neutral (whole building performance tradeoff method only)
5	f	90.1-2010f	Appendix G	Modifies Section G.3.1, Building Envelope. Specifies the vertical fenestration area for calculating baseline building performance for new buildings and additions.	Neutral (whole building performance tradeoff method only)
6	g	90.1-2010g	6. Heating, Ventilating, and Air-Conditioning and 12. Normative References	Adds efficiency requirements for commercial refrigerators, freezers and refrigeration equipment. Table 6.8.1L and Table 6.8.1M (now Tables 6.8.1-12 and 6.8.1-13 in Standard 90.1-2013) have been added which specify the energy use limits for refrigerators and freezers. The corresponding references have also been added in Chapter 12.	Neutral (adopts Federal standards)
7	h	90.1-2010h	6. Heating, Ventilating, and Air-Conditioning.	Modifies the minimum efficiency standards for water-to-air heat pumps (water loop, ground water and ground loop). The proposed cooling EERs and heating COPs are more stringent than the present values. Also removes the small duct high velocity heat pump product class from Table 6.8.1B (now Table 6.8.1-2 in Standard 90.1-2013).	Minor + (increases stringency of existing requirements)

**Table 3.1 (continued)**

Number	Addendum Letter	Full Name of Addendum	Section Affected in 90.1-2010	Description of Changes	Impact on Energy Efficiency (justification)
8	i	90.1-2010i	6. Heating, Ventilating, and Air-Conditioning and 3. Definitions	Increases the minimum efficiency standards for SPVAC and SPVHP. Also creates a new product class for SPVAC and SPVHP used in space constrained applications. This new product class only applies to non-weatherized products with cooling capacities <36,000 Btu/h and intended to replace an existing AC.	Minor + (increases stringency of existing requirements)
9	j	90.1-2010j	6. Heating, Ventilating, and Air-Conditioning.	Modifies the minimum efficiency requirements for evaporatively cooled air conditioners greater than or equal to 240,000 Btu/h and less than 760,000 Btu/h and heating type-other, in Table 6.8.1A (now Table 6.8.1-1 in Standard 90.1-2013). The value is reduced to account for increased pressure drop in such system types. The product class, small duct high velocity air conditioner, has been eliminated.	Minor - (but this is due to correction of an error)
10	k	90.1-2010k	8. Power and 12. Normative References	Modifies notes to Table 8.1 and specifies that nominal efficiencies would be established in accordance with the 10 CFR 431 test procedure for low-voltage dry-type transformers. The corresponding references have also been added in Chapter 12.	Neutral (simply specifies alternative rating standard)
11	l	90.1-2010l	6. Heating, Ventilating, and Air-Conditioning.	Fixes the mistake with 90.1-2010 fan power limitations that required the user to perform calculations for fan bhp even if the simplified nameplate hp option was being used.	Neutral (editorial correction)
12	m	90.1-2010m	9. Lighting	Adds some control requirements for lighting alterations, for interior and exterior applications. Adds a section for submittals and includes loading docks as a tradable surface. Modifies the provisions for additional interior lighting power, which would now be calculated on the basis of controlled wattage.	Major + (adds control requirements for lighting alterations)
13	n	90.1-2010n	10. Other Equipment	Clarifies that the total lumens/watt for the entire elevator cab is required to meet the efficiency requirement and that each individual light source is not required to meet the lumens/watt value.	Neutral (clarification only)
14	o	90.1-2010o	5. Building Envelope and 3. Definitions	Adds the definition for sectional garage doors. Also modifies Section 5.4.3.2 (d), fenestration air leakage provisions for doors, to include requirements for glazed sectional garage doors.	Minor + (reduces air leakage in glazed sectional garage doors)

**Table 3.1** (continued)

Number	Addendum Letter	Full Name of Addendum	Section Affected in 90.1-2010	Description of Changes	Impact on Energy Efficiency (justification)
15	p	90.1-2010p	5. Building Envelope and 12. Normative References	Modifies Section 5.5.3.1 and requires roof solar reflectance and thermal emittance testing to be in accordance with CRRC-1 Standard. Also modifies Section 12 by adding the reference for CRRC.	Neutral (simply specifies an alternative rating standard)
16	q	90.1-2010q	5. Building Envelope, 3. Definitions and 12. Normative References	Modifies Section 3 by changing the definition of dynamic glazing to include glazing systems or infill as well as shading systems between glazing layers and chromogenic glazing. Also modifies Section 5.8.2.2, by clarifying the requirements for labeling of fenestration and door products. The corresponding references to NFRC in Chapter 12 have also been updated.	Neutral (clarification only)
17	r	90.1-2010r	Appendix G and 12. Normative References	Clarifies the requirements related to temperature and humidity control in Appendix G and relocates all related wording to the Schedules section of Table 3.1. Additionally, clarity is provided for modeling systems that provide occupant thermal comfort via means other than other than directly controlling the air dry-bulb and wet-bulb temperature (i.e. radiant cooling/heating, elevated air speed, etc.). Permits the use of ASHRAE Standard 55 for calculation of PMV-PPD. Also updates the Normative References by including a reference to ASHRAE Standard 55-2010.	Neutral (whole building performance tradeoff method only)
18	s	90.1-2010s	6. Heating, Ventilating, and Air-Conditioning.	Modifies the requirement for the static pressure sensor location and the control requirements for setpoint reset for systems with DDC of individual zones. Ensures that savings from previously required static pressure reset will be realized.	Minor + (ensures savings from static pressure reset achieved)
19	u	90.1-2010u	6. Heating, Ventilating, and Air-Conditioning and 3. Definitions and 12. Normative References	Adds new definition as Fan Efficiency Grade (FEG) and requires each fan has a FEG of 67 or higher as defined by AMCA205-10 (Energy Efficiency Classification for Fans)	Major + (applies new requirements to individual fans)
20	v	90.1-2010v	8. Power	Clarifies the requirement for controlled receptacles in open offices applications by changing the requirement to the workstations themselves. Also requires the automatically controlled receptacles to be appropriately identified for the users benefit.	Neutral (clarification only)

**Table 3.1** (continued)

Number	Addendum Letter	Full Name of Addendum	Section Affected in 90.1-2010	Description of Changes	Impact on Energy Efficiency (justification)
21	w	90.1-2010w	3. Definitions, 11. Energy Cost Budget Method and Appendix G.	Adds definitions for on-site renewable energy and purchased energy. Clarifies the process for accounting for on-site renewable energy and purchased energy as well as calculating the annual energy costs in the ECB approach and Appendix G.	Neutral (whole building performance tradeoff method only)
22	y	90.1-2010y	3. Definitions and 10. Other Equipment	Revises the definitions of general purpose electric motors (subtype I &II) based on information from NEMA. Also updates the standard to include the new federal energy efficiency standards used in HVAC equipment, to be in effect from 2015. Adds Table 10.8D (now Table 10.8-4 in Standard 90.1-2013) which specifies minimum average full-load efficiency for Polyphase Small Electric Motors; and Table 10.8E (now Table 10.8-5 in Standard 90.1-2013) which specifies minimum average full-load efficiency for Capacitor-Start Capacitor-Run and Capacitor-Start Induction-Run Small Electric Motors.	Neutral (adopts Federal standards)
23	z	90.1-2010z	6. Heating, Ventilating, and Air-Conditioning.	Relocates the requirements for water economizers into the main economizer section, Section 6.5.1.5.	Neutral (editorial only)
24	aa	90.1-2010aa	6. Heating, Ventilating, and Air-Conditioning and 3. Definitions	Eliminates the contingency on DDC system existence for setpoint overlap restrictions, humidification and dehumidification controls, VAV fan control setpoint reset, multiple-zone VAV system ventilation optimization control, hydronic system differential pressure reset by valve position. Instead specifies for what system types or sizes DDC is required in new buildings and alterations. Also specifies minimal functional requirements for DDC systems. (Prior to this addendum certain controls requirements were only required when the controls were provided by a DDC system.)	Minor + (requires additional HVAC controls)
25	ad	90.1-2010ad	12. Normative References (related to 6. Heating, Ventilating, and Air-Conditioning)	Adds reference to specific addenda to AHRI standards 340/360 and 1230 being referenced.	Neutral (updates references only)
26	ae	90.1-2010ae	12. Normative References (related to 6. Heating, Ventilating, and Air-Conditioning)	Adds reference to specific addenda to AHRI standards 210/240 and 550/590 being referenced.	Neutral (updates references only)

**Table 3.1** (continued)

Number	Addendum Letter	Full Name of Addendum	Section Affected in 90.1-2010	Description of Changes	Impact on Energy Efficiency (justification)
27	af	90.1-2010af	6. Heating, Ventilating, and Air-Conditioning	Modifies heat rejection equipment (cooling tower) requirements to require that VSD controlled fans operate all fans at the same speed instead of sequencing them, and require that open-circuit towers with multiple cells operate all cells in parallel down to 50% of design flow.	Minor + (reduces cooling tower energy usage)
28	ag	90.1-2010ag	Appendix G and 12. Normative References	Establishes a method for gaining credit in Appendix G for buildings that undergo whole building air leakage testing to demonstrate that they have an air-tight building.	Neutral (whole building performance tradeoff method only)
29	ah	90.1-2010ah	Appendix G	Sets system sizing requirements in Appendix G for humid climates based on humidity ratio instead of supply air temperature differential. Sets baseline system dehumidification requirements.	Neutral (whole building performance tradeoff method only)
30	ai	90.1-2010ai	Appendix G	Modifies Appendix G to account for 3 prescriptive addenda that were incorporated in to standard 90.1-2010, but did not make it into Appendix G in time for publication. Updates economizer requirements to match addendum cy, establishes baseline transformer efficiency requirements to match addendum o, and establishes path A for centrifugal chiller baselines from addendum m.	Neutral (whole building performance tradeoff method only)
31	aj	90.1-2010aj	6. Heating, Ventilating, and Air-Conditioning	Requires fractional horsepower motors $\geq 1/12$ hp to be electronically-commutated motors or have a minimum 70% efficiency in accordance with 10 CFR 431. Also requires adjustable speed or other method to balance airflow.	Minor + (reduces fractional horsepower motor energy usage)
32	al	90.1-2010al	Appendix G	Establishes a consistent fuel source for space heating for baseline systems based on climate zone. Establishes a consistent fuel source for service water heating based on building type.	Neutral (whole building performance tradeoff method only)
33	am	90.1-2010am	6. Heating, Ventilating, and Air-Conditioning	Establishes minimum turndown for boilers and boiler plants with design input power of at least 1,000,000 Btu/h.	Major + (reduces energy usage for large boilers)



**Table 3.1** (continued)

Number	Addendum Letter	Full Name of Addendum	Section Affected in 90.1-2010	Description of Changes	Impact on Energy Efficiency (justification)
34	an	90.1-2010an	Appendix C	Rewrites entire Appendix C to use a simulation based approach for envelope tradeoffs.	Neutral (alternative compliance method only)
5	ap	90.1-2010ap	6. Heating, Ventilating, and Air-Conditioning and 3. Definitions.	Adds PUE as an alternative compliance methodology for data centers.	Neutral (alternative compliance method only)
36	aq	90.1-2010aq	6. Heating, Ventilating, and Air-Conditioning and 11. Energy Cost Budget	Expands the requirements for fan speed control for both chilled water and unitary direct expansion systems. In addition enhances the requirements for integrated economizer control and defines DX unit capacity staging requirements.	Major + (reduces fan energy usage)
37	ar	90.1-2010ar	6. Heating, Ventilating, and Air-Conditioning and 3. Definitions	Adds mandatory and prescriptive requirements for walk-in coolers and freezers and refrigerated display cases	Neutral (adopts Federal standards)
38	as	90.1-2010as	6. Heating, Ventilating, and Air-Conditioning	Requires humidifiers mounted in the airstream to have an automatic control valve shutting off preheat when humidification is not required, and insulation on the humidification system dispersion tube surface. (Avoidance of simultaneous heating and cooling at AHU.)	Minor + (reduces humidification energy usage)
39	at	90.1-2010at	3. Definitions, 5. Building Envelope, and 9. Lighting	Deletes the term clerestory and instead adds roof monitor and clarifies the definition. Changes the references in Chapters 5 and 9 from clerestory to roof monitor.	Neutral (clarification only)
40	au	90.1-2010au	6. Heating, Ventilating, and Air-Conditioning	Modifies Table 6.5.3.1.1B which addresses fan power limitation pressure drop adjustment credits. Deductions from allowed fan power are added for systems without any central heating or cooling as well as systems with electric resistance heating. Sound attenuation credit is modified to be available only when there are background noise criteria requirements.	Minor + (restricts sound attenuation credit and adds deductions for certain systems)
41	av	90.1-2010av	6. Heating, Ventilating, and Air-Conditioning	Modifies Section 6.5.1, exception k, applicable to Tier IV data centers, to make economizer exceptions more stringent and in agreement with ASHRAE TC 9.9.	Minor + (makes economizer exceptions more stringent)

**Table 3.1** (continued)

Number	Addendum Letter	Full Name of Addendum	Section Affected in 90.1-2010	Description of Changes	Impact on Energy Efficiency (justification)
42	aw	90.1-2010aw	11. Energy Cost Budget and Appendix G	Updates the reference year for ASHRAE Standard 140 and exempts software used for ECB and Appendix G compliance from having to meet certain sections of ASHRAE Standard 140.	Neutral (whole building performance tradeoff method only)
43	ax	90.1-2010ax	Appendix G	Modifies Table G3.1, Part 14 of Appendix G to exclude the condition that permits a building surface, shaded by an adjacent structure, to be simulated as north facing if the simulation program is incapable of simulating shading by adjacent structures.	Neutral (whole building performance tradeoff method only)
44	ay	90.1-2010ay	3. Definitions and 9. Lighting	Modifies daylighting requirements. Modifies definitions for daylight area under skylights, daylight area under roof monitors, primary sidelight area, and secondary sidelight area. Changes the criterion for applying automatic daylighting control for sidelighting and toplighting to a controlled lighting power basis and provides characteristics for the required photo controls. Adds control requirements for secondary sidelighted areas. Modifies Table 9.6.2 to include continuous dimming in secondary sidelighted areas, which is now based on an installed wattage rather than area of the space. Eliminates the need for effective aperture calculation.	Minor + (requires additional controls)
45	az	90.1-2010az	6. Heating, Ventilating, and Air-Conditioning	Increases the minimum efficiency of open circuit axial fan cooling towers. An additional requirement has been added for all types of cooling towers which states that the minimum efficiency requirements applies to the tower including the capacity effect of accessories which affect thermal performance. An additional footnote clarifies that the certification requirements do not apply to field erected cooling towers.	Minor + (increase efficiency of cooling towers)
46	ba	90.1-2010ba	6. Heating, Ventilating, and Air-Conditioning	Adds requirements for door switches to disable or reset mechanical heating or cooling when doors without automatic door closers are left open.	Minor + (reduces heating and cooling when doors are left open)

**Table 3.1 (continued)**

Number	Addendum Letter	Full Name of Addendum	Section Affected in 90.1-2010	Description of Changes	Impact on Energy Efficiency (justification)
47	bb	90.1-2010bb	3. Definitions, 5. Building Envelope, 11. Energy Cost Budget Method, and Appendix A	Modifies the building envelope requirements for opaque assemblies and fenestration in tables 5.5.1 through 5.5.8. Adds and modifies text in Section 5. Adds new visible transmittance (VT) requirement through Section 5.5.4.5. Also updates the NFRC 301 reference, references in Section 11 and modifies two metal building roof assemblies in Table A2.3.	Major + (increases stringency of building envelope requirements)
48	bc	90.1-2010bc	9. Lighting	Modifies requirements for automatic lighting control for guestroom type spaces. Exceptions to this requirement are lighting and switched receptacles controlled by captive key systems.	Minor + (requires automatic control of lighting and switched receptacles in hotel rooms)
49	bd	90.1-2010bd	9. Lighting	Adds more specific requirements for the functional testing of lighting controls, specifically, occupancy sensors, automatic time switches and daylight controls.	Minor + (improves functional testing of lighting controls)
50	be	90.1-2010be	9. Lighting	Makes minor revisions to Section 9.7.2.2, which addresses the scope of the operating and maintenance manuals required for lighting equipment and controls.	Neutral (clarification only)
51	bf	90.1-2010bf	8. Power	Addresses Section 8.4.2 on automatic receptacle control and increases the spaces where plug shutoff control is required. Clarifies the application of this requirement for furniture systems, lowers the threshold for turn off from 30 to 20 minutes, states a labeling requirement to distinguish controlled and uncontrolled receptacles and restricts the use of plug-in devices to comply with this requirement.	Minor + (reduces plug loads)
52	bg	90.1-2010bg	5. Building Envelope	Adds low-E requirements for storm window retrofits.	Minor + (requires low-E storm windows in retrofits)
53	bh	90.1-2010bh	9. Lighting	Modifies Table 9.6.1 Space-By-Space Lighting Power Density allowance.	Minor + (overall, LPDs go down)

**Table 3.1** (continued)

Number	Addendum Letter	Full Name of Addendum	Section Affected in 90.1-2010	Description of Changes	Impact on Energy Efficiency (justification)
54	bi	90.1-2010bi	6. Heating, Ventilating, and Air-Conditioning	Increase SEER and HSPF for air-cooled three-phase commercial air conditioners and heat pumps below 65,000 Btu/h. Effective 1/1/2015.	Minor + (increases stringency of existing requirements)
55	bj	90.1-2010bj	6. Heating, Ventilating, and Air-Conditioning.	Re-establishes the product class for SDHV air conditioners and heat pumps. Adds efficiency requirements for systems at <65,000 Btu/h below level of current federal standards.	Neutral (re-establishes efficiency requirements that do not meet the level of federal standards)
56	bk	90.1-2010bk	6. Heating, Ventilating, and Air-Conditioning	Increases cooling efficiency for PTACs.	Minor + (increases stringency of existing requirements)
57	bl	90.1-2010bl	11. Energy Cost Budget and Appendix G	Provides rules for removing fan energy from efficiency metrics when modeling in ECB or Appendix G.	Neutral (whole building performance tradeoff method only)
58	bn	90.1-2010bn	8. Power and 10. Other Equipment	Establishes electric and fuel metering requirements.	Neutral (metering by itself does not save energy)
59	bo	90.1-2010bo	7. Service Water Heating	Requires buildings with service water heating (SWH) capacity $\geq 1$ million Btu/h to have average thermal efficiency of at least 90%. Updates Table 7.8 to reflect federal requirements for electric water heaters. Updates the reference standard for swimming pool water heaters to ASHRAE Standard 146.	Minor + (requires large new gas SWH systems to have higher average efficiency)
60	bp	90.1-2010bp	6. Heating, Ventilating, and Air-Conditioning and 12. Normative References	Adds efficiency requirements (Btu/h-hp) to Table 6.8.1G (now Table 6.8.1-7 in Standard 90.1-2013) for evaporative condensers with ammonia refrigerants	Minor + (adds efficiency requirements for new products)

**Table 3.1 (continued)**

Number	Addendum Letter	Full Name of Addendum	Section Affected in 90.1-2010	Description of Changes	Impact on Energy Efficiency (justification)
61	bq	90.1-2010bq	6. Heating, Ventilating, and Air-Conditioning and 3. Definitions	Adds prescriptive requirements for the efficiency and improved control of commercial refrigeration systems.	Major + (adds new efficiency requirements for commercial refrigeration)
62	br	90.1-2010br	10. Other Equipment	Updates motor efficiency tables to match Federal rulemaking.	Neutral (implements Federal standards)
63	bs	90.1-2010bs	6. Heating, Ventilating, and Air-Conditioning	Reduces occupancy threshold for demand controlled ventilation from greater than 40 people per 1000 ft <sup>2</sup> to equal to or greater than 25 people per 1000 ft <sup>2</sup> with exemptions for certain occupancies.	Minor + (reduces ventilation energy usage)
64	bt	90.1-2010bt	6. Heating, Ventilating, and Air-Conditioning	Reduces the system size and outdoor air thresholds at which energy recovery is required. Relaxed in some climate zones.	Minor + (expands the use of exhaust air energy recovery to lower percent outdoor air)
65	bv	90.1-2010bv	5. Building Envelope	Reduces the area threshold at which skylights and daylighting controls are required.	Minor + (reduces lighting energy usage)
66	bw	90.1-2010bw	5. Building Envelope and 11. Energy Cost Budget Method	Modifies orientation requirements and adds SHGC tradeoff.	Minor + (provides more design flexibility leading to higher compliance with prescriptive path)
67	bx	90.1-2010bx	9. Lighting	Clarifies exceptions to occupancy sensor requirements.	Neutral (clarification only)

**Table 3.1 (continued)**

Number	Addendum Letter	Full Name of Addendum	Section Affected in 90.1-2010	Description of Changes	Impact on Energy Efficiency (justification)
68	by	90.1-2010by	9. Lighting	Significantly modifies the way requirements are presented in Section 9. Requires the use of certain lighting controls in more space types. Reduces the amount of time after occupants vacate a space for lights to be automatically reduced or shut off. Establishes table of lighting controls applicable to each space type.	Major + (requires more controls in more spaces and reduces time to reduction or shutoff)
69	bz	2007 90.1bz	8. Power	Adds a Section 8.4.2 which specifies requirements for installation of basic electrical metering of major end uses (total electrical energy, HVAC Systems, interior lighting, exterior lighting and receptacle circuits) to provide basic reporting of energy consumption data to building occupant.	Neutral (metering by itself does not save energy)
70	ca	90.1-2010ca	6. Heating, Ventilating, and Air-Conditioning	Adds control requirements for heating systems in vestibules.	Minor + (reduces vestibule heating energy usage)
71	cb	90.1-2010cb	6. Heating, Ventilating, and Air-Conditioning	Revises night setback requirements to a reset of 10°F heating & 5°F cooling and removes exceptions for climate zones. Changes optimum start requirement from > 10,000 cfm to any DDC system and adds a requirement that outside air temperature be used in optimum algorithms.	Minor + (expands heating and cooling setbacks)
72	cc	90.1-2010cc	6. Heating, Ventilating, and Air-Conditioning	Adds efficiency requirements (Btu/h-hp) to Table 6.8.1G (now Table 6.8.1-7 in Standard 90.1-2013) for evaporative condensers with R-507A.	Minor + (adds efficiency requirements for new products)
73	cd	90.1-2010cd	6. Heating, Ventilating, and Air-Conditioning and 7. Service Water Heating and 3. Definitions	Provides definition for piping to include all accessories in series with pipe such as pumps, valves, strainers, air separators, etc. This is meant to clarify that these accessories need to be insulated.	Neutral (editorial only)
74	ce	90.1-2010ce	Appendix G	Establishes a baseline system type for retail occupancies less than 3 stories in Appendix G.	Neutral (whole building performance tradeoff method only)

**Table 3.1** (continued)

Number	Addendum Letter	Full Name of Addendum	Section Affected in 90.1-2010	Description of Changes	Impact on Energy Efficiency (justification)
75	cf	90.1-2010cf	Appendix G	Establishes baseline WWR in Appendix G for strip malls.	Neutral (whole building performance tradeoff method only)
76	cg	90.1-2010cg	11. Energy Cost Budget and Appendix G	Modifies the simulation requirements for modeling mandatory automatic daylighting controls as well as automatic lighting controls. Also modifies the simulation requirements for automatic lighting controls in the proposed design, beyond the minimum mandatory requirements. Table G3.2, which provided power adjustment percentages for automatic lighting controls, has been deleted and savings through automatic control devices are now required to be modeled in building simulation through schedule adjustments for the proposed design or by lighting power adjustments defined in Table 9.6.3.	Neutral (whole building performance tradeoff method only)
77	ch	90.1-2010ch	6. Heating, Ventilating, and Air-Conditioning	Increases air- and water-cooled chiller efficiencies in Table 6.8.1C (now Table 6.8.1-3 in Standard 90.1-2013). Exempts water-cooled positive displacement chillers with leaving condenser temperature $\geq 115^{\circ}\text{F}$ (typically heat reclaim chillers).	Minor + (increases stringency of existing requirements)
78	ci	90.1-2010ci	3. Definitions, 11. Energy Cost Budget and Appendix G	Modifies requirements for the cooling tower fans in Chapter 11 baseline simulations, from two-speed to variable speed. A formula has been specified to calculate the condenser water design supply temperature. Similar revisions have been made to Appendix G for the cooling tower requirements. Definitions for cooling design wet-bulb temperature and evaporation design wet-bulb temperature have been added to Chapter 3.	Neutral (whole building performance tradeoff method only)
79	cj	90.1-2010cj	Appendix G	Creates modeling rules for computer rooms in Appendix G.	Neutral (whole building performance tradeoff method only)
80	ck	90.1-2010ck	6. Heating, Ventilating, and Air-Conditioning	Requires VAV dual maximum damper position when DDC system is present and clarifies dual maximum sequence.	Minor + (requires dual maximum control for VAV zones with DDC)

**Table 3.1 (continued)**

Number	Addendum Letter	Full Name of Addendum	Section Affected in 90.1-2010	Description of Changes	Impact on Energy Efficiency (justification)
81	cl	90.1-2010cl	6. Heating, Ventilating, and Air-Conditioning	Increases IEER requirements for air-cooled air conditioners and heat pumps and EER requirements for water and evaporatively cooled air conditioners and heat pumps in Tables 6.8.1A and B (now Tables 6.8.1-1 and 6.8.1-2 in Standard 90.1-2013).	Minor + (increases stringency of existing requirements)
82	cm	90.1-2010cm	5. Building Envelope	Clarifies how to interpret the use of dynamic glazing products given the requirements in Addendum bb (envelope requirements).	Neutral (clarification only)
83	cn	90.1-2010cn	Appendix G	Establishes modeling rules for laboratories with 100% OA in Appendix G.	Neutral (whole building performance tradeoff method only)
84	co	90.1-2010co	9. Lighting	Comprehensive update of LPDs in Table 9.5.1 - Building Area Method.	Major + (decreases LPD in most building types)
85	cp	90.1-2010cp	5. Building Envelope	Corrects non-residential U-factor and R-value requirements for steel joist floors in CZ3.	Minor + (increases R-value requirements for steel joist floors)
86	cr	90.1-2010cr	9. Lighting and 12. Normative References	Makes a number of adjustments to Table 9.6.1, Space-by-space LPD.	Minor + (plus on retail outweighs some negatives on other building types)
87	ct	90.1-2010ct	Appendix G	Identifies heated only storage systems 9 and 10 in Appendix G as being assigned one system per thermal zone.	Neutral (whole building performance tradeoff method only)
88	cv	90.1-2010cv	Appendix G	Establishes baseline system types in Appendix G for Assembly occupancies.	Neutral (whole building performance tradeoff method only)



**Table 3.1 (continued)**

Number	Addendum Letter	Full Name of Addendum	Section Affected in 90.1-2010	Description of Changes	Impact on Energy Efficiency (justification)
89	cy	90.1-2010cy	6. Heating, Ventilating, and Air-Conditioning	Reduces the design supply fan air flow rate for which energy recovery is required for systems that operate more than 8000 hours per year.	Minor + (applies energy recovery requirements to smaller fan systems)
90	cz	90.1-2010cz	6. Heating, Ventilating, and Air-Conditioning	Increases boiler efficiency for residential sized (NAECA covered) equipment, <3,000 Btu/h.	Neutral (adopts Federal standards)
91	da	90.1-2010da	5. Building Envelope	Relaxes air leakage requirements for high-speed doors for vehicle access and material transport.	Minor - (relaxes air leakage requirements for high-speed doors)
92	db	90.1-2010db	5. Building Envelope	Corrects residential U-factor and R-value requirements for steel joist floors in CZ3.	Minor - (relaxes steel joist floor requirements in CZ3)
93	dc	90.1-2010dc	9. Lighting	Clarifies automatic lighting and switched receptacle control in guest rooms as applied to individual spaces.	Neutral (clarification only)
94	dd	90.1-2010dd	5. Building Envelope and 3. Definitions	Clarifies roof insulation requirements, differentiating between roof recovering (on top of existing roof covering) and replacement of roof covering.	Neutral (clarification only)
95	de	90.1-2010de	6. Heating, Ventilating, and Air-Conditioning	Relaxes design requirements for waterside economizers for computer rooms.	Minor - (relaxes economizer requirements for computer rooms)
96	dg	90.1-2010dg	12. Normative References (related to 5. Building Envelope)	Updates reference to ANSI/CRRC-1 Standard 2012 (cool roof ratings).	Neutral (updates references only)
97	di	90.1-2010di	6. Heating, Ventilating, and Air-Conditioning	Establishes limits on using electric or fossil fuel to humidify or dehumidify between 30% and 60% RH except certain applications. Requires deadband on humidity controls.	Minor + (reduces humidification energy usage)

**Table 3.1** (continued)

Number	Addendum Letter	Full Name of Addendum	Section Affected in 90.1-2010	Description of Changes	Impact on Energy Efficiency (justification)
98	dj	90.1-2010dj	9. Lighting	Additional lighting power allowance for electrical/mechanical rooms made available to match 2010 level provided there is separate control for the additional lighting.	Neutral (tradeoff of additional lighting power for additional control)
99	dk	90.1-2010dk	9. Lighting	Eliminates the exemption for wattage used in spaces where lighting is specifically designed for those with age-related eye conditions or other medical conditions related to the eye, where special lighting or light levels might be needed.	Minor + (trades blanket exemption for more targeted LPD increases)
100	dl	90.1-2010dl	9. Lighting	Modifies hotel and motel guest room lighting power density.	Minor + (new average LPD less than previous requirements)
101	dm	90.1-2010dm	5. Building Envelope	Modifies section 5.4.3.4 for vestibules. Adds a size limit for large buildings, exemptions for semiheated spaces and elevator lobbies in parking garages.	Minor + (reduces vestibule energy usage)
102	dn	90.1-2010dn	6. Heating, Ventilating, and Air-Conditioning	Reduces the limits on hot gas bypass as a means of cooling capacity control.	Minor + (reduces hot gas bypass)
103	do	90.1-2010do	12. Normative References (related to 6. Heating, Ventilating, and Air-Conditioning)	Updates references to AHRI 550, AMCA 500, ANSI Z21.10.3 & Z21.47, ASHRAE 90.1 & 62.1, NEMA MG 1, & NFPA 70 & 96.	Neutral (updates references only)
104	dp	90.1-2010dp	3. Definitions (related to 6. Heating, Ventilating, and Air-Conditioning)	Corrects the definition of walk-in-cooler to be consistent with federal requirements.	Neutral (editorial only)
105	dq	90.1-2010dq	6. Heating, Ventilating, and Air-Conditioning	Deletes sizing requirements for pipes >24 inches in diameter	Minor - (eliminates sizing requirements for pipes above 24" in diameter)
106	dr	90.1-2010dr	3. Definitions (related to 5. Building Envelope)	Clarifies definition of building entrances to exclude electrical room, mechanical rooms, and other utility service entrances.	Neutral (clarification only)

**Table 3.1** (continued)

Number	Addendum Letter	Full Name of Addendum	Section Affected in 90.1-2010	Description of Changes	Impact on Energy Efficiency (justification)
107	ds	90.1-2010ds	5. Building Envelope and 3. Definitions	Revises the definitions of primary sidelighted area, secondary sidelighted area, and sidelighting effective area to use the term “vertical fenestration” instead of “window” to clarify that glazed doors and other fenestration products are included as well as windows. Additionally, the definition of daylight area under rooftop monitors is corrected to include the spread of light beyond the width of the rooftop monitor glazing.	Neutral (editorial only)
108	dt	90.1-2010dt	9. Lighting	Adds exceptions for control of exterior lighting integral to signage. Requires certain types of exterior lighting exempt from LPD requirements to be separately controlled.	Minor + (expansion of requirement to all signage may outweigh addition of exception)
109	dv	90.1-2010dv	6. Heating, Ventilating, and Air-Conditioning	Establishes chiller and boiler fluid flow isolation requirements so there is no flow through the equipment when not in use.	Minor + (reduces off hour chiller and boiler energy use)
110	dw	90.1-2010dw	6. Heating, Ventilating, and Air-Conditioning	Revises high limit shutoff for air economizers. Add sensor accuracy requirements.	Minor + (adds sensor accuracy requirements)

**KEY:** The following terms are used to characterize the effect of individual addenda on energy efficiency (as contained in the above table): Major + indicates that an addendum is anticipated to significantly improve energy efficiency; Minor + indicates that an addendum may improve energy efficiency in specific applications, Neutral indicates that an addenda is not anticipated to impact energy efficiency; and Minor – indicates that an addendum may increase energy use in certain applications.

Table 3.2 summarizes the overall impacts of addenda included in Standard 90.1-2013.

**Table 3.2. Summary of Addenda Impact**

Major Negative	Minor Negative	Neutral	Minor Positive	Major Positive	Total
None	5	53	44	8	110

The results of the textual analysis indicate that less than half of the changes (53 of the total of 110 listed) were considered neutral for the purpose of the determination. These include editorial changes, changes to reference standards, changes to alternative compliance paths, and other changes to the text of the standard that may improve the usability of the standard, but do not generally improve or degrade the energy efficiency of a building. Based on the analysis, the sum of the major positive and minor positive addenda (52) greatly overwhelms the number of minor negative addenda (5). Of those five addenda with negative impacts, none were determined to have a major impact, leading to the conclusion that the overall impact of the addenda on the standard is positive.

The eight major positive impacts on energy efficiency include the following:

1. Addendum 90.1-2010m – adds control requirements for lighting alterations.
2. Addendum 90.1-2010u – applies new efficiency requirements to individual fans.
3. Addendum 90.1-2010aq – reduces fan energy usage and improves economizer effectiveness.
4. Addendum 90.1-2010am – reduces large boiler energy usage.
5. Addendum 90.1-2010bb – increases stringency of building envelope requirements.
6. Addendum 90.1-2010bq – adds new efficiency requirements for commercial refrigeration.
7. Addendum 90.1-2010by – requires more lighting controls in more space and reduces time to reduction or shutoff.
8. Addendum 90.1-2010co – decreases LPD in most building types.

Many of these “major positive” addenda are self-descriptive. The high-level themes of the major positive addenda tend be:

- Better lighting, daylighting, and controls (90.1-2010m, 90.1-2010by, and 90.1-2010co)
- Better mechanical systems and application to more systems (90.1-2010u, 90.1-2010aq, and 90.1-2010bq)
- Better building envelope (90.1-2010bb)

The five negative impacts on energy efficiency include the following:

1. Addendum 90.1-2010j – reduces EER for evaporatively cooled air conditioners.
2. Addendum 90.1-2010da – relaxes air leakage requirements for high-speed doors.
3. Addendum 90.1-2010db – relaxes the U-factor requirement for residential steel joist floors in Climate Zone 3.
4. Addendum 90.1-2010de – relaxes economizer requirements for computer rooms.
5. Addendum 90.1-2010dq – eliminates sizing requirements for pipes above 24 inches in diameter.

None of these negative energy impacts is judged to be major. Addendum 90.1-2010j is described in its preamble as “fixing an error”; however, the fixed value does reduce efficiency. Addendum 90.1-2010da provides new requirements for high-speed doors that would have been required to meet tighter requirements for other non-swinging doors. Addendum 90.1-2010db raises the U-factor requirement for residential steel joist floors in Climate Zone 3. Addendum 90.1-2010de provides reduced economizer requirements for computer rooms compared to what was required in Standard 90.1-2010. Addendum 90.1-2010dq eliminates any requirements for piping over 24-inches in diameter, although such piping is likely to be uncommon in buildings covered by Standard 90.1.

Table 3.3 shows the results of the textual analysis on a section-by-section basis. This indicates the impact that different technical areas of the standard have on the efficiency improvements of the standard as a whole. Some addenda affect multiple sections. Addenda are listed by the primary technical section they address. Thus, an addendum that modifies the lighting requirements and a definition related to lighting is listed only in the lighting section. Any addendum that modifies only definitions or references would be listed under the technical section related to the definitions being modified. Any addendum that modifies multiple technical sections (for example, Building Envelope and Lighting) would be credited to each section. The overall addenda count noted at the bottom of Table 3.3 matches the 110 addenda processed for Standard 90.1-2013, as reported in Table 2.1, Table 3.1, and Table 3.2, and in the text of this document, but are not totals of the impacted sections listed in the table as some addenda impact multiple sections.

**Table 3.3. Results of Textual Analysis by Section of Standard 90.1-2013**

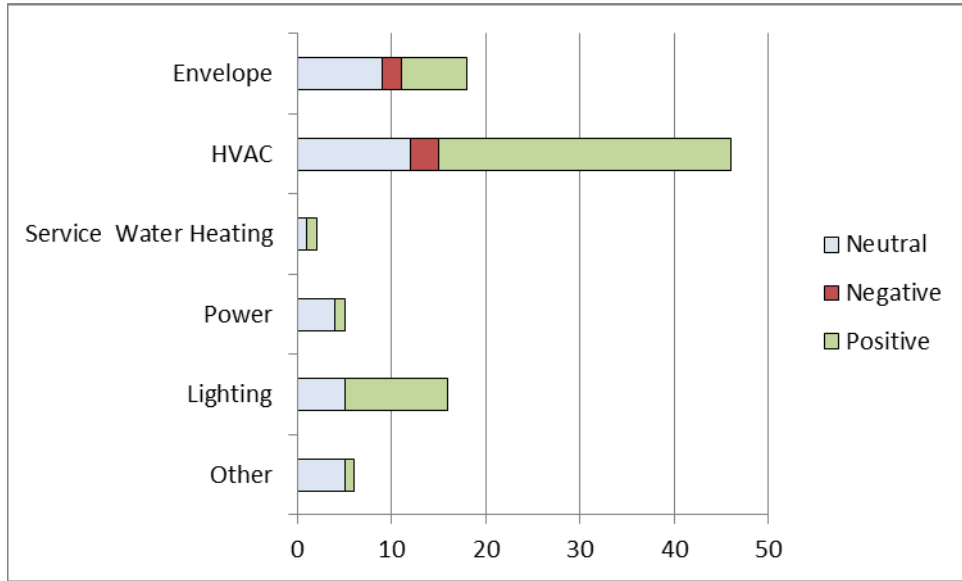
Section of Standard	Total Number of Changes Attributed to Section	Number of Positive (Energy Saving) Changes	Number of Neutral (No Energy Saving) Changes	Number of Negative (Energy Increasing) Changes
Title, (1) Purpose, and (2) Scope	0	0	0	0
(3) Definitions, Abbreviations and Acronyms*	*	*	*	*
(4) Administration and Enforcement	0	0	0	0
(5) Envelope and Normative Appendices	18	7	9	2
(6) HVAC Equipment and Systems	46	31	12	3
(7) Service Water Heating	2	1	1	0
(8) Power	5	1	4	0
(9) Lighting	16	11	5	0
(10) Other Equipment	6	1	5	0
(11) Energy Cost Budget	6	1***	5	0
Appendix G Performance Rating Method	20	0	20	0
Normative and Informative References*	*	*	*	*
Overall Addenda Count**	110	52	53	5

\*Changes to Definitions, Abbreviations, and Acronyms or Normative and Informative References are included in the relevant technical section.

\*\* The overall addenda count is not a sum of the values in the table because several addenda affect multiple sections in the standard.

\*\*\*The single addendum that is a positive change for the whole building sections (Section 11 Energy Cost Budget Method) is addendum 90.1-2010bw, which is rated as minor positive impact due to the impact it has on Section 3 Building Envelope, and not due to its impact on Section 11 Energy Cost Budget Method.

The number of positive and negative addenda for the six prescriptive sections (Building Envelope; Heating, Ventilating, and Air-Conditioning; Service Water Heating; Power; Lighting; and Other) is captured in Figure 3.1. Note that neutral addenda are ignored in this graphic representation, and that some addenda are attributed to more than one technical section.



**Figure 3.1.** Technical Section Addenda Count by Energy Efficiency Impact





## **4.0 Detailed Discussion of Impacts of Addenda on Various Sections of Standard 90.1-2013**

Standard 90.1-2013 contains 12 normative sections and 5 normative appendices that are considered part of the standard. Standard 90.1-2013 also contains two informative appendices that provide additional information relevant to use of the standard, but that are not considered part of Standard 90.1-2010. DOE's evaluation of Standard 90.1-2013 focuses on the normative sections and appendices. This chapter examines each normative section and its associated appendices to identify the changes associated with each section and to assess the impact of those changes on various compliance paths allowed for that section.

Sections 5 through 9 of Standard 90.1-2013 are the heart of the technical requirements. For Sections 5 through 9, Standard 90.1-2013 offers multiple compliance paths. Each section has mandatory requirements that must be met for all buildings. Each section may also have one or more sets of prescriptive requirements that must be met for all buildings unless a tradeoff option is used. Sections 5, 6, and 9 have specific tradeoff options for use within these sections. For example, Section 5 allows tradeoffs between window overhangs and solar heat gain coefficient, Section 6 between economizers and cooling efficiency, and Section 9 between lighting power and lighting controls. Section 6 also has a simple system approach that combines mandatory and prescriptive requirements for certain buildings and HVAC systems. Section 11 provides an overall whole building tradeoff option for Standard 90.1-2013 based on equal energy cost between a baseline building and the proposed design.

Some addenda affect more than one section. Addenda are listed in each technical section that they impact. In some cases, addenda are discussed for multiple sections. For example, addendum 90.1-2010bw impacts both the Building Envelope and Energy Cost Budget Method sections and is therefore discussed under both sections.

### **4.1 Changes to Title, Section 1 Purpose, and Section 2 Scope**

No changes were made to the Title, Purpose, and Scope during the creation of Standard 90.1-2013.

### **4.2 Changes to Section 3, Definitions, Abbreviations, and Acronyms**

Changes made to Section 3, Definitions, Abbreviations, and Acronyms, during the creation of Standard 90.1-2013 are included in the technical section most appropriate to the definition. For example, addendum 90.1-2010dr revises the definition of "building entrance" and is therefore discussed under Section 5, Building Envelope.

### **4.3 Changes to Section 4, Administration and Enforcement**

No changes were made to Section 4, Administration and Enforcement, during the creation of Standard 90.1-2013.

## 4.4 Changes to Section 5, Building Envelope and Normative Appendices A–D

A total of 18 addenda were made to Section 5, Building Envelope, and the associated Normative Appendices A–D during the creation of Standard 90.1-2013. Several addenda also modified definitions (Section 3) and normative references (Section 12), but are discussed under Building Envelope. One addendum (90.1-2010bw) updates Section 3, Building Envelope, and Section 11, Energy Cost Budget Method, and is discussed in both locations. One addendum (90.1-2010at) updates Section 3, Building Envelope, and Section 9, Lighting, and is discussed in both locations.

### Addendum 90.1-2010o

**Sections(s) Modified:** 5. Building Envelope and 3. Definitions, Abbreviations, and Acronyms

**Short Description:** Adds the definition for “sectional garage doors.” Also modifies Section 5.4.3.2 (d), fenestration air leakage provisions for doors, to include requirements for glazed sectional garage doors.

**Discussion:** Addendum 90.1-2010o adds a new definition of “sectional garage door” to Section 3 and modifies Section 5.4.3.2(d) to include glazed sectional garage doors to the category of doors having an air leakage requirement of 0.4 cfm/ft<sup>2</sup>.

**Impact:** Given that these doors would likely have fallen into a category with a higher air leakage requirement, this addendum is considered a minor positive in terms of energy efficiency.

### Addendum 90.1-2010p

**Sections(s) Modified:** 5. Building Envelope and 12. Normative References

**Short Description:** Modifies Section 5.5.3.1 and requires roof solar reflectance and thermal emittance testing to be in accordance with CRRC-1 Standard. Also modifies Section 12 by adding the reference for CRRC.

**Discussion:** Addendum 90.1-2010q replaces four ASTM references for roof solar reflectance and emittance with a reference to the Cool Roof Rating Council ANSI/CRRC-1 Standard-2010, “Cool Roof Rating Council – ANSI/CRRC-1 Standard” (CRRC 2010). Editorial changes are made to the Roof Solar Reflectance and Thermal Emittance section of Standard 90.1 to incorporate this change.

**Impact:** Because this addendum simply changes a rating standard, it is rated as neutral (no impact) in terms of energy efficiency.

### Addendum 90.1-2010q

**Sections(s) Modified:** 5. Building Envelope, 3. Definitions, Abbreviations, and Acronyms, and 12. Normative References

**Short Description:** Modifies Section 5.8.2.2 by clarifying the requirements for labeling of fenestration and door products. The corresponding references to NFRC in Chapter 12 have also been updated.

**Discussion:** Addendum 90.1-2010q modifies the definition of “dynamic glazing” to match the definition used by the NFRC. The addendum also modifies requirements for labeling of fenestration and doors to specifically mention site-built fenestration as a product requiring a label or signed certificate. The labeling requirements for doors are also folded into the labeling requirements for windows. The addendum also updates the four NFRC reference standards—100, 200, 300, and 400—from the 2004 version to the 2010 version (NFRC 2010a, NFRC 2010b, NFRC 2010c, and NFRC 2010e).

**Impact:** Given that this addendum is primarily a clarification, it is rated neutral (no impact) in terms of energy efficiency.

### **Addendum 90.1-2010an**

**Sections(s) Modified:** Appendix C

**Short Description:** Rewrites entire Appendix C to use a simulation-based approach for envelope tradeoffs.

**Discussion:** Appendix C of Standard 90.1 is the building envelope tradeoff methodology specified in Section 5.6 of Standard 90.1, hence the inclusion of this addendum in the Building Envelope section. Addendum 90.1-2010an completely replaces the existing regression equation-based tradeoff methodology with a new whole building simulation approach. Given that it is a complete replacement, detailed discussion of changes is not provided in this document.

**Impact:** Because this addendum simply changes the building envelope tradeoff methodology, it is considered neutral, with no impact on energy efficiency.

### **Addendum 90.1-2010at**

**Sections(s) Modified:** 5. Building Envelope, 9. Lighting, and 3. Definitions, Abbreviations, and Acronyms

**Short Description:** Deletes the term “clerestory” and adds “roof monitor” and clarifies the definition. Changes the references in Chapters 5 and 9 from clerestory to roof monitor.

**Discussion:** In Section 3, Addendum 90.1-2010at deletes the terms “clerestory” and “rooftop monitor” and adds the term “roof monitor.” The terms “fenestration,” “daylit area,” and “toplighting” are edited to use the term “roof monitor.” The addendum also makes minor changes to the daylight area width under roof monitors. Figure 3.2 in Standard 90.1-2010 for the daylight area under roof monitors is also replaced. In Sections 5 and 9, the addendum edits two sections to use the term “roof monitor”—Exception d to Section 5.5.4.2.3 and Section 9.4.1.5.

**Impact:** Given that the addendum is editorial, it is rated neutral (no impact) in terms of energy efficiency.

### **Addendum 90.1-2010bb**

**Sections(s) Modified:** 5. Building Envelope and 3. Definitions, Acronyms, and Abbreviations, Appendix A, and 11. Energy Cost Budget Method

**Short Description:** Modifies the building envelope requirements for opaque assemblies and fenestration in Tables 5.5.1 through 5.5.8 and associated text. Also updates the NFRC 301 reference (NFRC 2010d) and modifies two metal building roof assemblies in Table A2.3.

**Discussion:** Addendum 90.1-2010bb is a complex addendum that modifies a number of sections impacting building envelope requirements and definitions. A high-level summary of the addendum is provided below:

Section 3 – Modifies definitions for “continuous insulation,” “north-oriented,” and “vertical fenestration,” and moves definitions of “entrance door,” “fixed,” “operable,” “metal framing,” “metal framing, entrance door,” “metal framing, fixed,” “metal framing, operable,” and “nonmetal framing” from table footnotes to Section 3. Adds VT, FC (filled cavity), and LSG (light-to-solar-gain ratio) to Section 3.

Section 5 – Tables 5.5-1 through 5.5-8, the tables of prescriptive criteria for the building envelope, have been updated. For opaque elements, minimum insulation levels have increased for most assemblies in most climates. For vertical fenestration, the new criteria call for double-glazing with low-E in most climates, with triple-glazing in Alaska (to reduce energy consumption for space heating, which most often occurs during morning warm-up when lights and equipment are off and before sunrise), and good solar control (to reduce energy consumption for space cooling, which occurs primarily during daytime occupied hours). Also, a minimum VT/SHGC ratio has been added to enable good daylighting with minimum solar gain, while not restricting triple- and quadruple-glazing. The skylight criterion has been simplified for greater consistency with the 2009 International Energy Conservation Code. Also, see the text below for new footnotes added for fenestration U-factor criteria in Climate Zone 1 areas other than Miami and Hawaii and for floor insulation criteria in cold climates.<sup>1</sup>

The addendum also changes seven subsections of Section 5.

1. Section 5.5.3.1, the high albedo roof alternative was updated to reflect new roof insulation values in Table 5-5.
2. Section 5.5.3.2, the location of the applicable text of the Table 5.5 footnote for the insulation in masonry cores (sometimes called the perlite exception) was moved from Appendix A (Section A3.1.3.1) to Section 5. This is where it was located in the 1999 and 2001 editions of the standard.
3. Section 5.5.3.4, a steel-joint floor and wood-framed floor exception was added to account for increased insulation levels that occur in floors (similar to the single-rafter roof exception).
4. Section 5.5.4.2, the area references were deleted as they are already specified in Table 5.5 and an exception was added to allow the skylight area to be increased to 6% where skylights are designed and utilized as part of a daylighting scheme.
5. Section 5.5.4.3, one exception was added to allow the skylight U-factor to be increased where skylights are designed and utilized as part of a daylighting scheme. Also, more stringent U-factors are specified for vertical fenestration in areas of Climate Zone 1 with higher cooling design temperatures (e.g., Saudi Arabia).
6. Section 5.5.4.4, an exception was added to allow a modification of the SHGC criteria for vertical fenestration that faces north to account for the reduced solar heat gain on the north side of buildings in cold climates.
7. Section 5.5.4.5, text was added to refer to the table criteria for VT/SHGC.

The addendum also modifies Part 5. Building Envelope of Table 11.3.1 of the Energy Cost Budget Method section to correctly reference the new building envelope requirements tables.

Appendix A – Updates Appendices A2.3 (metal building roofs), A3.1 (mass walls), A3.2 (metal building walls), and A9 for metal building roof insulation.

**Impact:** Overall, due to the changes made to the building envelope requirements tables, this addendum is rated as a major positive in terms of energy efficiency.

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<sup>1</sup> See Tables 5.5-1 through 5.5-8 in Addenda 90.1\_2010\_bb in the 2013 Supplement to ANSI/ASHRAE/IES Standard 90.1-2010. “Energy Standard for Buildings Except Low-Rise Residential Buildings” (ASHRAE 2013a), for the final envelope requirements associated with addendum 90.1-2010bb. For a comparison of the differences between Standard 90.1-2010 and Standard 90.1-2013, see the table in Appendix A.

### Addendum 90.1-2010bg

**Sections(s) Modified:** 5. Building Envelope

**Short Description:** Adds requirements for low-E storm window retrofits.

**Discussion:** Addendum 90.1-2010bg updates the existing exception for storm window retrofits by requiring any storm window or glazed panel to have a low-emissivity coating unless the existing glazing already has a low-emissivity coating.

**Impact:** This addendum is rated as a minor positive because in some cases it will require the installation of low-E storm windows.

### Addendum 90.1-2010bv

**Sections(s) Modified:** 5. Building Envelope

**Short Description:** Reduces the area threshold at which skylights and daylighting controls are required.

**Discussion:** Addendum 90.1-2010bv addresses toplighting requirements and daylighting controls. This addendum reduces the space area threshold, adds single-story buildings, and expands the list of spaces where daylight would not adversely affect operation of the space (such as a movie theater seating area where daylight is not appropriate). The existing requirement states that in enclosed spaces larger than 5000 ft<sup>2</sup> and with ceiling heights greater than 15 feet (4.57 m), a minimum skylight fenestration area must be provided. This addendum reduces the enclosed space area threshold from 5000 to 2500 ft<sup>2</sup> (465 to 232 m<sup>2</sup>), which brings in more high-ceiling spaces and spaces in single-story buildings that were previously not required to install skylights.

**Impact:** Based on the reduced threshold for which skylights and daylighting controls are required, which should reduce energy usage, this addendum is rated as a minor positive in terms of energy efficiency.

### Addendum 90.1-2010bw

**Sections(s) Modified:** 5. Building Envelope and 11. Energy Cost Budget Method

**Short Description:** Modifies orientation requirements and adds SHGC tradeoff.

**Discussion:** Addendum 90.1-2010bw modifies existing fenestration orientation requirements. The addendum removes the existing requirement that the area of fenestration with south orientation must be greater than or equal to both the area of fenestration with east orientation and the area of fenestration with west orientation. The addendum then replaces this requirement with two new requirements that consider both the orientation and SHGC of fenestration in various orientations. The two new requirements are (in words):

- a. Western oriented fenestration area must be less than ¼ of the total fenestration area and eastern oriented fenestration must be less than ¼ of total fenestration area.
- b. Western solar aperture (area times SHGC) must less than or equal to ¼ of the total solar aperture and eastern solar aperture must less than or equal to ¼ of the total solar aperture.

The addendum also removes direction to use the northern orientation in the Southern Hemisphere, as the southern orientation is no longer part of the requirement. The addendum also adds two new exceptions. The first new exception is for buildings where the west-oriented and east-oriented vertical fenestration area (as defined in Section 5.5.4.5) does not exceed 20% of the gross wall area for each of those façades, and SHGC on those facades is no greater than 90% of the criteria in Tables 5.5-1 through 5.5-8. The second exception is buildings in Climate Zone 8. The addendum also changes how fenestration orientation is dealt with in whole building tradeoffs. Specifically, this addendum applies the approach

currently used in the Performance Rating Method to the Energy Cost Budget Method. This approach requires simulating the building in all four cardinal orientations and then averaging the results.

**Impact:** The overall impact of this addendum is rated as a minor positive in terms of energy efficiency.

#### Addendum 90.1-2010cm

**Sections(s) Modified:** 5. Building Envelope

**Short Description:** Clarifies how to interpret the use of dynamic glazing products given the requirements in addendum bb (envelope requirements).

**Discussion:** Addendum 90.1-2010cm adds mention of the new terms “VT/SHGC” and “LSG” used in addendum 90.1-2010bb to Section 5.5.4.1 and adds a new exception to Section 5.5.4.5 that describes how VT/SHGC should be calculated for dynamic glazing.

**Impact:** This addendum is primarily clarification and as such is rated as neutral (no impact) in terms of energy efficiency.

#### Addendum 90.1-2010cp

**Sections(s) Modified:** 5. Building Envelope

**Short Description:** Corrects non-residential U-factor and R-value requirements for steel joist floors in Climate Zone 3.

**Discussion:** Addendum 90.1-2010cp changes the non-residential U-factor for steel joist floors in Climate Zone 3 from U-0.052 to U-0.038 and changes the corresponding R-value requirements from R-19 to R-30.

**Impact:** This addendum is rated as a minor positive because U-factor requirements decrease.

#### Addendum 90.1-2010da

**Sections(s) Modified:** 5. Building Envelope

**Short Description:** Relaxes air leakage requirements for high-speed doors for vehicle access and material transport.

**Discussion:** Addendum 90.1-2010da provides a separate and higher air leakage rate for high-speed non-swinging doors. The addendum also clarifies which requirement covers upward acting non-swinging glazed doors. The addendum also adds a new exception for all types of fenestration and doors that are part of a building that has achieved a measured whole building air leakage rate of 0.4 cfm/ft<sup>2</sup>.

**Impact:** Overall, this addendum is a minor negative in terms of energy efficiency due to the allowance of higher leakage rates for high-speed doors.

#### Addendum 90.1-2010db

**Sections(s) Modified:** 5. Building Envelope

**Short Description:** Corrects residential U-factor and R-value requirements for steel joist floors in Climate Zone 3.

**Discussion:** Addendum 90.1-2010db modifies the residential U-factor and R-value requirements for steel joist floors in Climate Zone 3. The modification raises the U-factor from U-0.032 to U-0.038 and lowers the R-value from R-38 to R-30.

**Impact:** While this modification is described in the foreword to the addendum as “addresses an error,” it does represent a weakening of Standard 90.1 and therefore is a minor negative in terms of energy efficiency.

#### **Addendum 90.1-2010dd**

**Sections(s) Modified:** 5. Building Envelope and 3. Definitions, Abbreviations, and Acronyms

**Short Description:** Clarifies roof insulation requirements, differentiating between roof recovering (on top of existing roof covering) and replacement of roof covering.

**Discussion:** Addendum 90.1-2010dd defines two new terms: “roof covering” and “roof recovering.” In addition, the term “roof recovering” is added to the list of envelope alterations not subject to Standard 90.1. the addendum also modifies the existing exception that replacement of a roof covering is not subject to Standard 90.1 if there is insulation below the deck to remove the idea that the exception only applies if roof sheathing or roof insulation is not exposed and to add the concept of insulation integral to roof deck.

**Impact:** This addendum is considered a clarification only and therefore it is rated as neutral (no impact) in terms of energy efficiency.

#### **Addendum 90.1-2010dg**

**Sections(s) Modified:** 12. Normative References (related to 5. Building Envelope)

**Short Description:** Updates reference to ANSI/CRRC-1 Standard 2012 (cool roof ratings).

**Discussion:** While addendum 90.1-2010ae only modifies Section 12. Normative References, the normative references it modifies is directly related to building envelope. Addendum 90.1-2010dg simply updates the reference year of ANSI/CRRC-1 Standard, “Cool Roof Rating Council – ANSI/CRRC-1 Standard” (CRRC 2012), from 2010 to 2012.

**Impact:** Because the change is only to a reference standard, the addendum is rated as neutral (no impact) in terms of energy efficiency.

#### **Addendum 90.1-2010dm**

**Sections(s) Modified:** 5. Building Envelope

**Short Description:** Modifies Section 5.4.3.4 for vestibules. Adds a size limit for large buildings, exemptions for semiheated spaces and elevator lobbies in parking garages.

**Discussion:** Addendum 90.1-2010dm modifies the existing vestibule requirements in Section 5.4.3.4 in four ways: 1) a size limit is put on vestibule floor area, with no more than the greater of 50 ft<sup>2</sup> or 2% of the gross conditioned floor area for that level of the building; 2) editorial changes are made to two of the vestibule requirement exceptions; 3) the term “gross conditioned floor area” is substituted for “area” in three exceptions; and 4) a new section addressing vestibules in spaces with a gross conditioned floor area of 40,000 ft<sup>2</sup> or more and with automatic, electrically-driven, self-closing devices, which are required to have a minimum distance between interior and exterior doors of 16 feet.

**Impact:** The size limit on vestibules is the most significant change and this change is rated as a minor positive in terms of energy efficiency.

### Addendum 90.1-2010dr

**Sections(s) Modified:** 3. Definitions, Abbreviations, and Acronyms (Related to 5. Building Envelope)

**Short Description:** Clarifies definition of “building entrances” to exclude electrical rooms, mechanical rooms, and other utility service entrances.

**Discussion:** Addendum 90.1-2010dr addresses a definition used in Section 5 Building Envelope. Addendum 90.1-2010dr revises the definition of “building entrance” by replacing “turnstile” with “revolving door,” clarifying that the entrance can be used to exit the building as well as gain access to the building, and clarifies that the term “building entrance” does not include doors used to directly enter mechanical, electrical, and other utility service equipment rooms.

**Impact:** This addendum is primarily clarification and such is rated as neutral (no impact) in terms of energy efficiency.

### Addendum 90.1-2010ds

**Sections(s) Modified:** 5. Building Envelope and 3. Definitions, Abbreviations, and Acronyms

**Short Description:** Corrects the definitions of “primary sidelighted area,” “secondary sidelighted area,” and “sidelighting effective area” to use the term “vertical fenestration” instead of “window” to clarify that glazed doors and other fenestration products are included as well as windows. Additionally, the definition of “daylight area” under rooftop monitors is corrected to include the spread of light beyond the width of the rooftop monitor glazing.

**Discussion:** Addendum 90.1-2010ds modifies four definitions in Section 3—“daylight area,” “primary sidelighted area,” “secondary sidelighted area,” and “sidelighting effective aperture”—by referring to “vertical fenestration” as opposed to “windows.” Additionally, the term “clerestory” is used in definitions where needed. The addendum also updates Section 9.4.1.4, Automatic Daylighting Controls for Toplighting, to specifically mention clerestories.

**Impact:** Given that this addendum is primarily editorial, it is rated neutral (no impact) in terms of energy efficiency.

## **4.5 Changes to Section 6, Heating, Ventilating, and Air-Conditioning**

A total of 45 addenda were made to Section 6, Heating, Ventilating, and Air-Conditioning, during the creation of Standard 90.1-2013. Several addenda also modify definitions (Section 3) or normative references (Section 12) but are discussed in this section as the definitions or references modified are related to Section 6, Heating, Ventilating, and Air-Conditioning. One addendum (90.1-2010cd) also modifies Section 7, Service Water Heating, and is therefore discussed in both locations.

One major restructuring of Section 6 was that the equipment efficiency tables in Section 6.8.1 were renumbered from Table 6.8.1A to 6.8.1K to a new format of Table 6.8.1-1 to 6.8.1-11. The tables called out in this document correspond to the new table numbers used in Standard 90.1-2013.

### Addendum 90.1-2010g

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning and 12. Normative References

**Short Description:** Adds efficiency requirements for commercial refrigerators, freezers, and refrigeration equipment. Table 6.8.1L and Table 6.8.1M (now Tables 6.8.1-12 and 6.8.1-13 in Standard



90.1-2013), which specify the energy use limits for refrigerators and freezers, have been added. The corresponding references have also been added in Section 12.

**Discussion:** Section 136(c) of the Energy Policy Act of 2005 (EPAAct 2005) amended the Energy Policy and Conservation Act (EPCA) to prescribe energy conservation standards for self-contained equipment consisting of refrigerators with solid doors, refrigerators with transparent doors, freezers with solid doors, freezers with transparent doors, refrigerator/freezers with solid doors, and refrigerators with transparent doors designed for pull-down temperature applications (42 U.S.C. 6313(c)(1–3)). These standards became effective on January 1, 2010. Section 136(c) of EPAAct 2005 also amended EPCA to mandate that DOE sets standards for the following additional categories of equipment: ice-cream freezers; self-contained commercial refrigerators, freezers, and refrigerator-freezers without doors; and remote condensing commercial refrigerators, freezers, and refrigerator-freezers (42 U.S.C. 6313(c)(4)(A)). DOE published the final rule prescribing these standards on January 9, 2009 (74 FR 1092). The energy conservation standards established in the final rule are applicable to products manufactured on or after January 1, 2012. Addendum 90.1-2010g adopts both EPAAct 2005 requirements and the new rulemaking requirements.

**Impact:** Given that this addendum is simply adopting federal requirements, no additional savings are attributed to this addendum.

**Addendum 90.1-2010h**

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning.

**Short Description:** Modifies the minimum efficiency standards for water-to-air heat pumps (water loop, ground water and ground loop). The proposed cooling EERs and heating COPs are more stringent than the present values. Also removes the small duct high velocity heat pump product class from Table 6.8.1B (now Table 6.8.1-2 in Standard 90.1-2013).

**Discussion:** Addendum 90.1-2010h improves the minimum energy efficiency standards for water-to-air heat pumps (water loop, ground water and ground loop) listed in Table 6.8.1B of Standard 90.1-2010 (now Table 6.8.1-2 in Standard 90.1-2013). Table 4.1 shows the minimum efficiency for water-to-air heat pumps as required by Standard 90.1-2010 (before addendum h) and by addendum h. Note that the small duct high velocity product class is reestablished with a higher air conditioning efficiency requirement in addendum bj.

**Table 4.1. Water to Air Heat Pump Efficiency Improvements**

Equipment Type	Size Category	Rating Condition	Minimum Efficiency	
			STD 90.1-2010	Addendum h
Water to Air: Water Loop (cooling mode)	<17,000 Btu/h	86 °F entering water	11.2 EER	12.2 EER
	≥17,000 Btu/h and <65,000 Btu/h	86 °F entering water	12.0 EER	13.0 EER
	≥65,000 Btu/h and <135,000 Btu/h	86 °F entering water	12.0 EER	13.0 EER
Water to Air: Ground Water (cooling mode)	<135,000 Btu/h	59 °F entering water	16.2 EER	18.0 EER
Brine to Air: Ground Loop (cooling mode)	<135,000 Btu/h	77 °F entering fluid	13.4 EER	14.1 EER
Water to Air: Water Loop (heating mode)	<135,000 Btu/h (cooling capacity)	68 °F entering water	4.2 COP	4.3 COP
Water to Air: Ground Water (heating mode)	<135,000 Btu/h (cooling capacity)	50 °F entering water	3.6 COP	3.7 COP
Brine to Air: Ground Loop (heating mode)	<135,000 Btu/h (cooling capacity)	32 °F entering fluid	3.1 COP	3.2 COP

**Impact:** Overall, this addendum is considered to be a minor positive because addendum h does improve the performance of water to air heat pumps. This addendum is not considered a major positive because the use of water to air heat pumps is not that common.

#### **Addendum 90.1-2010i**

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning and 3. Definitions, Abbreviations, and Acronyms

**Short Description:** Increases the minimum efficiency standards for SPVAC and SPVHP. Also creates a new product class for SPVAC and SPVHP used in space-constrained applications. This new product class only applies to non-weatherized products with cooling capacities <36,000 Btu/h and intended to replace an existing AC.

**Discussion:** Addendum 90.1-2010i adds a new definition for non-weatherized space-constrained single-package vertical unit that addresses both air conditioners and heat pumps. This addendum also updates existing requirements for SPVAC and SPVHP in Table 6.8.1D (now Table 6.8.1-4 in Standard 90.1-2013) by increasing SPVAC and SPVHP cooling mode EERs from approximately 9 EER (depending on size of unit) to 10 EER and by increasing SPVHP heating mode COP from 2.9 to 3.0 COP for larger units. This addendum also implements new requirements for a “space constrained” SPVAC and SPVHP units.

**Impact:** The result of this addendum should be a minor positive improvement in efficiency.

#### **Addendum 90.1-2010j**

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning.

**Short Description:** Modifies the minimum efficiency requirements of for evaporatively cooled air conditioners units, of size category greater than or equal to 240,000 Btu/h and less than to 760,000 Btu/h and heating type-other, in Table 6.8.1A (now Table 6.8.1-1 in Standard 90.1-2013). The value is reduced to account for increased pressure drop in such system types. The product class, small duct high velocity air conditioner, has been eliminated.

**Discussion:** Addendum 90.1-2010j removes the category of small duct high velocity (air cooled) unitary air conditioners from Table 6.8.1A (now Table 6.8.1-1 in Standard 90.1-2013). The addendum also changes the required minimum efficiency for air conditioners, evaporatively cooled with a size category of greater than or equal to 240,000 Btu/h and less than 760,000 Btu/h and all other heating section type from 12.2 to 11.7 EER as of 6/1/2011. The addendum also removes a footnote related to the term “IPLV” (integrated partial load value) because the standard no longer uses that term. Note that a small duct high velocity product class is reestablished with a higher air conditioning efficiency requirement in addendum bj.

**Impact:** Overall, due to the reduction in the EER value, this addendum is rated as a minor negative in terms of energy efficiency, although it is noted that the foreword to this addendum describes this change as fixing an error.

#### **Addendum 90.1-2010l**

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning.

**Short Description:** Fixes the mistake with 90.1-2010 fan power limitations that required the user to perform calculations for fan bhp even if the simplified nameplate hp option was being used.

**Discussion:** Addendum 90.1-2010l adds a new exception to the Motor Nameplate Horsepower (Section 6.5.3.1.2) requirements that allows motors to meet the requirements of Section 6.5.3.1.1, Option 1 instead of the requirement of Section 6.5.3.1.2.

**Impact:** Review of these sections indicates that 6.5.3.1.2 essentially duplicates the nameplate horsepower limits in 6.5.3.1.1, indicating that this addendum should be rated as neutral (no impact) in terms of energy efficiency.

#### **Addendum 90.1-2010s**

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning.

**Short Description:** Modifies the requirement for the static pressure sensor location and the control requirements for setpoint reset for systems with DDC of individual zones. This ensures that savings from previously required static pressure reset will be realized.

**Discussion:** Addendum 90.1-2010s modifies the requirement for the static pressure sensor location and the control requirements for setpoint reset for systems with DDC of individual zones in Section 6. Specifically, the addendum changes the static sensor setpoint locations are changed from one-third of the total design fan static pressure to 1.2 inches w.c. An editorial change is made to specifically list an existing exception as an exception. New requirements are added to the Setpoint Reset section that controls must 1) monitor zone damper positions; 2) automatically detect zones that may be excessively driving reset logic; and 3) readily allow the operator to remove the zone(s) from the reset algorithm. Using a fixed setpoint may require sensors to be located closer to the zones and be set at a lower static pressure for high static pressure systems. The requirement to detect and allow removal of errant zones from the sequence avoids bad zones driving the system to full fan speed when unnecessary.

**Impact:** The addendum is intended to ensure that savings from previously required static pressure reset will be realized. The fixed setpoint of 1.2-inches is likely to be less than one-third of the total static pressure in many systems, resulting in a reduction in fan power. Based on this intent, this addendum is rated as a minor positive in terms of energy efficiency.

#### **Addendum 90.1-2010u**

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning, 3. Definitions, Abbreviations, and Acronyms, and 12. Normative References.

**Short Description:** Adds new definition of “Fan Efficiency Grade (FEG)” and requires that each fan have a FEG of 67 or higher as defined by AMCA 205-12, “Energy Efficiency Classification for Fans.”

**Discussion:** Addendum 90.1-2010u adds new definitions for “fan efficiency grade” and “power roof/wall ventilators (PRV).” This addendum also modifies the text of Section 6.5.3.1 to require that all fans have a fan efficiency grade of 67 or higher. This addendum also adds AMCA 205-12 “Energy Efficiency Classification for Fans,” as a normative reference. As pointed out in the foreword to this addendum, “fan power limits have been in Standard 90.1 for some time. These place restrictions on the design of systems and the amount of fan energy utilized. However the standard has not had a requirement for minimum fan efficiency.”

**Impact:** Given that this requirement is adding a new minimum requirement for fan efficiency and that fans are extremely common in commercial and high-rise multi-family residential buildings, this addendum is considered a major positive in terms of energy efficiency, especially for smaller systems with lower pressure drops that easily meet the fan power limitations.

### Addendum 90.1-2010z

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning.

**Short Description:** Relocates the requirements for water economizers into the main economizer section, Section 6.5.1.5.

**Discussion:** Addendum 90.1-2010z edits the wording of the Humidification subsection of Section 6 to clarify that it applies to economizers. The only change is that the title of the section is changed from “Humidification” to “Economizer Humidification System Impact” and the section is moved to be part of the overall economizer requirements.

**Impact:** Given that this change is simply editorial, this addendum is rated as neutral (no impact) in terms of energy efficiency.

### Addendum 90.1-2010aa

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning and 3. Definitions, Abbreviations, and Acronyms

**Short Description:** Eliminates the contingency on DDC system existence for setpoint overlap restrictions, humidification and dehumidification controls, VAV fan control setpoint reset, multiple-zone VAV system ventilation optimization control, and hydronic system differential pressure reset by valve position. Instead specifies for what system types or sizes DDC is required in new buildings and alterations. Also specifies minimal functional requirements for DDC systems. (Prior to this addendum certain controls requirements were only required when the controls were provided by a DDC system.)

**Discussion:** Addendum 90.1-2010aa adds the acronym “DDC” for “direct digital control” to Section 3, Definitions, Abbreviations, and Acronyms. The addendum also adds a new section for direct digital control with three parts: 1) DDC applications that require DDC for 3 new building situations and 5 existing building situations; 2) new requirements for DDC controls to have four capabilities – monitor zone and system demand for 5 parameters, transfer zone and system demand information to appropriate controllers, automatically detect those zones and systems that may be excessively driving the reset logic and generate an alarm to the system operator, and allow operator to remove zones from the reset algorithm (addendum 90.1 2010s also required the last two items for VAV static pressure reset—placing these requirements in a mandatory DDC section expands their scope to all resets, including chilled water and supply air); and 3) a requirement for DDC trending and graphically displaying input and output. With the clarity added for when DDC is required, it is possible to eliminate the contingency on DDC system existence for setpoint overlap restrictions, humidification and dehumidification controls, VAV fan control setpoint reset, multiple-zone VAV system ventilation optimization control, and hydronic system differential pressure reset by valve position.

**Impact:** While this addendum contains new requirements for DDC in 8 common situations, it is rated as a minor positive in terms of energy efficiency because DDC is standard practice in most of these situations anyway and two of VAV reset requirements were already required.

### Addendum 90.1-2010ad

**Sections(s) Modified:** 12. Normative References

**Short Description:** Adds reference to specific addenda to AHRI standards 340/360 and 1230 being referenced.

**Discussion:** Addendum 90.1-2010ad updates two references associated with Section 6, Heating, Ventilation, and Air-Conditioning. The reference to AHRI Standard 340/360-2007 (AHRI 2007) is updated to the same version with addenda 1 and 2, “Performance Rating of Commercial and Industrial

Unitary Air Air-Conditioning and Heat Pump Equipment.” The reference to AHRI Standard 1230-2010, “Performance Rating of Variable Refrigerant Flow (VRF) Multi-split Air-Conditioning and Heat Pump Equipment” (AHRI 2010), is updated to the same version with addendum 1.

Addenda 1 and 2 for AHRI Standard 340/360-2007 are described in the document as follows: (the text is quoted from AHRI Standard 340/360-2007 but reformatted for this document):

“Addendum 1 - The certification program scope, on the inside front cover, has been revised. New provisions have been added to the footnotes of Tables 5 and 6 to specify the tolerances associated with external static pressure for all units, and the leaving air dry-bulb temperature on variable air volume (VAV) units, respectively. The following tolerance has been added to the footnote of Table 5 of ANSI/AHRI Standard 340/360-2007: The tolerance for external static pressure (averaged during the run time) for all equipment is -0 in H<sub>2</sub>O [0 Pa], +0.05 in H<sub>2</sub>O [12.5 Pa]. The following tolerance has been added to the footnote of Table 6 of ANSI/AHRI Standard 340/360-2007: The tolerance for the leaving air dry-bulb temperature on VAV units is ±0.3 °F [±0.2 °C].”

“Addendum 2 - The language in Section 6.2.2 associated with units using discrete step fan control and variable air volume units has been revised. An external static equation has been added to the footnotes of Table 6. The following equation has been added to the footnote of Table 6 of ANSI/AHRI Standard 340/360-2007:

$$ExternalStatic = FullLoadExternalStatic \times \left( \frac{PartLoadCFM}{FullLoadCFM} \right)^2$$

Addendum 1 for AHRI Standard 1230- 2010 is described in the document as follows: (the text is quoted from AHRI Standard 340/360-2007 but reformatted for this document):

“Addendum 1 - The changes include:

3.25 Tested Combination. A sample basic model comprised of units that are production units, or are representative of production units, of the basic model being tested. The Tested Combination shall have the following features:

a. The basic model of a variable refrigerant flow system (—VRF system) used as a Tested Combination shall consist of an outdoor unit (an outdoor unit can include multiple outdoor units that have been folded into a single refrigeration system, with a specific model number) that is matched with between 2 and 5 12 indoor units. ~~(for systems with nominal cooling capacities greater than 150,000 Btu/h [43,846 W], the number of indoor units may be as high as 8 to be able to test non-ducted indoor unit combinations)~~

b. The indoor units shall:

b.1 Represent the highest sales model family as determined by type of indoor unit e.g. ceiling cassette, wall-mounted, ceiling concealed. etc. ~~If 5 are insufficient to reach capacity another model family can be used for testing.”~~

**Impact:** Review of the addendum to these two AHRI standards indicates that the changes are minor and that this addendum should be considered simply an update of reference standards. Therefore, addendum 90.1-2010ad is rated as neutral (no impact) in terms of energy efficiency.

### Addendum 90.1-2010ae

**Sections(s) Modified:** 12. Normative References

**Short Description:** Adds reference to specific addenda to AHRI standards 210/240 and 550/590 being referenced.

**Discussion:** Addendum 90.1-2010ae modifies two references associated with Section 6, Heating, Ventilation, and Air-Conditioning. The two references are AHRI 210/240-2008, “Unitary Air Conditioning and Air-Source Heat Pump Equipment” (AHRI 2008), and AHRI 550/590-2011 “Water-Chilling Packages Using the Vapor Compression Cycle” (AHRI 2011). The modifications are to require addenda 1 and 2 for AHRI 210/240 and to update from the 2003 version to the 2011 version of AHRI 550/590. The modifications to AHRI 210/240 for addenda 1 and 2 are described in the published document as follows (the text is quoted from AHRI 210/240-2008 with addenda 1 and 2 but reformatted for this document):

“Addendum 1 - The Integrated Part-Load Values (IPLV) methodology has been removed from the standard. This includes the deletion of: Section 3.6 Integrated Part Load Value (IPLV) Definition (page 2); “and in multiples of 0.1 for IPLV” from Section 6.1.2 (page 5); The Part Load Conditions line and Note 2 of Table 12 (page 21); Section 6.2 Part Load Ratings (pages 21-22); “plus the IPLV (where applicable)” from Section 6.4 (page 22); and Appendix E. The corresponding Table E1 has also been removed (pages 122-125).”

“Addendum 2 - The Integrated Energy Efficiency Ratio (IEER) methodology has been added to the standard for water-cooled and evaporatively-cooled products. It is not intended for air-cooled products which should be rated with SEER. This includes: The addition of 3.4.2 definition of IEER (page 2); The addition of “and in multiples of 0.1 for IEER” to Section 6.1.2 (page 5); The addition of Part-Load IEER Conditions to Test Conditions to Table 12 (page 21); The reinstatement of Note 2 in Table 12 (page 21); New Section 6.2 Part Load Ratings (pages 22-26). This new Section 6.2 is duplicated from Section 6.2 from AHRI Standard 340/360-2007 (AHRI 2007) with addenda 1 and 2.; The addition of “plus the IEER (where applicable),” to Section 6.4 (page 26); The addition of “except IEER which shall not be less than 90% of Published Ratings.” to Section 6.5 (page 26); and the addition of “3. Integrated Energy Efficiency Ratio, IEER,” to Section 7.1.b (page 27).”

**Impact:** The main change associated with addenda 1 and 2 is the substitution of the IEER for IPLV where appropriate. This change, along with the update to the version year for AHRI 550/590, is considered neutral, with no impact on energy efficiency.

### Addendum 90.1-2010af

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning

**Short Description:** Modifies heat rejection equipment (cooling tower) requirements to require multi-speed or variable speed fans and that VSD-controlled fans operate all fans at the same speed instead of sequencing them, and require that open-circuit towers with multiple cells operate all cells in parallel down to 50% of design flow

**Discussion:** Addendum 90.1-2010af makes four specific changes to Section 6. First, this addendum adds a requirement (in Section 6.5.5.4 of Standard 90.1-2013) for open circuit towers to have parallel operation and modulate condenser water flow down to 50% flow or the low flow of the smallest condenser water pump as a means to save energy. Second, this addendum requires that multiple cell heat rejection equipment with variable speed fan drives operate the maximum number of fans and to control all fans to the same fan speed to minimize energy use and that the minimum speed be as low as allowed by the fan-drive system manufacturer. Third, this addendum adds “dry coolers” as an example of a common heat rejection device. Fourth, this addendum eliminates an exception to the fan speed control requirements that

allowed up to one-third of the fans on a unit with multiple fans to be exempt as long as the lead fans complied with the requirement. Energy is generally saved by this addendum by reducing fan energy use at part load.

**Impact:** Overall, this addendum is evaluated as having a minor positive in terms of energy efficiency.

**Addendum 90.1-2010aj**

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning

**Short Description:** Requires fractional horsepower motors  $\geq 1/12$  hp to be electronically commutated motors or have a minimum 70% efficiency in accordance with 10 CFR 431. Also requires adjustable speed or other method to balance airflow.

**Discussion:** Addendum 90.1-2010aj adds a new set of requirements for fractional horsepower motors in Section 6.5.3.5 of Standard 90.1-2013 that includes both a 70% minimum efficiency and adjustable speed or other method to balance airflow. It is particularly applicable to fan powered boxes or fan coil units where electronically commutated motors can be used.

**Impact:** This addendum is rated as a minor positive in terms of energy efficiency.

**Addendum 90.1-2010am**

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning

**Short Description:** Establishes minimum turndown for boilers and boiler plants with design input power of at least 1,000,000 Btu/h.

**Discussion:** Addendum 90.1-2010am requires that boiler systems with design input of at least 1,000,000 Btu/h shall comply with the turndown ratio specified in the second column of Table 4.2.

**Table 4.2.** Addendum 2010 90.190.1-2010am Boiler Turndown Requirements

Boiler System Design Input (Btu/h)	Minimum Turndown Ratio	Implied Minimum Burner Capacity (Percent of Maximum)
$\geq 1,000,000$ and less than or equal to 5,000,000	3 to 1	33.3%
$> 5,000,000$ and less than or equal to 10,000,000	4 to 1	25%
$> 10,000,000$	5 to 1	20%

Turndown ratio is a measure of the modulation capabilities of the boiler burner. The third column of Table 4.2 shows implied minimum burner capacity that the system must be able to achieve, with larger boilers being required to achieve higher turndown ratios. When boilers turn down, efficiency is improved because there is a larger ratio of heat exchange surface to firing rate, so stack temperatures can be reduced at part load.

**Impact:** Given that these requirements were not in Standard 90.1 before and that boilers are fairly commonly used in commercial buildings, addendum am is estimated to be a major positive in terms of energy efficiency.

### Addendum 90.1-2010ap

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning and 3. Definitions, Abbreviations, and Acronyms

**Short Description:** Adds Power Utilization Effectiveness (PUE) as an alternative compliance methodology for data centers.

**Discussion:** Addendum 90.1-2010ap adds five new definitions to Section 3: “computer room energy,” “IT equipment energy,” “power usage effectiveness,” and two subcategories of “power usage effectiveness” or PUE: PUE<sub>0</sub> relates to peak demand and PUE<sub>1</sub> relates to annual energy use. The addendum also adds an alternative compliance path for computer room systems (in Section 6.6 of Standard 90.1-2013) that utilizes the power usage effectiveness concept. Computer rooms shown to use less demand or energy than either PUE target are deemed to meet code requirements.

**Impact:** Given that this is an alternative compliance path only, this addendum is rated as neutral (no impact) in terms of energy efficiency.

### Addendum 90.1-2010aq

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning and 11. Energy Cost Budget

**Short Description:** Expands the requirements for fan speed control for both chilled water and unitary direct expansion systems. In addition enhances the requirements for integrated economizer control and defines DX unit capacity staging requirements.

**Discussion:** Addendum 90.1-2010aq changes the requirements for fan control for both constant-volume and VAV units, including extending the fan part-load power requirements down to 1/4 hp (0.20 kW). In addition, it more clearly defines the requirements for integrated economizer control and defines DX unit capacity staging requirements (in Section 6.5.1.3). This addendum removes Section 6.4.3.10, Single Zone Variable Air Volume Controls, in its entirety and replaces it with a new Section 6.5.3.2.1, Fan Airflow Control. This addendum also changes Table 11.3.2A (now Table 11.3.2-1 in Standard 90.1-2013) for coordination between Section 6 and Section 11. Generally, the addendum saves energy by requiring multi-speed or variable speed fans for smaller units and adds a requirement for staging DX cooling systems. It clarifies how economizer integration is to be achieved with DX units, improving economizer operation.

Requirements that go into effect during the 2013 edition of the standard are shown in Table 4.3.

**Table 4.3.** Addendum 90.1-2010aq Fan Speed Control and Staging Requirements

Cooling type	Control Type	Capacity (Btu/h)	Fan Control (minimum speed)	Fan motor size (hp)	Capacity Staging
DX Cooling	Direct zone temperature	≥65,000	2-speed (66%)	any	2-stages
DX Cooling	Other control including VAV	≥65,000	variable (50%)	any	3-stages
		≥240,000	variable (50%)	any	4-stages
Chilled water and evaporative	Any	Any	variable (50%)	≥ 1/4	N/A



**Impact:** Overall, this addendum is rated a major positive in terms of energy efficiency for reducing fan energy.

### **Addendum 90.1-2010ar**

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning and 3. Definitions, Abbreviations, and Acronyms

**Short Description:** Adds mandatory and prescriptive requirements for walk-in coolers and freezers and refrigerated display cases.

**Discussion:** Addendum 90.1-2010ar adds definitions and requirements for walk-in coolers and freezers. In Section 3, this addendum adds six new definitions—“condensing unit,” “low-temperature refrigeration system,” “medium-temperature refrigeration system,” “saturated condensing temperature,” “walk-in cooler,” and “walk-in freezer”—and one new acronym, HVACR (heating, ventilation, air-conditioning, and refrigeration). This addendum adds refrigeration systems to those systems that must meet new building, addition, or alteration requirements for mechanical systems (Section 6.1). This addendum adds new requirements for walk-in coolers and freezers in Section 6.4.5 and new requirements for refrigeration systems in new Section 6.5.10.

**Impact:** All of these requirements are based on new federal standards and therefore this addendum is rated as neutral (no impact) in terms of energy efficiency.

### **Addendum 90.1-2010as**

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning

**Short Description:** Requires humidifiers mounted in the airstream to have an automatic control valve shutting off preheat when humidification is not required, and insulation on the humidification system dispersion tube surface. This avoids simultaneous heating and cooling at the air handling unit.

**Discussion:** Addendum 90.1-2010as addresses simultaneous heating and cooling in zone controls, hydronic systems, dehumidification systems, and humidification systems. The existing wording does not limit simultaneous heating and cooling in some air-handling equipment serving multiple zones. This addendum is intended to limit some of these cases. An existing requirement for humidifier preheat is merged into the section on humidification. A new requirement for insulation on humidification system dispersion tube hot surfaces in the airstreams of ducts or air-handling units is added. A new requirement for preheat coil controls is added.

**Impact:** The overall effect of this addendum should be to reduce energy usage during humidification and that leads to this addendum being rated a minor positive in terms of energy efficiency.

### **Addendum 90.1-2010au**

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning

**Short Description:** Modifies Table 6.5.3.1.1B, which addresses fan power limitation pressure drop adjustment credits. Deductions from allowed fan power are added for systems without any central heating or cooling as well as systems with electric resistance heating. Sound attenuation credit is modified to be available only when there are background noise criteria requirements.

**Discussion:** Addendum 90.1-2010au modifies Table 6.5.3.1.1B by limiting the existing 0.15 inches w.c. adjustment credit for sound attenuation systems to “fans serving spaces with design background noise goals below NC35” and by imposing three new deductions for systems without central cooling devices, systems without central heating devices, and systems with electric resistance heating. Given that the

addendum limits the use of the credit and imposes three additional deductions from allowed static pressure, the end result should be that fan systems should use less energy.

**Impact:** Given the number of other potential adjustments, this addendum is considered to be a minor positive in terms of energy efficiency.

#### **Addendum 90.1-2010av**

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning

**Short Description:** Modifies Section 6.5.1, exception k, applicable to Tier IV data centers, to make economizer exceptions stricter and in agreement with ASHRAE TC 9.9.

**Discussion:** Addendum 90.1-2010av modifies exception k to Section 6.5.1 by removing the words “mechanical cooling” in front of the word “design.” The intent of the addendum was to close a loophole that would potentially allow a data center that merely had a cooling design goal equal to that of Tier IV data center to use the exception. With the removal of the words “mechanical cooling,” the wording of exception k now reads “those spaces having a design of Tier IV as defined by ANSI/TIA 942,” with the implication that the data center must be a Tier IV data in its entirety.

**Impact:** With that interpretation of the addendum, Addendum 90.1-2010av is rated as a minor positive in terms of energy efficiency.

#### **Addendum 90.1-2010az**

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning

**Short Description:** Increases the minimum efficiency of open circuit axial fan cooling towers. An additional requirement has been added for all types of cooling towers, which states that the minimum efficiency requirements apply to the tower, including the capacity effect of accessories that influence thermal performance. An additional footnote clarifies that the certification requirements do not apply to field erected cooling towers.

**Discussion:** Addendum 90.1-2010az increases the minimum efficiency of open circuit axial fan cooling towers from 38.2 gpm/hp to 40.2 gpm/hp, at rated conditions. Additionally, a note “f” is added to Table 6.8.1G (now Table 6.8.1-7 in Standard 90.1-2013), clarifying that the required minimum efficiency rating for all types of cooling towers applies to models with options and accessories that affect the thermal performance of the whole unit, not just the base model.

**Impact:** Overall, this addendum is a minor positive because it increases open circuit axial fan cooling tower efficiency and includes the impact of accessories into the efficiency metric.

#### **Addendum 90.1-2010ba**

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning

**Short Description:** Adds requirements for door switches to disable or reset mechanical heating or cooling when doors without automatic door closers are left open.

**Discussion:** Addendum 90.1-2010ba adds a new Section 6.5.10, Door Switches, in Standard 90.1-2013. This new section requires that any conditioned space with a door that opens to the outdoors be provided with controls that disable mechanical heating and cooling or reset the heating and cooling setpoints when the door is open. The intent is to reduce unnecessary heating or cooling of additional outside air if a door is left open. There is an exception for doors with automatic closers.

**Impact:** Given that this addendum will definitely save energy when doors are left open, but that doors are not routinely left open, this addendum is considered to a minor positive in terms of energy efficiency.

#### **Addendum 90.1-2010bi**

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning

**Short Description:** Increase SEER and HSPF for air-cooled commercial three-phase air conditioners and heat pumps below 65,000 Btu/h. Effective January 1, 2015.

**Discussion:** Addendum 90.1-2010bi increases the minimum efficiency of air-cooled three-phase commercial air conditioners and the cooling mode for heat pumps with cooling capacity less than 65,000 Btu/h from SEER 13 to SEER 14 effective 1/1/2015. The addendum also increases the HSPF for heat pumps below 65,000 Btu/h from 7.7 to 8.2 effective January 1, 2015. These changes are not applicable to single-phase single package units which are regulated by NAECA.

**Impact:** Both of these changes increase requirements and will trigger a DOE review of these standards, and as such the addendum is rated as minor positive in terms of energy efficiency.

#### **Addendum 90.1-2010bj**

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning.

**Short Description:** Reestablishes the product class for Small Duct High Velocity (SDHV) air conditioners and heat pumps. Adds efficiency requirements for systems <65, 000 Btu/h.

**Discussion:** Addendum 90.1-2010bj reestablishes the product class for small-duct high-velocity air conditioners and heat pumps, which was deleted in Standard 90.1-2010. The minimum energy efficiency levels shown in 90.1-2013 are 11 SEER for air conditioners and 11 SEER/6.8 HSPF for heat pumps, which are identical to the efficiencies established by DOE for single-phase residential SDHV products. (Note that addenda 90.1-2010j and 90.1-2010h previously deleted this product group from 90.1's tables.) The DOE standards for commercial SDHV air conditioners, which are 13.0 SEER, and SDHV heat pumps, which are 13.0 SEER and 7.7 HSPF, were established for the overall equipment category of small commercial package air-conditioning and heating equipment by EISA 2007, as noted in the ASHRAE 2010 products rule.<sup>1</sup>

**Impact:** Given that the ASHRAE 90.1-2013 requirements for SDHV are set below federal levels and are therefore unenforceable, the impact of this addendum is rated as neutral (no impact) in terms of energy efficiency.

#### **Addendum 90.1-2010bk**

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning

**Short Description:** Increases cooling efficiency for PTACs.

**Discussion:** Addendum 90.1-2010bk raises the minimum energy efficiency requirements for standard-size PTACs to the same level as the package terminal heat pumps (PTHPs) reflected in the federal energy efficiencies established by DOE effective in October 2012. DOE's rulemaking sets the minimum EER for PTACs at a lower level than PTHPs. This addendum revises the equation for calculating the EER of PTACs (equation below) effective as of January 1, 2015.

$$\text{EER} = 14.0 - 0.3 \times \text{Capacity}/1,000$$

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<sup>1</sup> See [http://www1.eere.energy.gov/buildings/appliance\\_standards/pdfs/ashrae\\_90\\_1\\_2010\\_final\\_rule.pdf](http://www1.eere.energy.gov/buildings/appliance_standards/pdfs/ashrae_90_1_2010_final_rule.pdf) for the ASHRAE 2010 Products Rule.

**Impact:** Because addendum 90.1-2010bk increases the required efficiency for a DOE-regulated product and thereby starts DOE’s regulatory review and revision cycle, this addendum is estimated to be a minor positive in terms of energy efficiency.

#### Addendum 90.1-2010bp

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning and 12. Normative References

**Short Description:** Adds efficiency requirements (Btu/h-hp) to Table 6.8.1G (now Table 6.8.1-7 in Standard 90.1-2013) for evaporative condensers with ammonia refrigerants.

**Discussion:** Addendum 90.1-2010bp adds minimum efficiencies for evaporative condensers used in ammonia-based refrigeration systems. Specifically, new requirements are added to Table 6.8.1G (now Table 6.8.1-7 in Standard 90.1-2013) for propeller or axial fan evaporative condensers and for centrifugal fan evaporative condensers. Also, the now required test procedure Cooling Tower Institute (CTI) Acceptance Test Code ATC-106(11), “Acceptance Test Code for Mechanical Draft Evaporative Vapor Condensers,” is added to Section 12, Normative References. In addition, the revision date for CTI ATC - 105S was updated from the 1996 version to the 2011 version and the version date for CTI Std-201 was updated from the 2009 version to 2011 version. Finally, the mention of “R-22 test fluid” as part of the rating conditions for air-cooled condensers was deleted as the test standard (AHRI 460) now applies to all refrigerants.

**Impact:** The addition of new requirements for evaporative condensers is the major change focus of this addendum; however, the application is only to ammonia-based refrigeration systems that are a small share of the refrigeration market, so based on this change, this addendum is rated as a minor positive in terms of energy efficiency.

#### Addendum 90.1-2010bq

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning and 3. Definitions, Abbreviations, and Acronyms

**Short Description:** Adds prescriptive requirements for the efficiency of commercial refrigeration systems.

**Discussion:** Addendum 90.1-2010bq adds new definitions for “bubble point,” “refrigerant dew point,” “low-temperature refrigeration system,” and “medium temperature refrigeration system.” The addendum also adds the acronym “HVACR” for “heating, ventilating, air conditioning, and refrigerating.” The addendum adds a new requirement that walk-in freezers have temperature-based defrost termination control with a time limit default. The addendum also adds a new Section 6.4.6 in Standard 90.1-2013 for refrigerated display cases that contains four requirements: 1) refrigerated display cases must meet the minimum equipment efficiencies found in Tables 6.8.1A to 6.8.1M; 2) lighting in refrigerated display cases must be controlled by automatic time switches or motion sensor controls; 3) all low-temperature display cases must incorporate temperature-based defrost controls with a time-limit default; and 4) anti-sweat heaters must have anti-sweat heater controls.

The addendum also replaces the phrase “remote condensers not in a condensing unit” with “remote condensing unit” and adds ammonia refrigerant systems to the systems exempted from new Section 6.5.10. The addendum also makes it clear that new Section 6.5.11.1 (in Standard 90.1-2013) is focused on condensers serving refrigeration systems and adds instructions for calculating the saturated condensing temperature for blend refrigerants. The addendum also adds two new requirements that condensers serving refrigeration systems use some form of continuous variable speed control and that multiple fan

condensers be controlled in unison. The addendum also moves an existing requirement for minimum condensing temperature setpoint from one section to another.

The addendum also adds a new section on compressor systems (Section 6.5.11.2 of Standard 90.1-2013) that includes three new requirements: 1) compressors must have control systems that use floating suction pressure control logic; 2) liquid sub-cooling must be provided for certain sizes of low-temperature compressor systems, and 3) all compressors with internal or external crankcase heaters must provide a means to cycle the heaters off during operation.

**Impact:** Overall, the addendum provides a variety of new requirements for walk-in coolers and freezers, refrigerated display cases, condensers, and compressor systems, leading to the conclusion that this addendum will save energy. Because these systems are relatively common in the commercial sector, this addendum is considered to be a major positive in terms of energy efficiency.

### Addendum 90.1-2010bs

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning

**Short Description:** Reduces occupancy threshold for demand controlled ventilation from greater than 40 people per 1000 ft<sup>2</sup> to equal to or greater than 25 people per 1000 ft<sup>2</sup> with exemptions for certain occupancies.

**Discussion:** Addendum 90.1-2010bs updates existing requirements for ventilation controls for high-occupancy areas by reducing the occupancy threshold from >40 people per 1000 ft<sup>2</sup> to  $\geq 25$  people per 1000 ft<sup>2</sup>. This addendum also modifies an existing exception to this requirement by reducing the maximum size of exempted systems from 1200 to 750 cfm. An existing exemption for spaces where supply airflow rate minus makeup or outgoing transfer air was less than 1200 cfm was transformed into an exemption for spaces where 75% of space design outdoor airflow is required for makeup air that is exhausted or transfer air. Finally, a new exception was added for spaces with occupancy categories defined by ASHRAE Standard 62.1-2007 (ASHRAE 2007) as correctional cells, daycare sickrooms, science labs, barbers, beauty and nail salons, and bowling alleys.

**Impact:** The main feature of this addendum is the lowering of the occupancy threshold for demand controlled ventilation, and based on that change, this addendum is rated a minor positive in terms of energy efficiency.

### Addendum 90.1-2010bt

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning

**Short Description:** Reduces the threshold at which energy recovery is required. The threshold is relaxed in some climate zones.

**Discussion:** This addendum relaxes requirements for systems utilizing 70% or greater outdoor air in Climate Zones 3B, 3C, 4B, 4C, and 5B, but also adds new requirements for systems utilizing 30% or less outdoor air in Climate Zones 1A, 2A, 3A, 4A, 5A, 6A, 6B, 7, and 8. While there is a relaxation of requirements in mild climates, the relaxation is based on an analysis that shows added fan energy offsets heating and cooling savings in these climates. The requirement is expanded to units with lower outside airflows in hot and cold climate zones. Addendum 90.1-2010bt revised Table 6.5.6.1 in Standard 90.1-2010 (shown below as Table 4.4).

**Table 4.4.** Addendum 2010 90.190.1-2010bt Energy Recovery Requirements

Zone	% Outdoor Air at Full Design Airflow Rate							Design Supply Fan Airflow Rate (cfm)		
	>10% and <20%	≥20% and ≤30%	≥30% and <40%	≥40% and <50%	≥50% and <60%	≥60% and <70%	≥70% and <80%	≥80%		
3B, 3C, 4B, 4C, 5B	NR	NR	NR	NR	NR	NR	NR	≥5000	≥5000	NR
1B, 2B, 5C	NR	NR	NR	NR≥	NR≥	NR≥	NR≥	≥5000	≥4000	
6B	≥28000	≥26500	≥11000	≥5500	≥4500	≥3500	≥2500	≥2500	≥1500	
1A, 2A, 3A, 4A, 5A, 6A	≥26000	≥16000	≥5500	≥4500	≥3500	≥2000	≥1000	≥1000	≥0	
7,8	≥4500	≥4000	≥2500	≥1000	≥0	≥0	≥0	≥0	≥0	

NR – Not required

**Impact:** Overall, this change is viewed as a minor positive in terms of energy efficiency.

**Addendum 90.1-2010ca**

**Sections(s) Modified:** 6. Heating, Ventilating, and Air Conditioning

**Short Description:** Adds control requirements for heating systems in vestibules.

**Discussion:** Addendum 90.1-2010ca adds a requirement that heating systems in vestibules must include automatic controls configured to shut off the heating system when outdoor air temperatures are above 45°F (7°C). Vestibule heating systems shall also be controlled by a thermostat in the vestibule with a setpoint limited to a maximum of 60°F (16°C).

**Impact:** This addendum adds a new requirement for vestibule heating controls, and as such is rated as a minor positive in terms of energy efficiency.

**Addendum 90.1-2010cb**

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning

**Short Description:** Revises night setback requirements to a reset of 10°F heating and 5°F cooling and removes exceptions for climate zones. Changes optimum start requirement from units > 10,000 cfm to any DDC system and adds a requirement that outside air temperature be used in optimum algorithms.

**Discussion:** Addendum 90.1-2010cb makes several changes to the existing setback controls and optimum start controls portions of Section 6. For setback controls, the addendum eliminates the limitation of the heat setback requirement to Climate Zones 2–8, thereby adding the requirement to Climate Zone 1. The addendum changes the requirement from a fixed setback temperature of 55°F to one of 10°F below the occupied heating setpoint. The addendum also eliminates the limitation of cooling setback to Climate Zones 1b, 2b, and 3b, thereby applying the cooling setback to all climate zones. The addendum changes the requirement from a fixed cooling setback temperature of 90°F to one of at least 5°F higher than the occupied cooling setpoint. The addendum also modifies the exception for radiant heating systems by eliminating specific mention of floor and ceiling systems and adding a requirement that the exception applies only to those radiant systems configured with a setback heating setpoint of at least 4°F below the occupied heating setpoint.

For optimum start controls, the addendum eliminates the existing limitation to systems greater than 10,000 cfm (about 25 tons of cooling) with one or more supply fans and adds the requirement that this applies to all systems with setback controls and DDC. The addendum also specifically requires the control

algorithms used to consider the outdoor air temperature to avoid spaces not being fully warmed up by occupancy, thereby avoiding optimum start being disabled. The addendum also requires that mass radiant floor slab systems incorporate floor temperature into the optimum start algorithm.

**Impact:** Overall, the changes listed are likely to require setback and optimum start for more systems, and that would lead to the addendum being rated as a minor positive in terms of energy efficiency.

#### **Addendum 90.1-2010cc**

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning

**Short Description:** Adds efficiency requirements (Btu/h-hp) to Table 6.8.1G (now Table 6.8.1-7 in Standard 90.1-2013) for evaporative condensers with R-507A.

**Discussion:** Addendum 90.1-2010cc adds new requirements for minimum efficiencies for both axial and centrifugal fan evaporative condensers with R-507A as the test fluid to Table 6.8.1G (now Table 6.8.1-7 in Standard 90.1-2013). Because of the numerous halocarbon refrigerants that can be utilized, a footnote has been added to the table clarifying that evaporative condenser models intended for use with halocarbon refrigerants other than R-507A must meet the minimum efficiency requirements listed for R-507A as the test fluid.

**Impact:** Based on the fact this table adds requirements for new types of equipment, this addendum is rated as a minor positive.

#### **Addendum 90.1-2010cd**

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning, 7. Service Water Heating, and 3. Definitions, Abbreviations, and Acronyms

**Short Description:** Provides definition for piping to include all accessories in series with pipe such as pumps, valves, strainers, air separators, etc. The intent is to clarify that these accessories need to be insulated.

**Discussion:** Addendum 90.1-2010cd adds a new definition of “piping” to Standard 90.1 and then makes editorial changes to Sections 6 and 7 to change the word “pipe” to “piping” in eight locations.

**Impact:** This addendum may result in some savings where these accessories may not have been insulated before; however, as the changes are editorial, this addendum is rated as neutral (no impact) in terms of energy efficiency.

#### **Addendum 90.1-2010ch**

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning

**Short Description:** Increases air- and water-cooled chiller efficiencies in Table 6.8.1C (now Table 6.8.1-3 in Standard 90.1-2013). Exempts water-cooled positive displacement chillers with leaving condenser temperature  $\geq 115^{\circ}\text{F}$  (typically heat reclaim chillers).

**Discussion:** Addendum 90.1ch makes three changes related to chiller requirements in Standard 90.1. First, the requirements for chillers in Table 6.8.1C (now Table 6.8.1-3 in Standard 90.1-2013) are updated and the text describing that table is completely updated.<sup>1</sup> Second, the title of AHRI standard governing

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<sup>1</sup> See Table 6.81C in addendum 90.1\_2010\_ch in the 2013 Supplement to ANSI/ASHRAE/IES Standard 90.1-2010, “Energy Standard for Buildings Except Low-Rise Residential Buildings” (ASHRAE 2013a), for the revised table showing both the Standard 90.1-2010 requirements in the columns marked “Effective 1/1/2010” and the new requirements for Standard 90.1-2013 in the columns marked “Effective 1/1/2015”.

chillers is updated to match the correct title of the standard and to reference a revised version of the AHRI standard developed solely for SI units. Third, water-cooling positive displacement chilling packages with a condenser leaving fluid above 115°F are exempted from compliance with Table 6.8.1C (now Table 6.8.1-3 in Standard 90.1-2013). These packages are typically heat reclaim chillers for which no testing procedures have yet been developed.

**Impact:** Overall, the main impact of the addendum is the revision of the chiller efficiencies in Table 6.8.1C (now Table 6.8.1-3 in Standard 90.1-2013). Efficiency requirements for both air-cooled chillers and water-cooled chillers result in higher efficiency, and therefore this addendum is rated as a minor positive in terms of energy efficiency.

### **Addendum 90.1-2010ck**

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning

**Short Description:** Requires VAV dual maximum damper position when DDC system is present and clarifies dual maximum sequence of operations.

**Discussion:** Addendum 90.1-2010ck requires the use of dual maximum control for VAV zone control when the building has DDC controls. To accomplish this, this addendum establishes a distinction between zones with DDC and those without in the exceptions to Section 6.5.2.1, Zone Controls. Exception (a) now addresses zones without DDC, while exception (b) addresses zones with DDC. A new option is added for exception (b), part 1, which allows the exception if air flow rate in deadband is no more than the airflow rate required to comply with applicable codes or accreditation standards, such as pressure relationships or minimum air change rates. The existing part 3 of exception (b) (“Airflow between dead band and full heating or full cooling shall be modulated”) is deleted and two parts are added to exception (b): a new part 3 (“The first stage of heating consists of modulating the zone supply air temperature setpoint up to a maximum setpoint while the airflow is maintained at the dead band flow rate”) and a new part 4 (“The second stage of heating consists of modulating the airflow rate from the dead band flow rate up to the heating maximum flow rate”). This control sequence minimizes airflow during mild heating and prevents high discharge temperatures that would increase the ventilation requirements due to a reduction in ventilation effectiveness.

**Impact:** Because this addendum does improve control of VAV systems with DDC, this addendum is rated a minor positive in terms of energy efficiency.

### **Addendum 90.1-2010cl**

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning

**Short Description:** Increases IEER requirements for air-cooled air conditioners and heat pumps and EER requirements for water and evaporatively cooled air conditioners and heat pumps in Table 6.8.1A and B (now Tables 6.8.1-1 and 6.8.1-2 in Standard 90.1-2013).

**Discussion:** Addendum 90.1-2010cl modifies Tables 6.8.1A and 6.8.1B (now Tables 6.8.1-1 and 6.8.1-2 of Standard 90.1-2013) to update the IEER values for air-cooled and water-cooled air conditioners and heat pumps above 65,000 Btu/h. In Table 6.8.1A (now Table 6.8.1-1 in Standard 90.1-2013), for air-cooled air conditioners, all eight size ranges and heating section types of the appropriate size range acquire more efficient IEER values as of 2016. For water-cooled air conditioners, all eight size ranges and heating section types of the appropriate size range acquire more efficient IEER values as of 2016. For evaporatively cooled air conditioners, editorial changes were made to remove start dates for efficiency



requirements that have already come into effect and to remove outdated requirements.<sup>1</sup> In Table 6.8.1B (now Table 6.8.1-2 in Standard 90.1-2013), for air-cooled heat pumps, all six size ranges and heating section types of the appropriate size range acquire more efficient IEER values as of 2016.<sup>2</sup> It should be noted that federal requirements for this equipment are based on EER, so the addition of IEER is separate from federal standards.

**Impact:** Overall, this addendum represents an increase in efficiency for commonly used HVAC equipment, so it is rated a minor positive in terms of energy efficiency.

#### **Addendum 90.1-2010cy**

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning

**Short Description:** Reduces the design supply fan air flow rate for which energy recovery is required for systems that operate more than 8000 hours per year.

**Discussion:** Addendum 90.1-2010cy modifies the existing exhaust air energy recovery requirements in Section 6.5.6.1 created by addendum 90.1-2010bt by adding a new table of requirements for systems that operate more than 8000 hours per year and by limiting the existing requirements to all systems that operate less than 8000 hours per year.

**Impact:** Because the new requirements for systems that operate more than 8000 hours per year are considerably more stringent than corresponding requirements for systems that operate less than 8000 hours per year, this addendum is rated as a minor positive in terms of energy efficiency.

#### **Addendum 90.1-2010cz**

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning

**Short Description:** Increases boiler efficiency for residential sized (NAECA covered) equipment, <3,000 Btu/h.

**Discussion:** Addendum 90.1-2010cz updates the minimum efficiency requirements for gas-fired and oil-fired boilers in Table 6.8.1F (now Table 6.8.1-6 in Standard 90.1-2013). The addendum also adds footnotes that gas-fired boilers shall not be equipped with a constant burning pilot light and that hot-water boilers not equipped with a tankless domestic water heating coil must be equipped with an automatic means of adjusting water temperature in response to changes in inferred heat load. These revisions are done in accordance with Section 303 of the Energy Independence and Security Act of 2007.

**Impact:** Given that the changes are made in response to federal legislation, this addendum is rated as neutral (no impact) in terms of energy efficiency.

#### **Addendum 90.1-2010de**

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning

**Short Description:** Relaxes design requirements for waterside economizers for computer rooms.

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<sup>1</sup> See Table 6.81A in addendum 90.1\_2010\_cl in the 2013 Supplement to ANSI/ASHRAE/IES Standard 90.1-2010, “Energy Standard for Buildings Except Low-Rise Residential Buildings” (ASHRAE 2013a), for the revised table showing both the pre-2016 and post-2016 IEER requirements.

<sup>2</sup> See Table 6.81B in addendum 90.1\_2010\_cl in the 2013 Supplement to ANSI/ASHRAE/IES Standard 90.1-2010, “Energy Standard for Buildings Except Low-Rise Residential Buildings” (ASHRAE 2013a), for the revised table showing both the pre-2016 and post-2016 IEER requirements.

**Discussion:** Addendum 90.1-2010de revises the design requirements for waterside economizers used in computer room applications. The revisions include editorial revisions to the text of the exceptions to Section 6.5.1.2.1 and the addition of a new Table 6.5.1.2.1 in Standard 90.1-2013 that is specifically intended for use with water economizers used in computer room applications. The primary change implemented in this addendum is to consider the appropriate dry-bulb and wet-bulb temperatures for using the exceptions on a climate zone by climate zone basis rather than based on a single dry-bulb/wet-bulb combination for evaporative water economizers or a single dry-bulb temperature for dry cooler water economizers. For Climate Zone 1, the exceptions no longer apply. For Climate Zones 2A, 3A, 4A, and 5A, there is no change in requirements for evaporative water economizers, with the exception requiring 100% cooling load met at 40°F dry-bulb/35°F wet-bulb. For the remaining climate zones, the dry-bulb and wet-bulb temperatures are lowered by 5°F to 10°F. For dry cooler water economizers, there is no longer an exception for Climate Zone 1 and the dry-bulb requirements have been lowered from 5°F to 15°F in all other climate zones.

**Impact:** Overall, this addendum represents a minor negative in terms of energy efficiency.

#### **Addendum 90.1-2010di**

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning

**Short Description:** Establishes limits on using electric or fossil fuel to humidify or dehumidify between 30% and 60% RH except certain applications. Requires deadband on humidity controls.

**Discussion:** Addendum 90.1-2010di addresses the humidification and dehumidification requirements in Standard 90.1. A new requirement is added to Section 6.4.3.7, Humidification and Dehumidification, that requires humidity controls to prevent use of fossil fuel or electricity to produce RH above 30% in the warmest zone or below 60% in the coldest zones served. In conjunction with this change, one exception was modified to allow an exception if required by accreditation standards (as is common in hospitals) and to require that all exempt systems maintain at least a 10% RH deadband. Another exception was added for systems serving zones where humidity levels must be maintained within plus or minus 5%. A series of changes were also made to Section 6.5.2.3, Dehumidification. These include two editorial changes to the requirement and exceptions, as well as four technical changes to the exceptions: 1) the maximum size of the individual fan coil units is reduced from 80,000 to 65,000 Btu/h in exception b; 2) pharmacies are added to the list of special needs spaces in exception d; 3) a requirement is added that certain spaces allowed to reheat for dehumidification control must provide at least 75% of the annual energy needed for reheating or mixing air by site-recovered or site solar energy; and 4) the percentage of recovered or solar energy is increased from 75% to 90% and specifying annual energy in exception e.

**Impact:** Overall, this addendum is rated as a minor positive in terms of energy efficiency.

#### **Addendum 90.1-2010dn**

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning

**Short Description:** Reduces the limits on hot gas bypass as a means of cooling capacity control.

**Discussion:** Addendum 90.1-2010dn revises the existing hot gas bypass requirements by reducing the allowable percent of total capacity significantly (from 50% to 15% for units with a capacity of less than or equal to 240,000 Btu/h and from 25% to 10% for units with a capacity of greater 240,000 Btu/h). The addendum also specifies that hot gas bypass should be limited to these values for VAV units and single-zone VAV units and that hot gas bypass should not be used for constant-volume units.

**Impact:** Overall, this addendum is rated a minor positive for reducing hot gas bypass, an inefficient form of variable capacity control.

### **Addendum 90.1-2010do**

**Sections(s) Modified:** 12. Normative References (related to 6. Heating, Ventilating, and Air-Conditioning)

**Short Description:** Updates references to AHRI 550, AMCA 500, ANSI Z21.10.3 & Z21.47, ASHRAE 90.1 and 62.1, NEMA MG 1, and NFPA 70 and 96.

**Discussion:** Addendum 90.1-2010do updates references for nine standards referenced in the mechanical sections of Standard 90.1.

**Impact:** Given that this addendum only updated standards references, this addendum is rated neutral (no impact) in terms of energy efficiency.

### **Addendum 90.1-2010dp**

**Sections(s) Modified:** 3. Definitions, Abbreviations, and Acronyms (related to 6. Heating, Ventilating, and Air-Conditioning)

**Short Description:** Corrects the definition of “walk-in-cooler” to be consistent with federal requirements.

**Discussion:** Addendum 90.1-2010dp only updates a definition used in Section 6, Heating, Ventilating and Air-Conditioning. Addendum 90.1-2010dp modifies the definition of “walk-in cooler” to match the federal definition by replacing the word “but” with “and” and adding an “equal to” sign to the “less than 55°F” portion of the definition.

**Impact:** Given that this addendum updates a definition, it is rated neutral (no impact) in terms of energy efficiency.

### **Addendum 90.1-2010dq**

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning

**Short Description:** Deletes sizing requirements for pipes larger than 24 inches in diameter.

**Discussion:** Addendum 90.1-2010dq drops requirements for piping system design maximum flow rates for pipes larger than 24 inches in diameter because the analysis did not extend beyond 24-inch pipes.

**Impact:** Because there are now no flow rate limits for pipes larger than 24 inches in diameter, this constitutes a very slight weakening of the standard and therefore this addendum is rated a minor negative in terms of energy efficiency.

### **Addendum 90.1-2010dv**

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning

**Short Description:** Establishes chiller and boiler fluid flow isolation requirements so there is no flow through the equipment when not in use.

**Discussion:** Addendum 90.1-2010dv revises the existing chiller and boiler pump requirements in Standard 90.1. Specifically, the addendum makes it clear that this section applies only to chiller and boiler pumps and makes a number of editorial changes to the section. The addendum does add two new requirements (now in Section 6.5.4.3 of Standard 90.1-2013): When constant speed pumps serve multiple chillers (or boilers), the number of pumps must be no less than the number of chillers (or boilers) and the pumps must be staged off and on with the chillers (or boilers).

**Impact:** These requirements are intended reduce standby pump, chiller, and boiler energy use. Based on these new requirements, this addendum is rated as a minor positive in terms of energy efficiency.

#### Addendum 90.1-2010dw

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning

**Short Description:** Revises high-limit shutoff for air economizers. Adds sensor accuracy requirements.

**Discussion:** Addendum 90.1-2010dw modifies the existing high-limit shutoff control requirements for air economizers in Section 6. Specifically, the addendum deletes the existing table of high-limit shutoff control options, which lists the allowable and prohibited control types for each climate zone, and edits the existing table of high-limit shut-off control settings to show the climate zones for which a particular control type is allowed and the required high-limit setpoint for that control in particular climate zones. Two control types are no longer allowed: “electronic enthalpy” and “dew point and dry-bulb temperature.” Both fixed and differential enthalpy control now require a fixed dry-bulb temperature in combination to protect against humidity sensor inaccuracy. A new allowance is made for fixed dry-bulb temperature controls in Climate Zones 1A, 2A, 3A, and 4A. A new footnote to the table requires that devices with selectable rather than adjustable setpoints be capable of being set to within 2°F or 2 Btu/lb of the setpoint listed.

**Impact:** The addition of dry-bulb to enthalpy control has the main impact on energy use, and based on that change this addendum is rated as a minor positive in terms of energy efficiency.

## 4.6 Changes to Section 7, Service Water Heating

A total of two addenda were made to Section 7, Service Water Heating, during the creation of Standard 90.1-2013. One addendum (90.1-2010cd) also modifies Section 6, Heating, Ventilating, and Air-Conditioning, and is therefore discussed in both locations.

#### Addendum 90.1-2010bo

**Sections(s) Modified:** 7. Service Water Heating

**Short Description:** Requires buildings with service water heating (SWH) capacity  $\geq 1$  million Btu/h to have average efficiency of at least 90%. Updates Table 7.8 to reflect federal requirements for electric water heaters. Updates the reference standard for swimming pool water heaters to ASHRAE Standard 146.

**Discussion:** Addendum 90.1-2010bo adds a new requirement in Section 7.5.3 of Standard 90.1-2013 that new buildings with high capacity service water heating systems (defined as gas systems with a total installed input capacity of 1,000,000 Btu/h) have a minimum thermal efficiency of 90%. This essentially requires gas-condensing service water heaters for at least part of the equipment in large new buildings. The addendum also changes the test procedure for heat pump pool heaters to ASHRAE Standard 146, modifies the performance required for certain oil storage water heaters from 78% to 80% thermal efficiency, and modifies the performance required for electric water heaters to match current federal regulations.

**Impact:** Overall, the addition of the new requirement for buildings with high capacity systems to use gas-condensing units is judged the most significant change in this addendum. As this change (and the changes to the oil storage water heater requirements) only applies to a subset of building hot water systems, this addendum is rated as a minor positive in terms of energy efficiency.

### Addendum 90.1-2010cd

**Sections(s) Modified:** 6. Heating, Ventilating, and Air-Conditioning, 7. Service Water Heating, and 3. Definitions, Abbreviations, and Acronyms

**Short Description:** Provides definition for piping to include all accessories in series with pipe such as pumps, valves, strainers, air separators, etc. This is meant to clarify that these accessories need to be insulated.

**Discussion:** Addendum 90.1-2010cd adds a new definition of “piping” to Standard 90.1 and then makes editorial changes to Section 6 and Section 7 to change the word “pipe” to “piping” in eight locations.

**Impact:** This addendum may result in some savings where these accessories may not have been insulated before; however, as the changes are editorial, this addendum is rated as neutral (no impact) in terms of energy efficiency.

## 4.7 Changes to Section 8, Power

A total of five addenda were made to Section 8, Power, during the creation of Standard 90.1-2013. One addendum (90.1-2010bn) contains changes for Section 8, Power, and Section 10, Other Equipment, and is discussed under both sections. Several addenda also modify definitions (Section 3) or normative references (Section 12), but are discussed in this section as the definitions or references modified are related to Section 8, Power.

### Addendum 90.1-2010k

**Sections(s) Modified:** 8. Power and 12. Normative References

**Short Description:** Modifies notes to Table 8.1 and specifies that nominal efficiencies would be established in accordance with the 10 CFR 431 test procedure for low-voltage dry-type transformers. The corresponding references have also been added in Chapter 12.

**Discussion:** Addendum 90.1-2010k modifies the footnotes to Table 8.1 to direct use of 10 CFR 431 instead of NEMA TP1 (NEMA 2002) for low-voltage dry-type transformers. 10 CFR 431 is also added to Chapter 12. (The requirements for low-voltage dry-type transformers are now found in Section 8.4.4 of Standard 90.1-2013).

**Impact:** Because the only impact is to change the reference standard, this addendum is rated as neutral (no impact) in terms of energy efficiency.

### Addendum 90.1-2010v

**Sections(s) Modified:** 8. Power

**Short Description:** Clarifies the requirement for controlled receptacles in open offices by changing the requirement to the workstations themselves. Also requires the automatically controlled receptacles to be appropriately identified for the user’s benefit.

**Discussion:** Addendum 90.1-2010v revises the list of required areas to specifically include individual workstations in all space types not otherwise exempted and areas where modular furniture will be used but is not shown on the construction documents. This addendum also requires that the controlled receptacles be appropriately identified so that users can clearly distinguish between controlled and non-controlled receptacles.

**Impact:** Since this addendum primarily clarifies that the existing requirements include modular furniture, it is rated as neutral (no impact) in terms of energy efficiency.

### **Addendum 90.1-2010bf**

**Sections(s) Modified:** 8. Power

**Short Description:** Addresses Section 8.4.2 on automatic receptacle control and increases the spaces where plug shutoff control is required. Clarifies the application of this requirement for furniture systems, states a labeling requirement to distinguish controlled and uncontrolled receptacles, and restricts the use of plug-in devices to comply with this requirement.

**Discussion:** Addendum 90.1-2010bf modifies existing automatic receptacle control requirements by 1) specifically noting that receptacles must be automatically controlled; 2) specifying receptacles in all private offices, conference rooms, rooms used primarily for printing and copying, break rooms, class rooms, and individual workstations; 3) specifically noting branch feeder circuits installed for modular furniture; 4) reducing the size of an automatically controlled area from 25,000 to 5000 ft<sup>2</sup> and adding a requirement for manual override by occupants; 5) reducing the time allowed for occupancy sensors to turn off receptacles from 30 to 20 minutes after an area is unoccupied; 6) adding a requirement that controlled receptacles be marked to visually differentiate them from uncontrolled receptacles; 7) adding a requirement that plug-in devices not be used to meet the automatic receptacle control requirements; 8) clarifying that 24-hour operation is continuous operation (24 hours/day, 365 days/year) in an exception; and 8) changing the wording of another exception from “automatic shutoff” to “automatic control” for clarity.

**Impact:** Overall, the addendum should save energy by increasing the types of spaces where automatic receptacle control is required and is rated as a minor positive in terms of energy efficiency.

### **Addendum 90.1-2010bn**

**Sections(s) Modified:** 8. Power and 10. Other Equipment

**Short Description:** Establishes electric and fuel metering requirements.

**Discussion:** Addendum 90.1-2010bn implements additional whole building energy monitoring in Standard 90.1. There were existing electrical energy monitoring requirements in Section 8.4.3 in Standard 90.1-2013 due to addendum 90.1-2010bz and these requirements are expanded in addendum 90.1-2010bn. This addendum modifies the existing requirements by specifying that the provision only applies to new buildings and by providing five exceptions: 1) buildings less than 25,000 ft<sup>2</sup>; 2) individual tenant spaces less than 10,000 ft<sup>2</sup>; 3) dwelling units; 4) residential buildings with less than 10,000 ft<sup>2</sup> of common area; and 5) critical and equipment branches as defined by NEC Article 517.<sup>1</sup> In addition, existing exceptions for recording and reporting energy usage are modified to match exceptions for monitoring for buildings (to less than 25,000 ft<sup>2</sup>) and individual tenant spaces (to less than 10,000 ft<sup>2</sup>).

In Section 10, Other Equipment, a new Section 10.4.5 in Standard 90.1-2013 on whole building monitoring of natural gas, fuel oil, propane, steam, chilled water, and hot water is added with a similar list of exceptions to that found in Section 8, except that the critical and equipment branch exception is not included and the exception for hotels, motels, and restaurants is not included, while a new exception for fuel used for on-site emergency equipment is added. A new section on recording and reporting (Section 10.4.5.2 of Standard 90.1-2013) is added with the same exceptions as the monitoring portion of Section 10 (Section 10.4.5.1 of Standard 90.1-2013).

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<sup>1</sup> One issue noted with this addendum is that while it adds an exception based on NEC Article 517, NEC Article 517 was not added as a normative reference. This has been reported to the committee and will be addressed in 2016.

**Impact:** Overall, while the addition of metering requirements through addenda 90.1-2010bn and 90.1-2010bz may have a long-term effect on energy usage if the metered data is used to analyze problems, the addition of monitoring and recording and reporting requirements by themselves does not save energy, so this addendum is therefore rated neutral (no impact) in terms of energy efficiency.

#### Addendum 90.1-2010bz

**Sections(s) Modified:** 8. Power

**Short Description:** Adds Section 8.4.2, which specifies requirements for installation of basic electrical metering of major end uses (total electrical energy, HVAC systems, interior lighting, exterior lighting, and receptacle circuits) to provide basic reporting of energy consumption data to building occupant.

**Discussion:** Addendum 90.1-2010bz (formerly addendum bz to 90.1-2007) was the first of two addenda that significantly expand energy monitoring requirements for Standard 90.1-2013. The other addendum was 90.1-2010bn. Addendum 90.1-2010bz added new monitoring, recording, and reporting requirements for electrical energy to Section 8. These requirements were later modified in addendum 90.1-2010bn.

**Impact:** While the addition of metering requirements through addenda 90.1-2010bn and 90.1-2010bz may have a long-term effect on energy usage if the metered data is used to analyze problems and correction is conducted to improve energy performance, the addition of monitoring and recording and reporting requirements by themselves does not save energy; therefore, this addendum is rated neutral (no impact) in terms of energy efficiency.

## **4.8 Changes to Section 9, Lighting**

A total of 17 addenda were made to Section 9, Lighting, during the creation of Standard 90.1-2013. One addendum (90.1-2010at) updates Section 3, Building Envelope, and Section 9, Lighting, and is discussed in both locations. One major restructuring of Section 9 was that the tables in Section 9.4.2 were renumbered from Table 9.4.2A to 9.4.2B to a new format of Table 9.4.2-1 to 9.4.2-2. These tables were not modified by addenda, but were renumbered during the course of development of Standard 90.1-2013. Another major restructuring was that a number of sections were deleted, combined, or added in Standard 90.1-2013.

Table 4.5 shows the restructuring in Standard 90.1-2013.

**Table 4.5.** Restructuring of Section 9 in 90.1-2013

Section Number	Title 90.1-2010	Title 90.1-2013
9.4	Mandatory Provisions	Mandatory Provisions
9.4.1	Lighting Control	Lighting Controls
9.4.1.1	Automatic Lighting Shutoff	Interior Lighting Controls (includes contents of Sections 9.4.1.1, 9.4.1.2, 9.4.1.4, and 9.4.1.5 of Standard 90.1-2010)
9.4.1.2	Space Control	Parking Garage Lighting Controls (former Section 9.4.1.3 of Standard 90.1-2010)
9.4.1.3	Parking Garage Lighting Control	Special Applications (former Section 9.4.1.6 of Standard 90.1-2010)
9.4.1.4	Automatic Daylighting Controls for Primary Sidelighted Areas	Exterior Lighting Controls (former Section 9.4.17 of Standard 90.1-2010)
9.4.1.5	Automatic Daylighting Controls for Toplighted Areas	Not used in Standard 90.1-2013
9.4.1.6	Additional Controls	Not used in Standard 90.1-2013
9.4.1.7	Exterior Lighting Control	Not used in Standard 90.1-2013
9.4.2	Exit Signs (dropped in Standard 90.1-2013)	Exterior Building Lighting Power (former Section 9.4.3 of Standard 90.1-2010)
9.4.3	Exterior Building Lighting Power	Functional Testing (former Section 9.4.4 of in Standard 90.1-2010)
9.4.4	Functional Testing	
9.5	Building Area Method Compliance Path	Building Area Method Compliance Path
9.5.1	Building Area Method	Building Area Method
9.6	Alternative Compliance Path – Space-by-Space Method	Alternative Compliance Path – Space-by-Space Method
9.6.1	Space-by-Space Method	Space-by-Space Method
9.6.2	Additional Interior Lighting Power	Additional Interior Lighting Power
9.6.3	Room Geometry Adjustment	Additional Interior Lighting Power Using Non-Mandatory Controls (new for Standard 90.1-2013)
9.6.4	Not used in Standard 90.1-2010	Room Geometry Adjustment (former Section 9.6.3 in Standard 90.1-2010)
9.7	Submittals	Submittals
9.7.1	General	General
9.7.2	Completion Requirements	Completion Requirements
9.7.2.1	Drawings	Drawings
9.7.2.2	Manuals	Manuals
9.7.2.3	Not used in Standard 90.1-2010	Daylighting Documentation (new for Standard 90.1-2013)

**Addendum 90.1-2010m**

**Sections(s) Modified:** 9. Lighting

**Short Description:** Adds control requirements for lighting alterations, for interior and exterior applications. Adds a section for submittals and includes loading docks as a tradable surface. Modifies the provisions for additional interior lighting power, which is now calculated based on controlled wattage.

**Discussion:** Addendum 90.1-2010m makes several changes related to lighting:



- Clarifies that changes to existing building lighting must comply with the both the LPD requirements and the specific lighting control requirements.
- Adds specific exterior control requirements to exterior lighting alterations (daylight shutoff and façade/landscape after-hours shutoff).
- Adds the submittal section of the lighting section to the compliance path to ensure that it is clear that compliance with Section 9.7 on submittals is mandatory.
- Adds all nonhuman life forms to the exceptions because, like plants, the lighting needs for humans are not sufficient for the growth and maintenance of animals, which often require different light levels and lighting spectrum.
- Adds the exterior loading area type to Table 9.4.3b (now Table 9.4.2-2 in Standard 90.1-2013) because loading docks are specifically listed as being in the scope of Standard 90.1 (Section 9.1.1b) but they are not listed in Table 9.4.3b (now Table 9.4.2-2 of Standard 90.1-2013) and therefore have no power allowance associated with them.
- Modifies the application of control credits to the appropriate lighting and the specific lighting that is actually controlled.

**Impact:** Given that this addendum requires lighting controls to renovations and adds loading docks to the external lighting power allowances, it is as a major positive in terms of energy efficiency.

#### Addendum 90.1-2010at

**Sections(s) Modified:** 5. Building Envelope, 9. Lighting, and 3. Definitions, Abbreviations, and Acronyms

**Short Description:** Deletes the term “clerestory” and instead adds “roof monitor” and clarifies the definition. Changes the references in Chapters 5 and 9 from clerestory to roof monitor.

**Discussion:** In Section 3, addendum 90.1-2010at deletes the terms “clerestory” and “rooftop monitor” and adds the term “roof monitor.” The terms “fenestration,” “daylit area,” and “toplighting” are edited to use the term “roof monitor.” The addendum also makes minor changes to the daylight area width under roof monitors. Figure 3.2 for the daylight area under roof monitors is also replaced. In Sections 5 and 9, the addendum edits two sections to use the term “roof monitor”—exception d to Section 5.5.4.2.3 and Section 9.4.1.5 (now part of Section 9.4.1.1 of Standard 90.1-2013).

**Impact:** Given that the addendum is editorial, it is rated neutral (no impact) in terms of energy efficiency.

#### Addendum 90.1-2010ay

**Sections(s) Modified:** 9. Lighting and 3. Definitions, Abbreviations, and Acronyms

**Short Description:** Modifies daylighting requirements. Modifies definitions for daylight area under skylights, daylight area under roof monitors, primary sidelight area, secondary sidelight area. Modifies the thresholds for applying automatic daylighting control for sidelighting and toplighting to a wattage basis and provides characteristics for the required photo controls. Modifies Table 9.6.2 to include continuous dimming in secondary sidelighted areas, which is now based on a wattage level rather than space area. Eliminates the need for effective aperture calculation.

**Discussion:** Addendum 90.1-2010ay makes a number of changes related to daylighting and daylighting control:

- Changes the thresholds for applying daylighting controls to a wattage-controlled basis, which applies to more spaces in a building for additional energy savings.
- Simplifies the delineation of daylight zones and clarifies area calculations.
- Eliminates the need for effective aperture calculation.

**Impact:** Because this addendum expands the number of spaces that must utilize daylighting controls, it is rated a minor positive in terms of energy efficiency.

**Addendum 90.1-2010bc**

**Sections(s) Modified:** 9. Lighting

**Short Description:** Modifies requirements for automatic lighting control for guestroom-type spaces. Exceptions to this requirement are lighting and switched receptacles controlled by captive key systems.

**Discussion:** Addendum 90.1-2010bc adds automatic lighting control to guestroom-type spaces for additional energy savings and also allows captive key systems that provide similar savings control to comply.

**Impact:** Based on the expansion of lighting and switched receptacle control requirements to guest rooms, this addendum is rated as a minor positive in terms of energy efficiency.

**Addendum 90.1-2010bd**

**Sections(s) Modified:** 9. Lighting

**Short Description:** Adds more-specific requirements for the functional testing of lighting controls, specifically, occupancy sensors, automatic time switches, and daylight controls.

**Discussion:** Addendum 90.1-2010bd adds more-specific requirements to the functional testing of lighting controls for the common controls required by the standard and clarifies the description of entities allowed to perform the testing and verification.

**Impact:** Based on the addition of new functioning testing requirements for lighting controls, this addendum is rated as a minor positive in terms of energy efficiency.

**Addendum 90.1-2010be**

**Sections(s) Modified:** 9. Lighting

**Short Description:** Makes minor revisions to Section 9.7.2.2, which addresses the scope of the operating and maintenance manuals required for lighting equipment and controls.

**Discussion:** Addendum 90.1-2010be adds the descriptor phrase “including but not limited to lamps, ballasts, and drivers” to the mention of lighting equipment in Section 9.7.2.2, Manuals. The addendum also adds the word “cleaning” after the existing mention of a recommended relamping program.

**Impact:** Given that this addendum is essentially clarification, the estimated impact is neutral (no impact) in terms of energy efficiency.

**Addendum 90.1-2010bh**

**Sections(s) Modified:** 9. Lighting

**Short Description:** Modifies Table 9.6.1, Space-By-Space Lighting Power Density Allowance.

**Discussion:** Addendum 90.1-2010bh modifies the space-by-space method interior lighting power allowance table in five ways:

1. LPDs have been adjusted to account for changes to recommended light levels as published in the new IES Lighting Handbook, 10th Edition. Some values have increased while others have decreased.
2. Three new space types have been added in response to user requests: (a) Copy/Print Rooms; (b) Loading Docks, Interior; and (c) Computer Rooms.
3. New space types for Assisted Living Facilities were added, including corridor, dining area, lobby, restroom, chapel, and recreation room. In all cases, these modified LPDs are restricted to those spaces that are used primarily by the residents.
4. Some space types were renamed for consistency.
5. Some table footnotes were added to provide more-specific direction.

Addendum 90.1-2010cr further modified the LPD values to correct and add space types.<sup>1</sup> Of the five sets of changes noted above, those changes associated with items 2 and 3 are entirely new space types for Standard 90.1-2013 and therefore any consideration of the energy impact of these spaces types would depend on what would have been chosen from the available space types in Standard 90.1-2010 in the absence of these new space types. Items 4 and 5 are essentially editorial or clarification. That leaves item 1 as the only set of changes that can be easily evaluated for stringency.

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<sup>1</sup> See Table 9.6.1 in addendum by in the Addenda 2013 Supplement to ANSI/ASHRAE/IES Standard 90.1-2010, “Energy Standard for Buildings Except Low-Rise Residential Buildings” (ASHRAE 2013a). for the table showing the final LPDs from addenda 90.1-2010 bh, 90.1-2010cr, and 90.1-2010dl. The LPDs generated by these addenda were reformatted in addendum 90.1-2010by.

Table 4.6 and Table 4.7 show the changes made in this addendum that can be compared to existing values in Standard 90.1-2010.

**Table 4.6.** Addendum 2010 90.190.1-2010bh Space-by-Space Lighting Power Changes

	90.1-2010	Addendum bh	Change
<b>Common Space Types<sup>1</sup></b>	<b>LPD</b>		
	<b>watts/sq.ft</b>		
<b>Audience Seating Area —Permanent</b>			
<i>... in an auditorium</i>	0.79	0.63	0.16
<i>... in a gymnasium</i>	0.43	0.65	-0.22
<i>... in a penitentiary</i>	0.43	0.28	0.15
<b>Atrium</b>			
<b>Banking Activity Area</b>	1.38	1.01	0.37
<b><u>Breakroom</u></b> (See Lounge/Breakroom)			
<b>Classroom/Lecture Hall/Training Room</b>			
<b>Confinement Cells</b>	1.1	0.81	0.29
<b>Corridor<sup>2</sup></b>			
<i>... in a hospital</i>	0.89	0.79	0.1
<b>Dining Area</b>			
<i>... in a penitentiary</i>	1.07	0.96	0.11
<i>... in Bar/Lounge or Leisure Dining</i>	1.31	1.07	0.24
<b>Electrical/Mechanical Room</b>	0.95	0.42	0.53
<b>Food Preparation Area</b>	0.99	1.21	-0.22
<b><u>Guest Room</u></b>	0.93	0.47	0.46
<b>Laboratory</b>			
<i>... in or as a classroom</i>	1.28	1.43	-0.15
<b>Lobby</b>			
<i>... in a motion picture theater</i>	0.52	0.59	-0.07
<b>Lounge/Breakroom</b>			
<i>... in a healthcare facility</i>	1.07	0.92	0.15
<b>Office</b>			
<b>Pharmacy Area</b>	1.14	1.68	-0.54
<b>Restroom</b>			
<b>Sales Area<sup>4</sup></b>	1.68	1.59	0.09

**Table 4.7.** Addendum 2010 90.190.1-2010bh Building Area Lighting Power Changes

	90.1-2010	Addendum bh	Change
<b>Building Type Specific Space Types</b>	<b>LPD</b>		
	<b>watts/sq.ft</b>		
<b>Fire Station - Sleeping Quarters</b>	0.25	0.22	0.03
<b><u>Healthcare Facility</u></b>			
<i>... in an Imaging Room</i>	1.32	1.51	-0.19
<i>... in a Medical Supply Room</i>	1.27	0.74	0.53
<i>... in a Nurse's Station</i>	0.87	0.71	0.16
<i>... in an Operating Room</i>	1.89	2.48	-0.59
<b>Library</b>			
<i>... in a Reading Area</i>	0.93	1.06	-0.13
<b>Manufacturing Facility</b>			
<i>... in an Equipment Room</i>	0.95	0.74	0.21
<b>Performing Arts Theater - Dressing Room</b>	0.4	0.61	-0.21
<b>Retail Facilities</b>			
<i>... in a Dressing/Fitting Room</i>	0.87	0.71	0.16
<b>Sports Arena - Playing Area</b>			
<i>... for a Class I facility</i>	3.01	3.68	-0.67
<i>... for a Class II facility</i>	1.92	2.4	-0.48
<i>... for a Class III facility</i>	1.2	1.8	-0.6
<i>... for a Class IV facility</i>	0.72	1.2	-0.48
<b>Transportation Facility</b>			
<i>... in a baggage/carousel Area</i>	0.76	0.53	0.23
<i>... at a Terminal Ticket Counter</i>	1.08	0.8	0.28

**Impact:** The overall savings for the 16 changes to the space-by-space method is 0.09 W/ft<sup>2</sup> based on an unweighted average. The overall savings for the 15 changes for the building-specific space types is -0.12 W/ft<sup>2</sup> based on an unweighted average. This indicates that for the changes that can be quantified in addendum 90.1-2010bh, the impact is slightly negative (-0.03 W/ft<sup>2</sup> for the collection of 31 changes). This is a very small number and therefore further consideration is given of the changes discussed under item 3 above for Assisted Living. These changes were implemented as a replacement to a blanket exemption for Assisted Living facilities in exception g to Section 9.2.2.3 in Standard 90.1-2010. This exception was removed in Standard 90.1-2013 and therefore it is very likely that the values listed for Assisted Living facilities in both the space-by-space and building area tables do represent reductions in energy usage from what would have been installed under Standard 90.1-2013. For this reason, this addendum is rated a minor positive.

### Addendum 90.1-2010bx

**Sections(s) Modified:** 9. Lighting

**Short Description:** Clarifies exceptions to occupancy sensor requirements.

**Discussion:** Addendum 90.1-2010bx removes the statement from the exceptions list to Section 9.4.1.2b (now part of Section 9.4.1.1 of Standard 90.1-2013) that “these spaces are not required to be connected to other automatic lighting shutoff controls” because that was not in standard ASHRAE format for how exceptions are written. Section 9.4.1.2b (now part of Section 9.4.1.1 of Standard 90.1-2013) is in fact a requirement for an occupant sensor or timer switch that automatically turns lighting off, and therefore an exception to that requirement would mean that no automatic lighting shutoff control would be required. The addendum also removes an exception for spaces with multi-scene control systems and modifies the text of another exception to clarify that it is the space that is exempted from 9.4.1.2b (now part of Section 9.4.1.1 of Standard 90.1-2013).

**Impact:** The overall impact of this addendum is rated as neutral (no impact) in terms of energy efficiency, as it is only clarification.

### Addendum 90.1-2010by

**Sections(s) Modified:** 9. Lighting

**Short Description:** Requires the use of certain lighting controls in more space types. Reduces the amount of time after occupants vacate a space for lights to be automatically reduced or shut off. Establishes table of lighting controls applicable to each space type.

**Discussion:** Addendum 90.1-2010by completely replaces the interior lighting control requirements in Section 9.4.1 of Standard 90.1. Because this is a complete replacement, a line-by-line comparison is not appropriate. The foreword to the addendum notes that there are three major impacts of this addendum. First, it requires certain lighting controls in more space types and also reduces the times until lights are automatically shut off. Second, it provides a more tabular structure for lighting controls requirements. And third, it corrects errors in wattage thresholds for sidelighting and toplighting daylight responsive controls.<sup>1</sup> This addendum also provides a new format for LPD requirements that were impacted by addenda 90.1-2010bh, 90.1-2010cr, and 90.1-2010dl, as discussed elsewhere in this section.

**Impact:** Overall, due to the increase of lighting control requirements in more space types, this addendum is rated as a major positive in terms of energy efficiency.

### Addendum 90.1-2010co

**Sections(s) Modified:** 9. Lighting

**Short Description:** Comprehensive update of LPDs in Table 9.5.1 - Building Area Method.

**Discussion:** The original and revised LPDs by building area type are shown in Table 4.8, along with the calculated percentage change, with a decrease (negative values) indicating energy savings. As Table 4.8 shows, the majority of changes are negative, with 6 building area types increasing, 4 building area types staying the same, and 23 building area types decreasing. Overall, an unweighted average of the percentage change is about -4%, indicating that addendum co is a major positive in terms of energy efficiency.

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<sup>1</sup> See Table 9.6.1 in addendum by in the Addenda 2013 Supplement to ANSI/ASHRAE/IES Standard 90.1-2010, “Energy Standard for Buildings Except Low-Rise Residential Buildings” (ASHRAE 2013a), for the control requirements generated by addendum 90.1-2010by. This table also shows the final LPDs from addenda 90.1-2010bh, 90.1-2010cr, and 90.1-2010dl.

**Table 4.8.** Addendum 90.1-2010co Building Area Method Light Power Changes

Building Area Type	Standard 90.1-		Percentage Change
	2010	Addendum co	
Automotive facility	0.82	0.80	-2%
Convention center	1.08	1.01	-6%
Courthouse	1.05	1.01	-4%
Dining: bar lounge/leisure	0.99	1.01	2%
Dining: cafeteria/fast food	0.90	0.90	0%
Dining: family	0.89	0.95	7%
Dormitory	0.61	0.57	-7%
Exercise center	0.88	0.84	-5%
Fire station	0.71	0.67	-6%
Gymnasium	1.00	0.94	-6%
Health-care clinic	0.87	0.90	3%
Hospital	1.21	1.05	-13%
Hotel/Motel	1.00	0.87	-13%
Library	1.18	1.19	1%
Manufacturing facility	1.11	1.17	5%
Motel*	0.88	0.87*	-1%
Motion picture theater	0.83	0.76	-8%
Multifamily	0.60	0.51	-15%
Museum	1.06	1.02	-4%
Office	0.90	0.82	-9%
Parking garage	0.25	0.21	-16%
Penitentiary	0.97	0.81	-16%
Performing arts theater	1.39	1.39	0%
Police station	0.96	0.87	-9%
Post office	0.87	0.87	0%
Religious building	1.05	1.00	-5%
Retail	1.40	1.26	-10%
School/university	0.99	0.87	-12%
Sports arena	0.78	0.91	17%
Town hall	0.92	0.89	-3%
Transportation	0.77	0.70	-9%
Warehouse	0.66	0.66	0%
Workshop	1.20	1.19	-1%

\* Motel now part of combined hotel/motel.

**Impact:** Overall, most LPD requirements are reduced across various building types, indicating that this addendum should be rated a major positive.

### **Addendum 90.1-2010cr**

**Sections(s) Modified:** 9. Lighting and 12. Normative References

**Short Description:** Adjusts Table 9.6.1, Space-by-space LPD.

**Discussion:** Addendum 90.1-2010cr revises the requirements for five common space types in Table 9.6.1. The changes are shown in Table 4.9.<sup>1</sup>

<sup>1</sup> See Table 9.6.1 in addendum 90.1\_2010\_by in the 2013 Supplement to ANSI/ASHRAE/IES Standard 90.1-2010, “Energy Standard for Buildings Except Low-Rise Residential Buildings” (ASHRAE 2013a), for the table showing the final LPDs from addenda 90.1-2010 bh, 90.1-2010cr, and 90.1-2010dl. The LPDs generated by these addenda were reformatted in addendum 90.1-2010by.

**Table 4.9.** Addendum 90.1-2010cr Space-by-Space Light Power Changes

Space Type	Size Modifier	Standard 90.1-2010LPD	Addendum cr LPD	Percentage Change
Hospital Corridor	NA	0.79	0.99	25%
Dining Area in a facility for the visually impaired (and used primarily by staff)	NA	1.90	2.65	39%
Sales Area	NA	1.59	1.44	-9%
Storage Room	Greater than 50 ft <sup>2</sup>	0.63	0.63	No change
Storage Room	Less than or equal to 50 ft <sup>2</sup>	0.63	1.24	97%
Recreation room/common living room in Facility for the Visually Impaired (used primarily by staff)	NA	2.41	2.41	No change

The addendum also adds a new normative reference in ANSI/IES Research Project RP-28-2007, “Lighting and the Visual Environment for Senior Living” (IES 2007). This addendum deals with overall LPDs that were also dealt with in addenda 90.1-2010bh and 90.1-2010by.

**Impact:** Overall, the impact of this addendum is to allow more lighting power in hospital corridors, staff dining areas in facilities for the visually impaired, and small storage rooms. Balancing this out is the reduction in LPD allowed in sales areas. It is very likely that the reduction in allowed LPD more than balances out the increases in LPD for hospital corridors, staff dining areas in facilities for the visually impaired, and small storage rooms. Therefore, this addendum is considered a minor positive.

#### **Addendum 90.1-2010dc**

**Sections(s) Modified:** 9. Lighting

**Short Description:** Clarifies automatic lighting and switched receptacle control in guest rooms as applied to individual spaces.

**Discussion:** Addendum 90.1-2010dc modifies guestroom lighting requirements (including switched receptacles) in Standard 90.1 that were previously modified by addenda 90.1-2010bc and 90.1-2010by by clarifying that each enclosed space should be controlled independently. An exception is added for enclosed spaces where the lighting and switched receptacles are controlled by a captive key system.

**Impact:** The overall impact of this addendum is rated as neutral (no impact) in terms of energy efficiency, as it is only clarification.

#### **Addendum 90.1-2010dj**

**Sections(s) Modified:** 9. Lighting

**Short Description:** Allows additional lighting power allowance for electrical/mechanical rooms to increase the level to the same as provided in 90.1-2010, provided there is a separate control for the additional lighting.

**Discussion:** Addendum 90.1-2010dj adds a footnote to Table 9.6.1 that allows an additional 0.53 W/ft<sup>2</sup> for electrical/mechanical rooms (from the baseline amount of 0.42 W/ft<sup>2</sup>) as long as the additional lighting is separately controlled.

**Impact:** This addendum is essentially a tradeoff of additional LPD for additional controls and as such is rated as neutral (no impact) in terms of energy efficiency.



### Addendum 90.1-2010dk

**Sections(s) Modified:** 9. Lighting

**Short Description:** Eliminates the exemption for wattage used in spaces where lighting is specifically designed for those with age-related eye conditions or other medical conditions related to the eye, where special lighting or light levels might be needed.

**Discussion:** Addendum 90.1-2010dk eliminates an exception for lighting in spaces specifically designed for use by occupants with special lighting needs and also eliminates a requirement that internally illuminated exit signs not exceed 5 W per face. As noted in the foreword to this addendum, addenda 90.1-2010bh and 90.1-2010cr provide new, specific design lighting requirements for spaces occupied by those with special lighting needs. In addition, the 5 W per face requirement for exit signs is now a federal requirement and there is no longer any need for this requirement in Standard 90.1.

**Impact:** This addendum is rated as a minor positive because it trades the blanket exception for spaces occupied by occupants with special lighting needs for more targeted requirements found in other addenda.

### Addendum 90.1-2010dl

**Sections(s) Modified:** 9. Lighting

**Short Description:** Modifies hotel and motel guest room LPD.

**Discussion:** Addendum 90.1-2010dl deletes LPD requirements for hotel guest rooms and highway lodging guest rooms and provides a new requirement for guest rooms. This addendum modifies LPD values that were also modified in addenda 90.1-2010bh and 90.1-2010by.<sup>1</sup> The requirements for guest rooms in Standard 90.1-2010 and in this addendum are shown in Table 4.10.

**Table 4.10.** Addendum 90.1-2010dl Lighting Power Changes

Space Type	Standard 90.1-2010	Addendum 90.1-2010dl
Hotel Guest Rooms	1.11 W/ft <sup>2</sup>	NR
Highway Lodging Guest Rooms	0.75 W/ft <sup>2</sup>	NR
Guest Rooms	NR	0.91 W/ft <sup>2</sup>

**Impact:** The new requirement (0.91W/ft<sup>2</sup>) is slightly less than the average of the two original requirements (0.93) in Standard 90.1-2010, so this requirement is a minor positive in terms of energy efficiency.

### Addendum 90.1-2010dt

**Sections(s) Modified:** 9. Lighting

**Short Description:** Adds exceptions for control of exterior lighting integral to signage. Requires certain types of exterior lighting exempt from LPD requirements to be separately controlled.

**Discussion:** Addendum 90.1-2010dt addresses the exterior lighting and exterior lighting control requirements in Standard 90.1. The addendum removes mention of “advertising signage” and simply

<sup>1</sup> See Table 9.6.1 in addendum 90.1\_2010\_by in the 2013 Supplement to ANSI/ASHRAE/IES Standard 90.1-2010, “Energy Standard for Buildings Except Low-Rise Residential Buildings” (ASHRAE 2013a), for the control requirements generated by addendum 90.1-2010by. This table also shows the final LPDs from addenda 90.1-2010bh, 90.1-2010cr, and 90.1-2010dl.

refers to “signage” and makes it clear that lighting that is integral to signage and installed in signage by a manufacturer is exempt from exterior lighting control requirements and also not included in the exterior lighting power allowance. The addendum also moves a number of exterior lighting items such as temporary lighting, specialized signal, and directional lighting and other exterior lighting that would not be typically included in a building permit to separate exception under Exterior Building Lighting Power.

**Impact:** The impactful change here is the application of the requirement that all signage (and not just advertising signage) be controlled when not needed. For this reason, this addendum is rated as a minor positive in terms of energy efficiency.

## 4.9 Changes to Section 10, Other Equipment

A total of six addenda were made to Section 10, Other Equipment, during the creation of Standard 90.1-2013. One addendum (90.1-2010bn) also modifies Section 8, Power, and is therefore discussed in both locations. Several addenda also modify definitions (Section 3) or normative references (Section 12) but are discussed in this section as the definitions or references modified are related to Section 10, Other Equipment.

One major restructuring of Section 10 was that the tables in Section 10.8 were renumbered from Table 10.8A to 10.8C to a new format of Table 10.8-1 to 10.8-3. The tables called out in this document correspond to the table numbers used in Standard 90.1-2013.

### Addendum 90.1-2010a

**Sections(s) Modified:** 10. Other Equipment and 12. Normative References

**Short Description:** Specifies that nominal efficiencies for motors are required to be established in accordance with 10 CFR 431 instead of NEMA Standards (NEMA 2006). Modifies the footnotes to Tables 10.8A, 10.8B, and 10.8C (now Tables 10.8-1, 10.8-2, and 10.8-3 in Standard 90.1-2013). The corresponding reference for 10 CFR 431 has also been added.

**Discussion:** Addendum 90.1-2010a updates the test procedure references in the tables in Section 10.8 and adds a normative reference in Chapter 12.

**Impact:** Given that this addendum impacts test procedures and no other changes are made, this addendum is rated as neutral (no impact) in terms of energy efficiency.

### Addendum 90.1-2010b

**Sections(s) Modified:** 10. Other Equipment and 12. Normative References

**Short Description:** Requires escalators and moving walks to automatically slow when not conveying passengers. The corresponding reference to ASME A17.1/CSA B44 has also been added to the normative references.

**Discussion:** Addendum 90.1-2010b adds new requirements in Section 10.4.4 of Standard 90.1-2013 that escalators and moving walks automatically slow down when not conveying passengers and adds a normative reference to ASME A17.102010/CSA B44-10, “Safety Code for Elevators and Escalators,” (ASME/CSA 2010) as the source of information on how this should be done.

**Impact:** Given that escalators and moving walks are a minor energy user only affecting a small subset of building types, this addendum is rated as a minor positive in terms of energy efficiency.

### Addendum 90.1-2010n

**Sections(s) Modified:** 10. Other Equipment

**Short Description:** Clarifies that the total lumens per watt for the entire elevator cab is required to meet the efficiency requirement but that each individual light source is not required to meet the lumens per watt value.

**Discussion:** Addendum 90.1-2010n clarifies that the total lumens per watt for the entire elevator cab is required to meet the efficiency requirement but that it is not required that each individual light source must comply.

**Impact:** Given the fact that this addendum is simply clarification, it is rated neutral (no impact) in terms of energy efficiency.

### Addendum 90.1-2010y

**Sections(s) Modified:** 10. Other Equipment and 3. Definitions, Abbreviations, and Acronyms

**Short Description:** Revises the definitions of general purpose electric motors (subtypes I and II) based on information from NEMA. Adds Table 10.8D (now Table 10.8-4 in Standard 90.1-2013), which specifies minimum average full-load efficiency for poly-phase small electric motors; and Table 10.8E (now Table 10.8-5 in Standard 90.1-2013), which specifies minimum average full-load efficiency for capacitor-start capacitor-run and capacitor-start induction-run small electric motors.

**Discussion:** Addendum 90.1-2010y adds a new acronym for “IEC” (International Electrotechnical Commission), completely replaces existing definitions for “general purpose electric motor (subtype I)” and “general purpose electric motor (subtype II),” and adds a new definition for “small electric motor” to Section 3 and updates Section 10 to use these new terms. The addendum also adds two new tables with requirements for poly-phase small electric motors and capacitor-start capacitor-run and capacitor-start induction-run small electric motors.

**Impact:** All of the changes made in this addendum are the result of federal energy efficiency standards and therefore the impact of this addendum is neutral (no impact) in terms of energy efficiency.

### Addendum 90.1-2010bn

**Sections(s) Modified:** 8. Power and 10. Other Equipment

**Short Description:** Establishes electric and fuel metering requirements.

**Discussion:** Addendum 90.1-2010bn implements additional whole building energy monitoring in Standard 90.1. There were existing electrical energy monitoring requirements in Standard 90.1-2013 due to addendum 90.1-2010bz and these requirements are expanded in addendum bn. This addendum modifies the existing requirements by specifying that the provision only applies to new buildings and by providing five exceptions: 1) buildings less than 25,000 ft<sup>2</sup>; 2) individual tenant spaces less than 10,000 ft<sup>2</sup>; 3) dwelling units; 4) residential buildings with less than 10,000 ft<sup>2</sup> of common area; and 5) critical and equipment branches as defined by NEC Article 517.<sup>1</sup> In addition, existing exceptions for recording and reporting energy usage are modified to match exceptions for monitoring for buildings (to less than 25,000 ft<sup>2</sup>) and individual tenant spaces (to less than 10,000 ft<sup>2</sup>).

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<sup>1</sup> One issue noted with this addendum is that while it adds an exception based on NEC Article 517, NEC Article 517 was not added as a normative reference. This has been reported to the SSPC 90.1 and will be addressed in 2014.

In Section 10, Other Equipment, a new section on whole building monitoring of natural gas, fuel oil, propane, steam, chilled water, and hot water is added with a similar list of exceptions to those found in Section 8, except that the critical and equipment branch exception is not included and the exception for hotels, motels, and restaurants is not included, while a new exception for fuel used for on-site emergency equipment is added. A new section on recording and reporting is added with the same exceptions as the monitoring portion of Section 10.

**Impact:** Overall, while the addition of metering requirements through addenda 90.1-2010bn and 90.1-2010bz may have a long-term effect on energy usage if the metered data is used to analyze problems, the addition of monitoring and recording and reporting requirements by themselves does not save energy, so this addendum is estimated to be neutral or have no energy impact.

### **Addendum 90.1-2010br**

**Sections(s) Modified:** 10. Other Equipment

**Short Description:** Updates motor efficiency tables to match Federal rulemaking.

**Discussion:** Addendum 90.1-2010br updates motor definitions and motor efficiency tables in line with a DOE rulemaking. In addition, the efficiency requirements for motors that were produced before December 19, 2010, have been removed because they are no longer allowed to be manufactured in or imported to the United States.

**Impact:** Given that this addendum simply implements a federal rulemaking, it is rated neutral (no impact) in terms of energy efficiency.

## **4.10 Changes to Section 11, Energy Cost Budget Method**

A total of six addenda were made to Section 11, Energy Cost Budget Method, during the creation of Standard 90.1-2013. A number of these addenda also modify Normative Appendix G, Performance Rating Method, and are therefore discussed in both locations. One addendum (90.1-2010bw) updates Section 3, Building Envelope, and Section 11, Energy Cost Budget Method, and is discussed in both locations.

One major restructuring of Section 11 was that the tables in Section 11.3.2 were renumbered from Table 11.3.2A to a new format of Table 11.3.2-1. The tables called out in this document correspond to the table numbers used in Standard 90.1-2013.

### **Addendum 90.1-2010w**

**Sections(s) Modified:** 11. Energy Cost Budget Method, Appendix G. Performance Rating Method, and 3. Definitions, Abbreviations, and Acronyms

**Short Description:** Adds definitions for on-site renewable energy and purchased energy. Clarifies the process for accounting for on-site renewable energy and purchased energy as well as calculating the annual energy costs in the ECB approach and Appendix G.

**Discussion:** Addendum 90.1-2010w clarifies the credit for on-site renewable energy and site recovered energy in Section 11 and Appendix G. Definitions for on-site renewable energy and purchased energy have been added along with clearer guidance on the determination of applicable credits in Section 11 and Appendix G. Credit available for tradeoffs from on-site renewable energy is limited in Section 11 to a maximum of 5% of the calculated energy-cost budget.

**Impact:** Given that this addendum impacts only one of the whole building tradeoffs in Standard 90.1, the impact is rated as neutral (no impact) in terms of energy efficiency.

#### **Addendum 90.1-2010aw**

**Sections(s) Modified:** 11. Energy Cost Budget, Appendix G. Performance Rating Method, and 12. Normative References

**Short Description:** Updates the reference year for ASHRAE Standard 140 and exempts software used for ECB and Appendix G compliance from having to meet certain sections of ASHRAE Standard 140.

**Discussion:** Addendum 90.1-2010aw excludes testing for Sections 7 and 8 of ASHRAE Standard 140-2011 (ASHRAE 2011) from the existing requirement to test to all of Standard 140-2011. Sections 7 and 8 (titled “Class II Test Procedures” and “Class II Output Requirements,” respectively) are focused on testing of home energy rating systems (HERS) and as low-rise residential buildings such as homes that fall outside the scope of Standard 90.1, there is no need to test software used for Standard 90.1 against these two sections. In addition, the addendum updates the reference year for Standard 140 from 2004 to 2011.

**Impact:** Because this addendum is just changing the rules of the whole building tradeoffs in Standard 90.1, the overall energy impact of this addendum is neutral (no impact) in terms of energy efficiency.

#### **Addendum 90.1-2010bl**

**Sections(s) Modified:** 11. Energy Cost Budget and Appendix G. Performance Rating Method

**Short Description:** Provides rules for removing fan energy from efficiency metrics when modeling in ECB or Appendix G.

**Discussion:** Addendum 90.1-2010bl adds a methodology for removing the fan energy component of HVAC efficiency ratings when fan energy is included in that rating. This addendum is applied to Section 11, Energy Cost Budget Method, and Appendix G. In Section 11, the change is added to Section 11.3.2 and Tables 11.3.1 and 11.3.2A. In Appendix G, the change is added to Section G3.1.2.1 and Table G3.1, Part 10, HVAC Systems.

**Impact:** Because this addendum only impacts whole building tradeoffs, the overall impact on energy efficiency is estimated to be neutral (no impact) in terms of energy efficiency.

#### **Addendum 90.1-2010bw**

**Sections(s) Modified:** 5. Building Envelope and 11. Energy Cost Budget Method

**Short Description:** Modifies orientation requirements and adds SHGC tradeoff.

**Discussion:** Addendum 90.1-2010bw modifies existing fenestration orientation requirements by removing the existing requirement that the area of fenestration with south orientation must be greater than or equal to both the area of fenestration with east orientation and the area of fenestration with west orientation and replaces this requirement with two new requirements that consider both the orientation and SHGC of fenestration in various orientations. The two new requirements are (in words):

- a. Western oriented fenestration area must be less than one-quarter of the total fenestration area and eastern oriented fenestration must be less than one-quarter of total fenestration area.
- b. Western solar aperture (area times SHGC) must less than or equal to one-quarter of the total solar aperture and eastern solar aperture must less than or equal to one-quarter of the total solar aperture.

The addendum also removes direction to use the northern orientation in the Southern Hemisphere as the southern orientation is no longer part of the requirement. The addendum also adds two new exceptions. The first new exception is for buildings where the west-oriented and east-oriented vertical fenestration area (as defined in Section 5.5.4.5) does not exceed 20% of the gross wall area for each of those façades, and SHGC on those facades is no greater than 90% of the criteria in Tables 5.5-1 through 5.5-8. The second exception is buildings in Climate Zone 8. The addendum also changes how fenestration orientation is dealt with whole building tradeoffs by using the same approach in the Energy Cost Budget Method as currently used in the Performance Rating Method, that is, simulating the building in all four cardinal orientations and then averaging the results.

**Impact:** The overall impact of this addendum is rated as a minor positive in terms of energy efficiency.

### **Addendum 90.1-2010cg**

**Sections(s) Modified:** 11. Energy Cost Budget and Appendix G. Performance Rating Method

**Short Description:** Modifies the simulation requirements for modeling mandatory automatic daylighting controls as well as automatic lighting controls. Also modifies the simulation requirements for automatic lighting controls in the proposed design, beyond the minimum mandatory requirements. Table G3.2, which provided power adjustment percentages for automatic lighting controls, has been deleted and savings through automatic control devices are now required to be modeled in building simulation through schedule adjustments for the proposed design or by lighting power adjustments defined in Table 9.6.3.

**Discussion:** Addendum 90.1-2010cg modifies Section 11 and Appendix G to include changes that were made in Addenda 90.1-2010d, 90.1-2010x, 90.1-2010ab, and 90.1-2010ac that impact Section 11 and Appendix G. All of these changes deal with automatic lighting controls. Specifically, this addendum updates Section 11 by updating Part 6 Lighting of Table 11.3.1 to include a requirement that the proposed design simulated schedules include the impact of mandatory automatic lighting requirements in Section 9.4.1 (with an exception allowing a specific daylighting controls simulation) and that the proposed design may include other automatic lighting controls not required in Section 9.4.1. The budget building design portion of Table 11.3.1 was also modified to distinguish between mandatory and non-mandatory lighting controls in Section 9.4.1. For Appendix G, similar changes were made to Table G3.1 and in addition, Table G3.2 Power Adjustment Percentages for Automatic Lighting Controls was deleted.

**Impact:** Given that this addendum only makes changes to the whole building tradeoff methodology sections of Standard 90.1, this addendum is rated neutral (no impact) in terms of energy efficiency.

### **Addendum 90.1-2010ci**

**Sections(s) Modified:** 11. Energy Cost Budget, Appendix G. Performance Rating Method, and 3. Definitions, Abbreviations, and Acronyms

**Short Description:** Modifies requirements for the cooling tower fans in Chapter 11 baseline simulations, from two-speed to variable speed. A formula has been specified to calculate the condenser water design supply temperature. Similar revisions have been made to Appendix G for the cooling tower requirements. Definitions for cooling design wet-bulb temperature and evaporation design wet-bulb temperature have been added to Chapter 3.

**Discussion:** Addendum 90.1-2010ci modifies the definition of “cooling design wet-bulb temperature” and adds a new definition for “evaporation design wet-bulb temperature.” The addendum specifically specifies an “open circuit” cooling tower shall be simulated in footnote e of Table 11.3.2A (now Table 11.3.2-1 in Standard 90.1-2013) in Section 11. The addendum also updates the design requirements for cooling towers sizing to be based on the “evaporation design wet-bulb temperature.”

**Impact:** Given that this addendum only makes changes to the whole building tradeoff methodology sections of Standard 90.1, it is rated neutral (no impact) in terms of energy efficiency.

## 4.11 Changes to Section 12, Normative References

Changes made to Section 12, Normative References, during the creation of Standard 90.1-2013 are included in the technical section most appropriate to the definition. For example, addendum 90.1-2010b adds new requirements for escalators and moving walks to Section 10, Other Equipment, and adds a normative reference to ASME A17.1-2010/CSA B44-10, “Safety Code for Elevators and Escalators” (ASME/CSA 2010).

## 4.12 Changes to Informative Appendix E, Informative References

No changes were made solely to Informative Appendix E, Informative References, during the creation of Standard 90.1-2013.

## 4.13 Changes to Informative Appendix F Addenda Description Information

Informative Appendix F, Addenda Description Information, is simply a list of all addenda to Standard 90.1-2010 processed during the creation of Standard 90.1-2013. Informative Appendix F is completely replaced each time Standard 90.1 is updated.

## 4.14 Changes to Normative Appendix G, Performance Rating Method

A total of 20 addenda were made to Normative Appendix G, Performance Rating Method, during the creation of Standard 90.1-2013. A number of these addenda also modify Section 11, Energy Cost Budget Method, and are therefore discussed in both locations.

One major restructuring of Appendix G was that the tables in Section G3.1.1 were renumbered from Table G3.1.1A and G3.1.1B to a new format of Table G3.1.1-1 and G3.1.1-2. The tables called out in this document correspond to the new table numbers used in Standard 90.1-2013.

### Addendum 90.1-2010c

**Sections(s) Modified:** Appendix G

**Short Description:** Adds requirements for laboratory exhaust fans to Section G3.1.1, Baseline HVAC System Type and Definition. Lab exhaust fans are required to be modeled as constant horsepower, reflecting constant volume stack discharge with outside air bypass.

**Discussion:** Addendum 90.1-2010c requires that lab exhaust fans be modeled as constant horsepower reflecting constant volume stack discharge with outdoor air bypass in the baseline HVAC system in Appendix G.

**Impact:** Given that this change is only to one of the whole building tradeoff methodologies, this addendum is rated neutral (no impact) in terms of energy efficiency.

### Addendum 90.1-2010e

**Sections(s) Modified:** Appendix G

**Short Description:** Updates language in Section G3.1, Part 5, Building Envelope, to require that existing buildings use the same envelope baseline as new buildings with the exception of fenestration area.

**Discussion:** Addendum 90.1-2010e modifies Appendix G of Standard 90.1 to create a consistent baseline building envelope for the Performance Rating Method. Standard 90.1-2010 specifies that the baseline building envelope of an existing building reflect the existing conditions rather than the minimum prescriptive requirements of the standard as specified for new buildings and additions. This addendum will provide more consistency in the Performance Rating Method, as all other regulated building components (e.g., mechanical and lighting systems) currently require that the baseline building model be consistent with the standard's prescriptive requirements, regardless of whether the project is new construction or modification to an existing building. With the exception of fenestration area, all other baseline conditions must reflect the standard's prescriptive requirements.

**Impact:** Given that this change is only to one of the whole building tradeoff methodologies, this addendum is rated neutral (no impact) in terms of energy efficiency.

### Addendum 90.1-2010f

**Sections(s) Modified:** Appendix G

**Short Description:** Modifies Section G.3.1, Building Envelope. Specifies the vertical fenestration area for calculating baseline building performance for new buildings and additions.

**Discussion:** Addendum 90.1-2010f establishes baseline window-to-wall areas for different building types. Prior to this addendum, the baseline building window area was equal to the proposed building window area, provided the proposed area was below the prescriptive limit (40%). This has several negative consequences. It caused the baseline energy performance to vary in response to the design window area, so that the baseline becomes a moving target. As a result, two similar buildings with very different energy uses due to differences in window area could have the same performance rating. Another outcome of the existing approach is that it does not reward projects that use an integrated design process to optimize window area to balance heating and cooling loads with daylighting energy savings. The baseline includes the same optimized window area, which has frustrated many design teams. This addendum sets the window area to a level that is average for each building type so that the proposed design will reflect the energy implications of window area.

**Impact:** Given that this change is only to one of the whole building tradeoff methodologies, this addendum is rated neutral (no impact) in terms of energy efficiency.

### Addendum 90.1-2010r

**Sections(s) Modified:** Appendix G and 12. Normative References

**Short Description:** Clarifies the requirements related to temperature and humidity control in Appendix G and relocates all related wording to the Schedules section of Table 2.1. Additionally, clarity is provided for modeling systems that provide occupant thermal comfort via means other than directly controlling the air dry-bulb and wet-bulb temperature (i.e., radiant cooling/heating, elevated air speed, etc.). Permits the use of ASHRAE Standard 55-2010 (ASHARE 2010a) for calculation of PMV-PPD. Also updates the normative references by including a reference to ASHRAE Standard 55-2010.

**Discussion:** Addendum 90.1-2010r modifies Table G3.1 in two ways: 1) Under Section 1, Design Model, Part b – moving the statement that temperature and humidity control setpoints and schedules and



temperature control throttling range be the same for both the proposed and baseline design from this section to 4. Schedules; and 2) adding a new exception to Section 4, Schedule, to allow setpoints and schedules for HVAC systems that automatically provide occupant thermal comfort via means other than direct control of air dry-bulb and wet-bulb temperature to vary between the proposed and baseline design as long as equivalent levels of thermal comfort are provided via the methodologies of ASHRAE Standard 55. The addendum also adds a normative reference to ASHRAE Standard 55.

**Impact:** Given that this addendum impacts only one of the whole building tradeoff methodologies in Standard 90.1, the impact is rated as neutral (no impact) in terms of energy efficiency.

#### **Addendum 90.1-2010w**

**Sections(s) Modified:** 11. Energy Cost Budget Method, Appendix G, and 3. Definitions, Abbreviations, and Acronyms

**Short Description:** Adds definitions for on-site renewable energy and purchased energy. Clarifies the process for accounting for on-site renewable energy and purchased energy as well as calculating the annual energy costs in the ECB approach and Appendix G.

**Discussion:** Addendum 90.1-2010w clarifies the credit for on-site renewable energy and site recovered energy in Section 11 and Appendix G. Definitions for on-site renewable energy and purchased energy have been added along with clearer guidance on the determination of applicable credits in Section 11 and Appendix G. Credit available for tradeoffs from on-site renewable energy is limited in Section 11 to a maximum of 5% of the calculated energy-cost budget.

**Impact:** Given that this addendum impacts only one of the whole building tradeoff methodologies in Standard 90.1, the impact is rated as neutral (none).

#### **Addendum 90.1-2010ag**

**Sections(s) Modified:** Appendix G and 12. Normative References.

**Short Description:** Establishes a method for gaining credit in Appendix G for buildings that undergo whole building air leakage testing to demonstrate that they are air-tight.

**Discussion:** Addendum 90.1-2010ag revises Table G3.1 by adding a new Section b under 5. Building Envelope, that requires infiltration modeling assumptions be the same for the proposed design and baseline design, except for buildings where whole-building air leakage testing is performed, the proposed design air leakage rate is to be based on the measured value. This addendum also adds a new Section G3.1.1.4, Modeling Building Envelope Infiltration, to provide more direction for simulating building infiltration. This addendum also adds a new normative reference in ASTM E779-10, "Standard Test Method for Determining Air Leakage Rate by Fan Pressurization." As pointed out in the short description above, this allows credit for some measure of air-tightness beyond the 0.4 cfm/ft<sup>2</sup> assumed for the baseline design.

**Impact:** Because this addendum is just changing the rules of one of the whole building tradeoffs in Standard 90.1, the overall energy impact of this addendum is neutral (no impact) in terms of energy efficiency.

#### **Addendum 90.1-2010ah**

**Sections(s) Modified:** Appendix G

**Short Description:** Sets system sizing requirements in Appendix G for humid climates based on humidity ratio instead of supply air temperature differential. Sets baseline system dehumidification requirements.

**Discussion:** Addendum 90.1-2010ah sets system sizing requirements for humid climates based on humidity ratios rather than temperature differences. Buildings located in humid climates may require dehumidification and reheat of supply air to maintain space dry-bulb temperatures even when ventilation requirements may be no more than local code and/or Standard 62.1-2007 (ASHRAE 2007). Appendix G baseline building design systems 3 through 8 are “single-path” airflow systems, and unless the requirements for exhaust air energy recovery (Section 6.5.6.1) are met, the baseline building design system may be required to reheat the supply airstream given the dehumidification load.

Because space dehumidification setpoints must be the same between the baseline building design and proposed design, humid climates may result in the baseline building design system having to substantially sub-cool the supply airstream and, in turn, reheat to maintain the space supply air dry-bulb setpoint. In some scenarios, this may result in considerable energy consumption for the baseline building design. The new exception b to Section G3.1.2.9.1 allows the baseline building design supply air to be sized based on the same humidity ratio difference of the proposed design. New Section G3.1.3.18 requires the baseline building design to count only 25% of the total energy used to reheat the supply airstream. The assumption is that 75% of the total energy used to reheat in the baseline building design comes from a recovered source (i.e., condenser heat recovery or exhaust air energy recovery, etc.). By comparison, Section G3.1.3.18 requires design teams to seriously consider limiting or eliminating reheat (by using dedicated outdoor air units, condenser heat recovery, or exhaust air energy recovery, etc.) in the proposed design, because the baseline building design gets 75% of its total reheat energy from a recovered source.

**Impact:** Because this addendum is just changing the rules of one of the whole building tradeoffs in Standard 90.1, the overall energy impact of this addendum is neutral (no impact) in terms of energy efficiency.

#### **Addendum 90.1-2010ai**

**Sections(s) Modified:** Appendix G

**Short Description:** Modifies Appendix G to account for three prescriptive addenda that were incorporated into Standard 90.1-2010, but did not make it into Appendix G in time for publication. Updates economizer requirements to match addendum cy, establishes baseline transformer efficiency requirements to match addendum o, and establishes path A for centrifugal chiller baselines from addendum m.

**Discussion:** Addendum 90.1-2010ai updates Section 11 and Appendix G to be consistent with three addenda to Standard 90.1-2007. The changes to Section 11.3.2(b) and G3.1.2.1 are in response to addendum m to Standard 90.1-2007, which introduced the two paths for chiller efficiency. The new row for Table G3.1 is in response to addendum o to Standard 90.1-2007, which added new requirements for distribution transformers. The changes to Section G3.1.2.8 and Tables G3.1.2.6A, G3.1.2.6B, and 11.3.2D are in response to addendum 90.1-2007cy.

**Impact:** Because this addendum is just changing the rules of one of the whole building tradeoffs in Standard 90.1, the overall energy impact of this addendum is neutral (no impact) in terms of energy efficiency.

#### **Addendum 90.1-2010al**

**Sections(s) Modified:** Appendix G

**Short Description:** Establishes a consistent fuel source for space heating for baseline systems based on climate zone. Establishes a consistent fuel source for service water heating based on building type.

**Discussion:** Addendum 90.1-2010al modifies the baseline building design used in Appendix G. Prior to addendum al, in Appendix G, the choice of space heating energy source (either electricity or fossil fuel) in

the proposed design determines the energy source in the baseline building design. Similarly, the choice of service water heating energy source in the proposed design determines the water heating energy source in the baseline building design. This results, for some buildings, in wide variations in baseline energy-cost budgets, depending on whether electricity or fossil fuel is specified for the proposed design. In some cases, the choice of either electricity or fossil fuel in the proposed design provides a much higher baseline energy cost budget than if the alternative energy source were used. This provides an incentive to use one energy source over the other in order to claim greater savings.

To prevent this unintended impact on the energy savings projected using Appendix G, this addendum specifies the energy source for space heating and water heating to be used in the baseline building design, regardless of the type of energy specified for space heating or water heating in the proposed design. The space heating energy source is determined by climate zone, and the water heating energy source is determined by the type of activity that is proposed for that area of the building. (Building area, rather than whole building, is used for water heating in order to accommodate mixed-use buildings.) Electric space heating is specified for the baseline building design for climate zones where electric space heating is most common (Climate Zones 1 through 3a) and fossil fuel space heating is specified in the baseline building design where it is more common (Climate Zones 3b through 8.) Similarly, building areas with low service water heating demand such as offices, where electricity is most often used for water heating, specify electric water heating for the baseline building design, and uses with high service water heating demand such as hotels, where fossil fuels are used more often for service water heating, specify fossil fuel water heating for the baseline building design.

Where fossil fuels are specified using this procedure, the baseline building energy costs will be based on natural gas costs, unless natural gas is not available at the building location, in which case propane is used for energy costs. The choices of space heating and service water heating energy sources were based on the most common energy source found for that application in the most recent (2003) DOE Energy Information Administration's Commercial Buildings Energy Consumption Survey and on current standard practice. The specification of a consistent baseline building energy budget for a particular proposed building, regardless of the energy source chosen for actual installation in the proposed building, should make energy savings determined using Appendix G more consistent and equitable.

**Impact:** Because this addendum is just changing the rules of one of the whole building tradeoffs in Standard 90.1, the overall energy impact of this addendum is neutral (no impact) in terms of energy efficiency.

#### **Addendum 90.1-2010aw**

**Sections(s) Modified:** 11. Energy Cost Budget, Appendix G, and 12. Normative References

**Short Description:** Updates the reference year for ASHRAE Standard 140 and exempts software used for ECB and Appendix G compliance from having to meet certain sections of ASHRAE Standard 140.

**Discussion:** Addendum 90.1-2010aw excludes testing for Sections 7 and 8 of ASHRAE Standard 140-2011 (ASHRAE 2011) from the existing requirement to test to all of Standard 140-2011. Sections 7 and 8 (titled "Class II Test Procedures" and "Class II Output Requirements," respectively) are focused on testing of HERS and as low-rise residential buildings such as homes fall outside the scope of Standard 90.1, there is no need to test software used for Standard 90.1 against these two sections. In addition, the addendum updates the reference year for Standard 140 from 2004 to 2011.

**Impact:** Because this addendum is just changing the rules of the whole building tradeoffs in Standard 90.1, the overall energy impact of this addendum is neutral (no impact) in terms of energy efficiency.

#### **Addendum 90.1-2010ax**

**Sections(s) Modified:** Appendix G

**Short Description:** Modifies Table G3.1, part 14 of Appendix G to exclude the condition that permits a building surface, shaded by an adjacent structure, to be simulated as north-facing if the simulation program is incapable of simulating shading by adjacent structures.

**Discussion:** Addendum 90.1-2010ax requires that all shading by adjacent structures be modeled per G3.1, part 14a.

**Impact:** Because this addendum is just changing the rules of one of the whole building tradeoffs in Standard 90.1, the overall energy impact of this addendum is neutral (no impact) in terms of energy efficiency.

#### **Addendum 90.1-2010bl**

**Sections(s) Modified:** 11. Energy Cost Budget and Appendix G

**Short Description:** Provides rules for removing fan energy from efficiency metrics when modeling in ECB or Appendix G.

**Discussion:** Addendum 90.1-2010bl adds a methodology for removing the fan energy component of HVAC efficiency ratings when fan energy is included in that rating. This addendum is applied to Section 11, Energy Cost Budget Method, and Appendix G. In Section 11, the change is added to Section 11.3.2 and Tables 11.3.1 and 11.3.2A. In Appendix G, the change is added to Section G3.1.2.1 and Table G3.1, Part 10, HVAC Systems.

**Impact:** Because this addendum only impacts whole building tradeoffs, the overall impact on energy efficiency is estimated to be neutral (no impact) in terms of energy efficiency.

#### **Addendum 90.1-2010ce**

**Sections(s) Modified:** Appendix G

**Short Description:** Establishes a baseline system type for retail occupancies less than three stories in Appendix G.

**Discussion:** Addendum 90.1-2010ce establishes package single-zone systems as the baseline HVAC system type for all retail occupancies of two stories or fewer. Prior to this change, large low-rise retail facilities would have VAV reheat baseline systems, which are uncommon in that building type. This change sets a more realistic baseline building HVAC system.

**Impact:** Because this addendum is just changing the rules of one of the whole building tradeoffs in Standard 90.1, the overall energy impact of this addendum is neutral (no impact) in terms of energy efficiency.

#### **Addendum 90.1-2010cf**

**Sections(s) Modified:** Appendix G

**Short Description:** Establishes baseline WWR in Appendix G for strip malls.

**Discussion:** Addendum 90.1-2010cf updates Appendix G to add a baseline WWR for strip malls. Addendum 90.1-2010f established baseline building WWRs for different building types in Appendix G. Based on limited data available at the time, a value only applicable to standalone retail buildings was established. Since that time, new data have enabled the establishment of a (WWR) for retail strip-mall buildings, which is added in this current addendum.

**Impact:** Because this addendum is just changing the rules of one of the whole building tradeoffs in Standard 90.1, the overall energy impact of this addendum is neutral (no impact) in terms of energy efficiency.

#### **Addendum 90.1-2010cg**

**Sections(s) Modified:** 11. Energy Cost Budget and Appendix G

**Short Description:** Modifies the simulation requirements for modeling mandatory automatic daylighting controls as well as automatic lighting controls. Also modifies the simulation requirements for automatic lighting controls in the proposed design, beyond the minimum mandatory requirements. Table G3.2, which provided power adjustment percentages for automatic lighting controls, has been deleted and savings through automatic control devices are now required to be modeled in building simulation through schedule adjustments for the proposed design or by lighting power adjustments defined in Table 9.6.3.

**Discussion:** Addendum 90.1-2010cg modifies Section 11 and Appendix G to include changes that were made in addenda 90.1-2010d, 90.1-2010x, 90.1-2010ab, and 90.1-2010ac that impact Section 11 and Appendix G. All of these changes deal with automatic lighting controls. Specifically, this addendum updates Section 11 by updating Part 6, Lighting, of Table 11.3.1 to include a requirement that the proposed design simulated schedules include the impact of mandatory automatic lighting requirements in Section 9.4.1 (with an exception allowing a specific daylighting controls simulation) and that the proposed design may include other automatic lighting controls not required in Section 9.4.1. The budget building design portion of Table 11.3.1 was also modified to distinguish between mandatory and non-mandatory lighting controls in Section 9.4.1. For Appendix G, similar changes were made to Table G3.1 and in addition, Table G3.2, Power Adjustment Percentages for Automatic Lighting Controls, was deleted.

**Impact:** Given that this addendum only makes changes to the whole building tradeoff methodology sections of Standard 90.1, it is rated neutral (no impact) in terms of energy efficiency.

#### **Addendum 90.1-2010ci**

**Sections(s) Modified:** 11. Energy Cost Budget, Appendix G. Performance Rating Method, and 3. Definitions, Abbreviations, and Acronyms

**Short Description:** Modifies requirements for the cooling tower fans in Chapter 11 baseline simulations, from two-speed to variable speed. A formula has been specified to calculate the condenser water design supply temperature. Similar revisions have been made to Appendix G for the cooling tower requirements. Definitions for cooling design wet-bulb temperature and evaporation design wet-bulb temperature have been added to Chapter 3.

**Discussion:** Addendum 90.1-2010ci modifies the definition of “cooling design wet-bulb temperature” and adds a new definition for “evaporation design wet-bulb temperature.” The addendum specifically specifies an “open circuit” cooling tower shall be simulated in footnote e of Table 11.3.2A (now Table 11.3.2-1 in Standard 90.1-2013) in Section 11. The addendum also updates the design requirements for cooling towers sizing to be based on the “evaporation design wet-bulb temperature.”

**Impact:** Given that this addendum only makes changes to the whole building tradeoff methodology sections of Standard 90.1, it is rated neutral (no impact) in terms of energy efficiency.

### Addendum 90.1-2010cj

**Sections(s) Modified:** Appendix G

**Short Description:** Creates modeling rules for computer rooms in Appendix G.

**Discussion:** Addendum 90.1-2010cj creates modeling rules for computer rooms in Appendix G.

**Impact:** Given that this addendum only makes changes to the whole building tradeoff methodology sections of Standard 90.1, it is rated neutral (no impact) in terms of energy efficiency.

### Addendum 90.1-2010cn

**Sections(s) Modified:** Appendix G

**Short Description:** Establishes modeling rules for laboratories with 100% outdoor air in Appendix G.

**Discussion:** Addendum 90.1-2010cn allows laboratory designs that incorporate strategies to reduce peak airflows and minimum unoccupied airflows to document energy savings associated with reduced outdoor air volumes. Laboratory systems are often required by the rating authority or accreditation standards to be 100% outdoor air.

Currently, the standard requires ventilation rates for the baseline design to be the same as for the proposed design. Rating authorities interpret this to mean that in the case where baseline airflow is greater than in the proposed design, the baseline system is to be modeled as a recirculating air system. To provide credit to proposed design systems that have lower peak design airflow, the baseline is allowed to vary from the proposed. In addition, the current standard requires baseline minimum airflows in laboratory spaces to be the largest of 50% of zone peak airflow, the minimum outdoor airflow rate, or the airflow rate required to comply with applicable codes or accreditation standards.

Where owners install systems and controls that reduce laboratory airflows below these minimum thresholds, the baseline is required to be modeled as a recirculating system, and the proposed design is not credited with savings associated with reduced outdoor air conditioning.

**Impact:** Given that this addendum only makes changes to the whole building tradeoff methodology sections of Standard 90.1, it is rated neutral (no impact) in terms of energy efficiency.

### Addendum 90.1-2010ct

**Sections(s) Modified:** Appendix G

**Short Description:** Identifies heated-only storage systems 9 and 10 in Appendix G as being assigned one system per thermal zone.

**Discussion:** Addendum 90.1-2010ct modifies Section G3.1.1, Baseline HVAC System Type and Description, to require that for systems 9 and 10 each thermal block be modeled with its own HVAC system, as opposed to requiring that each floor be modeled with a separate HVAC system.

**Impact:** Overall, this addendum impacts only the whole building tradeoff methodology in Appendix G and is therefore rated as neutral (no impact) in terms of energy efficiency.

**Addendum 90.1-2010cv**

**Sections(s) Modified:** Appendix G

**Short Description:** Establishes baseline system types in Appendix G for assembly occupancies.

**Discussion:** Addendum 90.1-2010cv adds two new baseline system types for public assembly building types in Table G3.1.1A (now Standard G3.1.1-1 in Standard 90.1-2013). The addendum also adds a new footnote to the table that defines public assembly building types. The addendum also adds references to the two new system types in 11 locations in Appendix G.

**Impact:** Overall, this addendum impacts only the whole building tradeoff methodology in Appendix G and is therefore rated as neutral (no impact) in terms of energy efficiency.





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## Appendix A. Comparison of Building Envelope Requirements in Standard 90.1-2010 and Standard 90.1-2013

This appendix compares building envelope requirements from Standard 90.1-2010 and addendum 90.1-2010bb. The addendum version published in the 2013 Addenda Supplement to Standard 90.1-2010 (ASHRAE 2013a) contains only a complete replacement version of the building envelope requirements tables and does not identify where changes have been made. The tables below show a side-by-side comparison of the envelope requirements between 90.1-2010 and 90.1-2013 and can be used to identify specific building envelope requirements that have changed.

Abbreviations used in Opaque Envelope tables below:

2010            Requirements in 90.1-2010

bb              Requirements in addendum 90.1-2010bb

**Table A.1.** Addendum 90.1-2010bb Changes to Opaque Envelope U-factor Requirements for Non-Residential Buildings

	Climate Zone															
	1		2		3		4		5		6		7		8	
	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb
IEAD Roof <sup>1</sup>	0.063	0.048	0.048	0.039	0.048	0.039	0.048	0.032	0.048	0.032	0.048	0.032	0.048	0.028	0.048	0.028
Metal Building Roof	0.065	0.041	0.055	0.041	0.055	0.041	0.055	0.037	0.055	0.037	0.049	0.031	0.049	0.029	0.035	0.026
Attic Roof	0.034	0.027	0.027	0.027	0.027	0.027	0.027	0.021	0.027	0.021	0.027	0.021	0.027	0.017	0.021	0.017
Mass Wall	0.580	0.580	0.151	0.151	0.123	0.123	0.104	0.104	0.090	0.090	0.080	0.080	0.071	0.071	0.071	0.048
Metal Building Wall	0.093	0.094	0.093	0.094	0.084	0.094	0.084	0.060	0.069	0.050	0.069	0.050	0.057	0.044	0.057	0.039
Steel-Frame Wall	0.124	0.124	0.124	0.077	0.084	0.077	0.064	0.064	0.064	0.055	0.064	0.049	0.064	0.049	0.064	0.037
Wood-Frame Wall	0.089	0.089	0.089	0.089	0.089	0.089	0.089	0.064	0.064	0.051	0.051	0.051	0.051	0.051	0.036	0.032
Below Ground Wall <sup>2</sup>	1.140	1.140	1.140	1.140	1.140	1.119	1.140	0.119	0.119	0.119	0.119	0.092	0.119	0.063	0.119	0.063
Mass Floor	0.322	0.322	0.107	0.107	0.107	0.074	0.087	0.057	0.074	0.057	0.064	0.051	0.064	0.042	0.057	0.038
Steel-Joist Floor	0.350	0.350	0.052	0.038	0.052	0.052	0.038	0.038	0.038	0.038	0.038	0.032	0.038	0.032	0.032	0.032
Wood-Framed Floor	0.282	0.282	0.051	0.033	0.051	0.033	0.033	0.033	0.033	0.033	0.033	0.027	0.033	0.027	0.033	0.027
Unheated Slab on Grade <sup>3</sup>	0.730	0.730	0.730	0.730	0.730	0.730	0.730	0.520	0.730	0.520	0.540	0.510	0.520	0.510	0.520	0.434
Heated Slab on Grade <sup>3</sup>	1.020	1.020	1.020	0.900	0.900	0.860	0.860	0.843	0.860	0.688	0.860	0.688	0.843	0.671	0.688	0.671

U-factors are expressed in Btu/h-ft<sup>2</sup>-°F.

(1) IEAD: insulation entirely above deck.

(2) Below ground wall requirements are expressed in terms of C-factor (Btu/h-ft<sup>2</sup>-°F)

(3) Unheated and heated slab on grade requirements are expressed in terms of F-factor (Btu/h-ft-°F)

**Table A.2.** Addendum 90.1-2010bb Changes to Opaque Envelope U-factor Requirements for Residential Buildings

	Climate Zone															
	1		2		3		4		5		6		7		8	
	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb
IEAD Roof <sup>1</sup>	0.048	0.039	0.048	0.039	0.048	0.039	0.048	0.032	0.048	0.032	0.048	0.032	0.048	0.028	0.048	0.028
Metal Building Roof	0.065	0.041	0.055	0.041	0.055	0.041	0.055	0.037	0.055	0.037	0.049	0.029	0.049	0.029	0.035	0.026
Attic Roof	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.021	0.027	0.021	0.027	0.021	0.027	0.017	0.021	0.017
Mass Wall	0.151	0.151	0.123	0.123	0.104	0.104	0.090	0.090	0.080	0.080	0.071	0.071	0.071	0.071	0.052	0.048
Metal Building Wall	0.093	0.094	0.093	0.094	0.084	0.072	0.084	0.050	0.069	0.050	0.069	0.050	0.057	0.044	0.057	0.039
Steel-Frame Wall	0.124	0.124	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.055	0.064	0.049	0.042	0.049	0.037	0.037
Wood-Frame Wall	0.089	0.089	0.089	0.089	0.089	0.064	0.064	0.064	0.051	0.051	0.051	0.051	0.051	0.051	0.036	0.032
Below Ground Wall <sup>2</sup>	1.140	1.140	1.140	1.140	1.140	0.119	0.119	0.092	0.119	0.092	0.119	0.063	0.092	0.063	0.075	0.063
Mass Floor	0.322	0.322	0.087	0.087	0.087	0.074	0.074	0.051	0.064	0.051	0.057	0.051	0.051	0.042	0.051	0.038
Steel-Joist Floor	0.350	0.350	0.052	0.038	0.052	0.032	0.038	0.038	0.038	0.038	0.032	0.032	0.032	0.032	0.032	0.032
Wood-Framed Floor	0.282	0.282	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.027	0.033	0.027	0.033	0.027
Unheated Slab on Grade <sup>3</sup>	0.730	0.730	0.730	0.730	0.730	0.540	0.540	0.520	0.540	0.510	0.520	0.434	0.520	0.434	0.510	0.424
Heated Slab on Grade <sup>3</sup>	1.020	1.020	1.020	0.860	0.900	0.860	0.860	0.688	0.860	0.688	0.688	0.671	0.688	0.671	0.688	0.373

U-factors are expressed in Btu/h-ft<sup>2</sup>-°F.

(1) IEAD: insulation entirely above deck.

(2) Below ground wall requirements are expressed in terms of C-factor (Btu/h-ft<sup>2</sup>-°F).

(3) Unheated and heated slab on grade requirements are expressed in terms of F-factor (Btu/h-ft-°F).

**Table A.3.** Addendum 90.1-2010bb Changes to Opaque Envelope U-factor Requirements for Semi-heated Buildings

	Climate Zone															
	1		2		3		4		5		6		7		8	
	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb
IEAD Roof <sup>1</sup>	0.218	0.218	0.218	0.173	0.173	0.119	0.173	0.093	0.119	0.063	0.093	0.063	0.093	0.039	0.063	0.039
Metal Building Roof	0.167	0.115	0.097	0.096	0.097	0.096	0.097	0.082	0.083	0.082	0.072	0.060	0.072	0.037	0.065	0.037
Attic Roof	0.081	0.081	0.081	0.053	0.053	0.053	0.053	0.034	0.053	0.034	0.034	0.034	0.034	0.027	0.034	0.027
Mass Wall	0.580	0.580	0.580	0.580	0.580	0.580	0.580	0.580	0.151	0.151	0.151	0.151	0.123	0.123	0.104	0.104
Metal Building Wall	0.113	0.352	0.113	0.162	0.113	0.162	0.113	0.162	0.113	0.094	0.113	0.094	0.113	0.072	0.113	0.060
Steel-Frame Wall	0.352	0.352	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.084	0.124	0.084	0.124	0.064	0.084	0.064
Wood-Frame Wall	0.292	0.292	0.089	0.089	0.089	0.089	0.089	0.089	0.089	0.089	0.089	0.089	0.089	0.064	0.089	0.051
Below Ground Wall <sup>2</sup>	1.140	1.140	1.140	1.140	1.140	1.140	1.140	1.140	1.140	1.140	1.140	1.119	1.140	0.119	1.140	0.119
Mass Floor	0.322	0.322	0.322	0.322	0.322	0.137	0.137	0.107	0.137	0.107	0.137	0.087	0.107	0.074	0.087	0.064
Steel-Joist Floor	0.350	0.350	0.069	0.069	0.069	0.052	0.069	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
Wood-Framed Floor	0.282	0.282	0.066	0.066	0.066	0.051	0.066	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.033	0.033
Unheated Slab on Grade <sup>3</sup>	0.730	0.730	0.730	0.730	0.730	0.730	0.730	0.730	0.730	0.730	0.730	0.730	0.730	0.730	0.730	0.540
Heated Slab on Grade <sup>3</sup>	1.020	1.020	1.020	1.020	1.020	1.020	1.020	0.900	1.020	0.900	1.020	0.860	0.900	0.860	0.900	0.860

U-factors are expressed in Btu/h-ft<sup>2</sup>-°F.

(1) IEAD: insulation entirely above deck.

(2) Below ground wall requirements are expressed in terms of C-factor (Btu/h-ft<sup>2</sup>-°F).

(3) Unheated and heated slab on grade requirements are expressed in terms of F-factor (Btu/h-ft-°F).

**Table A.4.** Addendum 90.1-2010bb Changes to Fenestration Requirements for Nonresidential Buildings

	Climate Zone															
	1		2		3		4		5		6		7		8	
	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb
Vertical Fenestration, U-factor																
Non-metal Framing	1.20	0.50	0.75	0.40	0.65	0.35	0.40	0.35	0.35	0.32	0.35	0.32	0.35	0.32	0.35	0.32
Metal Framing (curtainwall/storefront)/ Fixed Metal Framing	1.20	0.57	0.70	0.57	0.60	0.50	0.50	0.42	0.45	0.42	0.45	0.42	0.40	0.38	0.40	0.38
Metal Framing (entrance door)	1.20	1.10	1.10	0.83	0.90	0.77	0.85	0.77	0.80	0.77	0.80	0.77	0.80	0.77	0.8	0.77
Metal Framing (all other)/ Operable Metal Framing	1.20	0.65	0.75	0.65	0.65	0.60	0.55	0.50	0.55	0.50	0.55	0.50	0.45	0.40	0.45	0.40
Vertical Fenestration, SHGC																
All framing types	0.25	0.25	0.25	0.25	0.25	0.25	0.40	0.40	0.40	0.40	0.40	0.40	0.45	0.45	0.45	0.45

**Table A.5.** Addendum 90.1-2010bb Changes to Fenestration Requirements for Residential Buildings

	Climate Zone															
	1		2		3		4		5		6		7		8	
	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb
Vertical Fenestration, U-factor																
Non-metal Framing	1.20	0.50	0.75	0.40	0.65	0.35	0.40	0.35	0.35	0.32	0.35	0.32	0.35	0.32	0.35	0.32
Metal Framing (curtainwall/storefront)/ Fixed Metal Framing	1.20	0.57	0.70	0.57	0.60	0.50	0.50	0.42	0.45	0.42	0.45	0.42	0.40	0.38	0.40	0.38
Metal Framing (entrance door)	1.20	1.10	1.10	0.83	0.90	0.77	0.85	0.68	0.80	0.68	0.80	0.68	0.80	0.68	0.80	0.68
Metal Framing (all other)/ Operable Metal Framing	1.20	0.65	0.75	0.65	0.65	0.6	0.55	0.50	0.55	0.50	0.55	0.50	0.45	0.40	0.45	0.40
Vertical Fenestration, SHGC																
All framing types	0.25	0.25	0.25	0.25	0.25	0.25	0.40	0.40	0.40	0.40	0.40	0.40	1.00	0.45	1.00	0.45



**Table A.6.** Addendum 90.1-2010bb Changes to Fenestration Requirements for Semi-heated Buildings

	Climate Zone															
	1		2		3		4		5		6		7		8	
	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb
Vertical Fenestration, U-factor																
Non-metal Framing	1.20	0.93	1.20	0.93	1.20	0.87	1.20	0.51	1.20	0.45	0.65	0.45	0.65	0.32	0.65	0.32
Metal Framing (curtainwall/storefront)/ Fixed Metal Framing	1.20	1.20	1.20	1.20	1.20	1.20	1.20	0.73	1.20	0.62	0.60	0.51	0.60	0.38	0.60	0.38
Metal Framing (entrance door)	1.20	1.20	1.20	1.20	1.20	1.20	1.20	0.81	1.20	0.70	0.90	0.59	0.90	0.44	0.90	0.44
Metal Framing (all other)/ Operable Metal Framing	1.20	1.10	1.20	0.83	1.20	0.77	1.20	0.77	1.20	0.77	0.65	0.77	0.65	0.77	0.65	0.77
Vertical Fenestration, SHGC																
All framing types	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

**Table A.7.** Addendum 90.1-2010bb Changes to Skylight Requirements for Non-Residential Buildings

	Climate Zone															
	1		2		3		4		5		6		7		8	
	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb
Skylights, U-factor, 0-3% skylight area <sup>1</sup>																
Skylights with curb – glass	1.98	0.75	1.98	0.65	1.17	0.55	1.17	0.50	1.17	0.50	1.17	0.50	1.17	0.50	0.98	0.50
Skylights with curb – plastic	1.90	0.75	1.90	0.65	1.30	0.55	1.30	0.50	1.10	0.50	0.87	0.50	0.87	0.50	0.61	0.50
Skylights without curb – all	1.36	0.75	1.36	0.65	0.69	0.55	0.69	0.50	0.69	0.50	0.69	0.50	0.69	0.50	0.58	0.50
Skylights, SHGC, 0-2% skylight area																
Skylights with curb – glass	0.36	0.35	0.36	0.35	0.39	0.35	0.49	0.40	0.49	0.40	0.49	0.40	0.68	1.00	1.00	1.00
Skylights with curb – plastic	0.34	0.35	0.39	0.35	0.65	0.35	0.65	0.40	0.77	0.40	0.71	0.40	0.77	1.00	1.00	1.00
Skylights without curb – all	0.36	0.35	0.36	0.35	0.39	0.35	0.49	0.40	0.49	0.40	0.49	0.40	0.68	1.00	1.00	1.00
Skylights, SHGC, 2-3% skylight area <sup>1</sup>																
Skylights with curb – glass	0.19	0.35	0.19	0.35	0.19	0.35	0.39	0.35	0.39	0.35	0.49	0.35	0.64	0.35	1.00	0.35
Skylights with curb – plastic	0.27	0.35	0.34	0.35	0.34	0.35	0.34	0.35	0.62	0.35	0.58	0.35	0.71	0.35	1.00	0.35
Skylights without curb – all	0.19	0.35	0.19	0.35	0.19	0.35	0.39	0.35	0.39	0.35	0.49	0.35	0.64	0.35	1.00	0.35

(1) For 90.1-2010, U-factor requirements and SHGC requirements apply to skylight areas of up to 5%.

**Table A.8.** Addendum 90.1-2010bb Changes to Skylight Requirements for Residential Buildings

	Climate Zone															
	1		2		3		4		5		6		7		8	
	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb
<b>Skylights, U-factor, 0-3% skylight area<sup>1</sup></b>																
Skylights with curb – glass	1.98	0.75	1.98	0.65	1.17	0.55	1.17	0.50	1.17	0.50	0.98	0.50	1.17	0.50	0.98	0.50
Skylights with curb – plastic	1.90	0.75	1.90	0.65	1.30	0.55	1.30	0.50	1.10	0.50	0.74	0.50	0.61	0.50	0.61	0.50
Skylights without curb – all	1.36	0.75	1.36	0.65	0.69	0.55	0.69	0.50	0.69	0.50	0.58	0.50	0.69	0.50	0.58	0.50
<b>Skylights, SHGC, 0-2% skylight area</b>																
Skylights with curb – glass	0.19	0.35	0.19	0.35	0.36	0.35	0.36	0.40	0.49	0.40	0.46	0.40	0.64	1.00	1.00	1.00
Skylights with curb – plastic	0.27	0.35	0.27	0.35	0.27	0.35	0.62	0.40	0.77	0.40	0.65	0.40	0.77	1.00	1.00	1.00
Skylights without curb – all	0.19	0.35	0.19	0.35	0.36	0.35	0.36	0.40	0.49	0.40	0.49	0.40	0.64	1.00	1.00	1.00
<b>Skylights, SHGC, 2-3% skylight area<sup>1</sup></b>																
Skylights with curb – glass	0.16	0.35	0.19	0.35	0.19	0.35	0.19	0.40	0.39	0.40	0.36	0.40	0.64	1.00	1.00	1.00
Skylights with curb – plastic	0.27	0.35	0.27	0.35	0.27	0.35	0.27	0.40	0.62	0.40	0.55	0.40	0.77	1.00	1.00	1.00
Skylights without curb – all	0.19	0.35	0.19	0.35	0.19	0.35	0.19	0.40	0.39	0.40	0.49	0.40	0.64	1.00	1.00	1.00

(1) For 90.1-2010, U-factor requirements and SHGC requirements apply to skylight areas of up to 5%.

**Table A.9.** Addendum 90.1-2010bb Changes to Skylight Requirements for Semi-heated Buildings

	Climate Zone															
	1		2		3		4		5		6		7		8	
	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb	2010	bb
Skylights, U-factor, 0-3% skylight area <sup>1</sup>																
Skylights with curb - glass	1.98	1.80	1.98	1.80	1.98	1.70	1.98	1.15	1.98	0.98	1.98	0.85	1.98	0.85	1.30	0.85
Skylights with curb - plastic	1.90	1.80	1.90	1.80	1.90	1.70	1.90	1.15	1.90	0.98	1.90	0.85	1.90	0.85	1.10	0.85
Skylights without curb - all	1.36	1.80	1.36	1.80	1.36	1.70	1.36	1.15	1.36	0.98	1.36	0.85	1.36	0.85	0.81	0.85
Skylights, SHGC, 0-2% skylight area																
Skylights with curb - glass	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Skylights with curb - plastic	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Skylights without curb - all	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Skylights, SHGC, 2-3% skylight area <sup>1</sup>																
Skylights with curb - glass	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Skylights with curb - plastic	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Skylights without curb - all	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

(1) For 90.1-2010, U-factor requirements and SHGC requirements apply to skylight areas of up to 5%.





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