BEC-2011

Building Code of Pakistan

(Energy Provisions-2011)

(Promulgated Vide S.R.O. 249(I)/2013 Dated 28th May, 2013)

PAKISTAN ENGINEERING COUNCIL
NATIONAL ENERGY CONSERVATION CENTRE (ENERCON)
MINISTRY OF HOUSING AND WORKS

ENERCON

Building Code of Pakistan

(Energy Provisions-2011)

2011

This Code is dedicated to the memory of all children, women and men suffered and lost lives due to energy shortage

PREFACE

Introduction

Pakistan is facing a huge energy shortfall. On one hand, this has led to extended black-outs and brown-outs, and on the other it has made energy a very expensive commodity. It is therefore imperative to design better systems that minimize energy consumption and improve efficiency. Energy Provisions in Pakistan Building Code 1986 need to be comprehensively bolstered, so that safety and economic health of communities is protected. This has been encapsulated in these "Energy Provisions-2011" as an integral part of Pakistan Building Code 1986. The thrust of these Provisions is to provide energy efficiency benchmarks for buildings. Energy Provisions are compatible with relevant standards of ASHRAE, ANSI, ARI, ASTM etc. Revision to these Provisions will be done every three years, i.e. if not required earlier, so that they are debated upon and kept continuously relevant.

Development

Government of Pakistan has mandated ENERCON to act as the national coordinator for energy conservation measures and policy. In this regard, ENERCON approached Pakistan Engineering Council for review and finalization of Building Code of Pakistan (Energy Provisions-2011). Pakistan Engineering Council, being the statutory body for the development and implementation of building codes, constituted a Task Force for said development. The implementation and enforcement of this Code vest with Ministry of Housing and Works, through concerned authorities.

These Provisions focus on high-end domestic and commercial consumers, and are designed to conserve energy without compromising public safety. Every effort has been made to ensure that these Provisions do not unnecessarily increase cost, or restrict use of new materials and technology. The future development of Energy Provisions-2011 shall encompass low-end users and buildings, if deemed necessary upto 10KW and/or of appropriate covered area.

Adoption

The Energy Provisions shall be adopted as an integral part of Building Code of Pakistan 1986. The notification (SRO) for adoption must give general legal cover to the Code, for enforcement. Such notification shall also allow changes to be made after a minimum of three years, and a maximum of five years by Pakistan Engineering Council along with relevant stakeholders.

Maintenance

The Energy Provisions-2011 of the Code shall be kept updated by a Standing Committee working under the aegis of Pakistan Engineering Council. This Committee shall interact with representatives of industry, engineering professionals and other stakeholders through an open code development process before any change is suggested.

Waiver

While utmost care has been taken by the members who contributed in developing these provisions of the Code, the individuals concerned, and/or their respective organizations, accept no liability resulting from the compliance, or non-compliance of the said Provisions by practitioners. The power to ensure compliance vests only with the Government of Pakistan.

ACKNOWLEDGEMENTS

A document as important and detailed as this Code has input from many individuals. While it is not possible to acknowledge everyone's effort here, it is important to list those in the PEC Task Force for Development of Building Code of Pakistan (Energy Provisions-2011);

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SOURCE DOCUMENTS

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The only exception is Section-4 Building Envelope, which has been developed keeping in view Energy Codes of regional countries and the local environment.

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SECTION – 1

1. PURPOSE

The purpose of Energy Provisions-2011 is to provide minimum requirements for energy-efficient design and construction of buildings. In the current scenario, energy has become a defining factor in the progress of nations. For Pakistan, it is absolutely imperative that we improve energy efficiency in buildings by incorporating international best practices appropriate to our environment, coupled with traditional materials, technologies and craftsmanship developed indigenously over a very long time.

While sustainable alternate energy sources must be developed and harnessed, it is more important that we use existing energy resources in a more efficient way.

SECTION – 2

2. Title

This Code shall be known as the Building Code of Pakistan- Energy Provisions 2011 hereinafter referred to as the "Energy Provisions 2011".

2.1 Scope

These Provisions shall apply to buildings and building clusters that have: a total connected load of 100 kW or greater, or a contract demand of 125 kVA or greater, or a conditioned area of 900 m^2 or greater, or unconditioned buildings of covered area of 1,200 m^2 or more.

The scope of the Energy Provisions is applicable to the following to provide minimum energy-efficient requirements for the design and construction of:

1) new buildings and their systems

2) new portions of existing buildings and their systems, if the conditioned area or connected load exceeds the prescribed above

3) new systems and new equipment in existing buildings, and

4) increase in the electricity load beyond the limit mentioned above

2.2 Applicable Building Systems

The Energy Provisions shall apply to the following:

(a) building envelopes,

(b) building mechanical systems and equipment, including heating, ventilation, and air conditioning (HVAC),

(c) service water heating,

(d) lighting, and

(e) electrical power and motors.

2.3 Exemptions

The Energy Provisions shall not apply to the following:

(a) buildings that do not use either electricity or fossil fuel,

(b) Government notified historically significant and heritage buildings,

(c) equipment and portions of building systems that use energy only for manufacturing processes.

2.4 Limitation

In case of any conflict, relevant Provisions of Safety, Health, or Environmental Codes shall prevail.

SECTION – 3

3. ADMINISTRATION AND ENFORCEMENT

3.1 Compliance Requirements

Review and approval of plans and specifications by respective sanctioning and development authorities/ municipalities shall be in accordance with Energy Provisions-2011.

3.1.1 Mandatory Requirements

Compliance with the requirements of the Energy Provisions-2011 shall be mandatory for all applicable buildings mentioned in Section - 2.

3.1.2 New Buildings

New buildings shall comply with the provisions of Sections 4 through 8.

3.1.3 Alterations to Existing Buildings:

Alterations to existing buildings and building systems shall comply with the Energy Provisions-2011 of Sections 4.0 through Section 8.0.

3.1.3.1 Building Envelope

Alterations to the building envelope shall comply with the requirements of Section – 4.

3.1.3.2 Heating, Ventilation and Air Conditioning

Alterations to building heating, ventilation and air conditioning equipment or systems shall comply with the requirements of Section- 5, applicable to the portions of the building and its systems being altered. Any new equipment or control devices/systems installed in conjunction with the alteration shall comply with the specific minimum efficiency requirements applicable to that equipment or control device/system provided herein.

3.1.3.3 Service Water Heating

Alterations to building service water heating equipment or systems shall comply with the requirements of Section – 6, applicable to the portion of

the building and its system being altered. Any new equipment or control devices/system installed in conjunction with the alteration shall comply with

specific minimum efficiency requirements applicable to that equipment or system/control device provided herein.

3.1.3.4 Lighting

Alterations to building lighting equipment or systems shall comply with the lighting power density requirements of Section – 7, applicable to the portion/s of the building and its system being altered. Any new equipment or system/control devices installed in conjunction with the alteration shall with comply the specific requirements applicable to that equipment or system/control device provided herein.

3.1.3.5 Electric Power System and Motors

Alterations to building electric power systems and motor shall comply with the requirements of Section – 8, applicable to the portions of the building and its systems being altered. Any new equipment or control devices installed in conjunction with the alteration shall comply with the specific requirements applicable to that equipment or control device.

3.2 Administrative Requirements

Administrative requirements relating to permit requirements, having jurisdiction, energy standards, interpretations, claims of exemptions, and rights of appeal are specified by the authority having jurisdiction.

3.3 Compliance Documents

Compliance documents shall show all pertinent data and features of the building, equipment, and systems in sufficient detail to permit the authority having jurisdiction to verify that the building complies with the Energy Provisions 2011.

3.4 Supplementary Information

The authority having jurisdiction may require supplementary information necessary to verify compliance with these Provisions, such as calculations, worksheets, compliance forms, manufacturer's literature, or other data.

SECTION – 4

4. BUILDING ENVELOPE

4.1 General

The criteria set in this section establish the minimum energy conservation and efficiency requirements for the building envelope. Design criteria that results in greater levels of energy efficiency and conservation shall be allowed. The building envelope shall comply with the mandatory provisions of this Section.

4.2 Mandatory Requirements

4.2.1 Building Envelope

The design of buildings, and selection of materials forming their surfaces, shall aim at reducing heat transfer to and from buildings and adhere to the following criteria.

4.2.1.1 External Walls and Roofs

Overall U values of external walls and roofs shall not exceed limits specified in Table 4.2.1.1.

TABLE 4.2.1.1: External Walls and Roof

Wall	U: 0.57 W/m^2.K (0.100 Btu/h.ft^2. ^oF)
Roof	U: 0.44 W/m^2.K (0.078 Btu/h.ft^2. ^oF)

4.2.1.2 Glass and Framing System

a) For buildings with external glass area, not exceeding 40% of the external wall area of the building, the overall U values and shading coefficient shall not exceed limits specified in Table 4.2.1.2A.

TABLE 4.2.1.2A: External Glass Area (≤40%)

Heat Transmission Coefficient (U)	3.5 W/m^2.K (0.44 Btu/h.ft^2. ^oF)
Shading Coefficient (SC)	0.76

b) For buildings with external glass area, in excess of 40% of the external wall area of the building, the overall U values and shading coefficient shall not exceed limits specified in Table

4.2.1.2B.

TABLE 4.2.1.2B: External Glass Area (>40%)

Heat Transmission Coefficient (U)	2.5 $W/m^2.K$ (0.37 $Btu/h.ft^2.\ ^oF$)
Shading Coefficient (SC)	0.35

4.2.1.1 Air Leakage/ Infiltration

The building envelope shall be durably sealed, caulked, gasketed, or weather-stripped to minimize air leakages wherever the tendency exits.

Vestibules/ lounges/ entrances shall be provided to minimize infiltration through revolving/ sliding/ swinging doors.

Air leakages for revolving/ sliding/ swinging entrance/ exit doors shall not exceed 5.0 $L/s/m^2$ (1.0 cfm/ft^2) and for windows, doors air leakage shall not exceed 2.0 $L/s/m^2$ (0.4 cfm/ft^2).

4.3 Compliance Documentation

The authority having jurisdiction would develop the required documents for implementation.

SECTION – 5

5. HEATING, VENTILATING AND AIR CONDITIONING

5.1 General

All heating, ventilating and air-conditioning shall comply with the mandatory Provisions of this Section.

5.1 Mandatory Requirements

5.1.1 Controls

5.2.1.1 System Control

All mechanical cooling and heating systems shall be controlled by a building management system or a time clock that:

a) Can start and stop the system under different schedules for three different day types per week,
b) is capable of retaining programming and time setting during a loss of power for a period of at least 10 hours, and
(c) Includes an accessible manual override that allows temporary operation of the system for up to 2 hours.

Exceptions to 5.2.1.1:

(a) Residential sector with non centralized system/s

5.2.1.2 Temperature Control

Temperature to be maintained as follows:

Summer:	not less than	25^{o}C
Winter:	not more than	22^{o}C

5.2.1.3 Dead Band

All heating and cooling equipment shall be temperature controlled. Where a unit provides both heating and cooling, controls shall be capable of providing a temperature dead band of 3°C (5°F) within which the supply of heating and cooling energy to the zone is shut off or reduced to a minimum. Where separate heating and cooling equipment

serve the same

temperature zone, thermostats shall be interlocked to prevent simultaneous heating and cooling.

Exceptions to 5.2.1.3:

a) Thermostats that require manual changeover between heating and cooling modes.

b) Special occupancy or special applications where wide temperature ranges are not acceptable (such as retirement homes, process applications, data processing, museums, some areas of hospitals) and are approved by the authority having jurisdiction.

5.2.1.4 Mechanical Ventilation

Each mechanical ventilation system (supply and/or exhaust) shall be equipped with a readily accessible switch or other means for shut off or for volume reduction or shut off when full ventilation is not required. Automatic or gravity dampers that close when the system is not operating shall be provided for outdoor air intake and exhausts. Automatic or manual dampers installed for the purpose of shutting off ventilation systems shall be designed with tight shutoff characteristics to minimize air leakage.

Exceptions to 5.2.1.4

Manual dampers for outdoor intakes may be used in the following cases:

a) For single and multi family residential buildings.
b) Dampers are not required when ventilation air flow is less than 100 ft^3/ min (0.047 m^3/ s).

5.2.1.5 Non- Residential Kitchen Space

Non-residential kitchen space shall be designed with an exhaust air and make up air balance such that the space is never under a positive pressure with reference to adjacent space.

5.2.1.6 Cooling Towers

All cooling towers and closed circuit fluid coolers shall have preferably variable drives either two speed motors / pony motors, controlling the fans.

5.2.2 Piping and Ductwork

(a) Piping shall be insulated in accordance with table 5.2.2A:

TABLE 5.2.2A*
Minimum Pipe Insulation Thickness [a]

Fluid Design Operation Temp. Range (°F)	Insulation Conductivity		Nominal Pipe or Tube Size (In.)				
	Conductivity Btu. in./ (h.ft^2.°F)	Mean Rating Temp. °F	< 1	1 to < 1-1/2	1-1/2 to < 4	4 to < 8	≥ 8
Heating Systems (Steam, Steam Condensate, and Hot Water) [b, c]							
> 350	0.32 - 0.34	250	2.5	3.0	3.0	4.0	4.0
251 – 350	0.29 – 0.32	200	1.5	2.5	3.0	3.0	3.0
201 – 250	0.27 – 0.30	150	1.5	1.5	2.0	2.0	2.0
141 – 200	0.25 – 0.29	125	1.0	1.0	1.0	1.5	1.5
105 – 140	0.22 – 0.28	100	0.5	0.5	1.0	1.0	1.0
Domestic and Service Hot Water Systems							
105+	0.22 – 0.28	100	0.5	0.5	1.0	1.0	1.0
Cooling Systems (Chilled Water, Brine, and Refrigerant) [d]							
40 – 46	0.22 – 0.28	100	0.5	0.5	1.0	1.0	1.0
< 40	0.22 – 0.28	100	0.5	1.0	1.0	1.0	1.5

a For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows:

$$T = r\{(1+ t/r)^{K/k} - 1\}$$

Where T = minimum insulation thickness (in.), r = insulation thickness listed in this table for applicable fluid temperature and pipe size, K = conductivity of alternate material at mean rating temperature (Btu in. [h ft^2, ^{0}F], and k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.

b These thicknesses are based on energy *efficiency* consideration only. Additional insulation is sometimes required relative to safety issues/surface temperature.

c Piping insulation is not required between the control valve and coil on run-outs when the control value is located within 4 ft of the coil and the pipe size is 1 in. or less.

d These thicknesses are based on energy *efficiency* consideration only. Issues such as water vapor permeability or surface condensation sometimes require vapor retarders or additional insulation.

(b) Ductwork shall be insulated in accordance with table 5.2.2B.

TABLE 5.2.2B
Minimum Duct Insulation R-Value [a], Combined Heating and Cooling Supply Ducts and Return Ducts

	Duct Locations						
	Exterior	Ventilated Attic	Un-vented Attic above Insulated Ceiling	Un-vented Attic with Roof Insulation [a]	Unconditioned Space [b]	Indirectly Conditioned Space [e]	Buried
Supply Ducts							
	R-6	R-6	R-8	R-3.5	R-3.5	none	R-3.5
Return Ducts							
	R-3.5	R-3.5	R-3.5	None	none	none	None

a Insulation R-value, measured in (h. ft^2. ^0F)/Btu, are for the insulation as installed and do not include film resistance. The required minimum thicknesses do not consider water vapor transmission and possible surface condensation. Where exterior walls are used as plenum walls, wall insulation shall be as required by the most restrictive condition of 5.2.4.2 or Section 4, Insulation resistance measured on a horizontal plane in accordance with ASTM C518 at a mean temperature of 75 ^0F at the installed thickness.
b Includes crawl spaces, both ventilated and non ventilated.
c Includes return air plenums with or without exposed roofs above.

5.2.3 System Balancing

5.2.3.1 General

Construction documents shall require that all HVAC systems be balanced in accordance with generally accepted engineering standards. Construction documents shall require that a written testing, commissioning and balance report be provided to the owner or the designated representative of the building owner for HVAC systems serving zones with a total conditioned area exceeding 5000m^2 ft^2 (5000 ft^2).

5.2.3.2 Air System Balancing

Air systems shall be balanced in a manner to first minimize throttling losses. Then, for fans with fan system power greater than 1.0 hp (0.75 kW), fan speed shall be adjusted to meet design flow conditions.

5.2.3.3 Hydronic System Balancing

Hydronic systems shall be proportionately balanced in a manner to first minimize throttling losses; then the pump impeller shall be trimmed or pump speed shall be adjusted to meet design flow conditions.

Exceptions to 5.2.3.3:

Impellers need not be trimmed nor pump speed adjusted:

(a) For pumps with pump motors of 10 hp or less,

(b) When throttling results in no greater than 5% of the nameplate horsepower draw, or 3 hp (2.24 kW), whichever is greater, above that required if the impeller was trimmed.

5.2.4 Condenser

5.2.4.1 Condenser Location

Care shall be exercised in locating the condenser in such a manner that heat sink is free of interference from heat discharge by devices located in adjoining spaces and also does not interfere with such other systems installed nearby.

5.2.4.2 Treated Water for Condenser

All buildings using centralized cooling water system shall use soft water for the condenser and chilled water system.

5.3 Recommended Guidelines

5.3.1 Minimum Equipment Efficiencies

HVAC Equipment shall meet or exceed the minimum performance at the specified rating conditions when tested in accordance with the specified test procedures. The Equipment shall satisfy all stated requirements unless otherwise stated.

TABLE 5.3.1 A
Air Conditioners and Condensing Units

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency [a]	Test Procedure [b]
Air Conditioners, Air Cooled	<65,000 Btu/h[c]	All	Split System	12.0 SEER	ARI 210/240
			Single Package	12.0 SEER	
Through-the- Wall, Air Cooled	≤30,000 Btu/h[c]	All	Split System	12.0 SEER	
			Single Package	12.0 SEER	
Small-Duct High-Velocity, Air Cooled	< 65,000 Btu/h[c]	All	Split System	10 SEER	
Air Conditioners, Air Cooled	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	10.3 EER	ARI 340/360
		All other	Split System and Single Package	10.1 EER	

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency [a]	Test Procedure [b]
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	9.7 EER	
		All other	Split System and Single Package	9.5 EER	
	≥ 240,000 Btu/h and < 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	9.5 EER 9.7 IPLV	
		All other	Split System and Single Package	9.3 EER 9.5 IPLV	
	≥ 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	9.2 EER 9.4 IPLV	
		All other	Split System and Single Package	9.0 EER 9.2 IPLV	

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency [a]	Test Procedure [b]
Air Conditioners, Water and Evaporatively Cooled	< 65,000 Btu/h	All	Split System and Single Package	12.1 EER	ARI 210/240
	≥ 65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.5 EER	ARI 340/360
		All other	Split System and Single Package	11.3 EER	
	≥ 135,000 Btu/h and <240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER	
		All other	Split System and Single Package	10.8 EER	
	≥ 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	1 1.0 EER 10.3 IPLV	
		All other	Split System and Single Package	10.8 EER 10.1 IPLV	
Condensing Units, Air Cooled	≥ 135,000 Btu/h			10.1 EER 11.2 IPLV	ARI 365

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency [a]	Test Procedure [b]
Condensing Units, Water or Evaporatively Cooled	≥ 135,000 Btu/h			13.1 EER 13.1 IPLV	

a PLVs and part load rating conditions are only applicable to equipment with capacity modulation.

b ASHRAE 90.1-2004 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

c Single-phase, air-cooled air-conditioners < 65,000 Btu/h are regulated by NAECA. SEER values are those set by NAECA.

TABLE 5.3.1B
Electrically Operated Unitary and Applied Heat Pumps
Minimum Efficiency Requirements

Equipment Type	Size Category	Heating Section Type	Sub-Category Or Rating Condition	Minimum Efficiency [a]	Test Procedure [b]
Air Cooled (Cooling Mode)	<65,000 Btu/h[c]	All	Split System Single Package	12.0 SEER	ARI 210/240
				12.0 SEER	
Through the Wall (Air Cooled, Cooling Mode)	<30,000 Btu/h[c]	All	Split System	12.0 SEER	
			Single Package	12.0 SEER	
Small-Duct High-Velocity (Air Cooled, Cooling Mode)	< 65,000 Btu/h[c]	All	Split System	10 SEER	
Air Cooled (Cooling Mode)	>65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	10.1 EER	ARI 340/360
		All other	Split System and Single Package	9.9EER	
	>135,000 Btu/h and <240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	9.3 EER	
		All other	Split System and Single Package	9.1 EER	
	>240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	9.0 EER 9.2IPLV	
		All other	Split System and Single Package	8.8 EER 9.0IPLV	
Water-Source (Cooling Mode)	<17,000Btu/h	All	860F Entering Water	11.2 EER	ISO-13256-1

Equipment Type	Size Category	Heating Section Type	Sub-Category Or Rating Condition	Minimum Efficiency [a]	Test Procedure [b]
	> 17,000 Btu/h and <65,000 Btu/h	All	860F Entering Water	12.0 EER	ISO-13256-1
	>65,000 Btu/h and < 135,000 Btu/h	All	860F Entering Water	12.0EER	ISO-13256-1
Ground water-Source (Cooling Mode)	<135,000 Btu/h	All	590F Entering Water	16.2 EER	ISO-13256-1
Ground Source (Cooling Mode)	< 135,000 Btu/h	All	770FEntering Water	13.4 EER	ISO-13256-1
Air Cooled (Heating Mode)	<65,000 Btu/h[c] (Cooling Capacity)	-	Split System	7.4 HSPF	ARI 210/240
			Single Package	7.4 HSPF	
Through the Wall (Air Cooled, Heating Mode)	<30,000 Btu/h[c] (Cooling capacity)	-	Split System	7.4 HSPF	
			Single Package	7.4 HSPF	
Small-Duct High-Velocity (Air Cooled, Heating Mode)	< 65,000 Btu/h[c] (Cooling capacity)	-	Split System	6.8 HSPF	ARI 210/240
Air Cooled (Heating Mode)	>65,000 Btu/h and <135,000 Btu/h (Cooling Capacity)	-	47°F db/43°F wb Outdoor air	3.2 COP	ARI 340/360
			17°F db/15°F wb Outdoor air	2.2 COP	
	>135,000 Btu/h (Cooling Capacity)	-	47°F db/43°F wb Outdoor air	3.1 COP	
			17°F db/15°F wb Outdoor air	2.0 COP	
Water-Source (Heating Mode)	<135,000 Btu/h (Cooling Capacity)	-	68°F Entering Water	4.2 COP	ISO-13256-1
Groundwater-Source (Heating Mode)	<135,000 Btu/h (Cooling Capacity)	-	50°F Entering Water	3.6 COP	ISO-13256-1
Ground Source (Heating Mode)	< 135,000 Btu/h (Cooling Capacity)	-	32°F Entering Water	3.1 COP	ISO-13256-1

a IPLVs and Part load rating conditions are only applicable to equipment with capacity modulation.

b ASHRAE 90.1-2004 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

c Single phase, air-cooled heat pumps < 65,000 Btu/h are regulated by NAECA, SEER and HSPF values those set by NAECA.

TABLE 5.3.1C
Water Chilling Packages
Minimum Efficiency Requirements

Equipment Type	Size Category	Subcategory or Rating Condition	Minimum Efficiency [a]	Test Procedure [b]
Air Cooled	All Capacities		2.80 COP 3.05 IPLV	ARI550/590
Water Cooled, Electrically Operated, (Reciprocating)	All Capacities		4.20 COP 5.05 IPLV	ARI550/590
Water Cooled, Electrically Operated, (Rotary Screw and Scroll)	<150 tons		4.45 COP 5.20 IPLV	ARI550/590
	≥150 tons and <300 tons		4.90 COP 5.60 IPLV	
	≥300 tons		5.50 COP 6.15 IPLV	
Water Cooled, Electrically Operated, Centrifugal	<15O tons		5.00 COP 5.25 IPLV	ARI550/590
	≥150 tons and <300 tons		5.55 COP 5.90 IPLV	
	≥300 tons		6.10 COP 6.40 IPLV	
Water-Cooled Absorption Single Effect	All Capacities		0.7 COP	
Absorption Double Effect, Indirect-Fired	All Capacities		1.00 COP 1.05 IPLV	
Absorption Double Effect, Direct-Fired	All Capacities		1.00 COP 1.00 IPLV	

a The chiller equipment requirements do not apply for chillers used in low-temperature applications where the design leaving fluid temperature is $<40^0$F.

b ASHRAE 90.1-2004 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

TABLE 5.3.1D

Electrically Operated Packaged Terminal Air Conditioners, Packaged Terminal Heat Pumps, Single-Package Vertical Air Conditioners, Single -Package Vertical Heat Pumps, Room Air Conditioners, and Room Air Conditioner Heat Pumps-Minimum Efficiency Requirements

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Minimum Efficiency	Test Procedure [a]
PTAC (Cooling Mode) New Construction	All Capacities	95°F db Outdoor air	12.5-(0.213 x Cap/l000)^{c} EER	ARI 310/380
PTAC (Cooling Mode) Replacements[b]	All Capacities	95°F db Outdoor air	10.9 - (0.213 x Cap/l000)^{C} EER	
PTHP (Cooling Mode) New Construction	All Capacities	95°F db Outdoor air	12.3 - (0.213 x Cap/l000)^{C} EER	
PTHP (Cooling Mode) Replacements[b]	All Capacities	95°F db Outdoor air	10.8-(0.213 x Cap/ l000)^{C} EER	
PTHP (Heating Mode) New Construction	All Capacities		3.2 - (0.026 x Cap/l000)^{C} COP	
PTHP (Heating Mode) Replacements[b]	All Capacities		2.9 - (0.026 x Cap/l000)^{C} COP	
SPVAC (Cooling Mode)	All Capacities	95°F db/75°F wb Outdoor air	8.6 EER	ARI 390
SPVHP (Cooling Mode)	All Capacities	95°F db/75°F wb Outdoor air	8.6. EER	
SPVHP (Heating Mode)	All Capacities	47°F db/43°F wb Outdoor air	2.7 COP	
Room Air Conditioners, with Louvered Sides	<6000 Btu/h		9.7 SEER	ANSV AHAM RAC-I
	≥6000 Btu/h and <8000 Btu/h		9.7 EER	
	≥8000 Btu/h and <14,000 Btu/h		9.8 EER	
	≥14,000 Btu/h and <20,000 Btu/h		9.7 SEER	
	≥20,000 Btu/h		8.5 EER	
Room Air Conditioners, Without Louvered Sides	<8000 Btu/h		9.0 EER	
	≥8000 Btu/h and <20,000 Btu/h		8.5 EER	
	≥20,000 Btu/h		8.5 EER	
Room Air Conditioner Heat Pumps with	<20,000 Btu/h		9.0 EER	
	≥20,000 Btu/h		8.5 EER	
Room Air Conditioner Heat Pumps without Louvered Sides	<14,000 Btu/h		8.5 EER	
	≥14,000 Btu/h		8.0 EER	

a ASHRAE 90.1-2004 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

b Replacement units must be factory labeled as follows:"MANUFACTURED FOR

REPLACEMENT APPLICATIONS ONLY; NOT TO BE INSTALLED IN NEW CONSTRUCTION PROJECTS," Replacement efficiencies apply only to units with existing sleeves less than 16 in. high and less than 42 in. wide.

c Cap means the rated cooling capacity of the product in Btu/h. If the unit's capacity is less than 7000 Btu/h, use 7000 Btu/h in the calculation. If the unit's capacity is greater than 15,000 Btu/h, use 15,000 Btu/h in the calculation.

TABLE 5.3.1E

Warm Air Furnaces and Combination Warm Air Furnaces/Air-Conditioning Units, Warm Air Duct Furnaces and Unit Heaters

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Minimum Efficiency [a]	Test Procedure [b]
Warm Air Furnace, Gas-Fired	<225,000 Btu/h		78% AFUE or 80%E_t [d]	DOE 10 CFR Part 430 or ANSI Z21.47
	≥225,000 Btu/h	Maximum Capacity [d]	80% E_c [c]	ANSI Z21.47
Warm air Furnace, Oil-Fired	<225,000 Btu/h		78% AFUE or 80%E_t [d]	DOE 10 CFR Part 430 or UL 727
	≥225,000 Btu/h	Maximum Capacity [e]	81%E_t [f]	UL 727
Warm Air Duct Furnaces, Gas-Fired	All Capacities	Maximum Capacity [e]	80%E_c [g]	ANSI Z83.9
Warm Air Unit Heaters, Gas-Fired	All Capacities	Maximum Capacity [e]	80%E_c [g]	ANSI Z83.8
Warm Air Unit Heaters, Oil-Fired	All Capacities	Maximum Capacity [e]	80% E_c [g]	UL 731

a E_t= thermal efficiency. See test procedure for detailed discussion.

b ASHRAE 90.1-2004 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

c E_c = combustion *efficiency*. Units must also include an interrupted or intermittent ignition device (110), have jacket losses not exceeding 0.75% of the input rating, and have either power venting or a flue damper. A vent damper is an acceptable alternative to a flue damper for those furnaces where combustion air is drawn from the conditioned space.

d Combination units not covered by NAECA (3-phase power or cooling capacity greater than or equal to 65,000 Btu/h) may comply with either rating.

e Minimum and maximum ratings as provided for and allowed by the unit's controls.

f E_t thermal efficiency. Units must also include an interrupted or intermittent ignition device (IID), have jacket losses not exceeding 0.75% of the input rating, and have either power venting or a flue damper. A vent damper is an acceptable alternative to a (contd.)

flue damper for those furnaces where combustion air is drawn from the conditioned space.

g E_c = combustion efficiency. See test procedure for detailed discussion.

TABLE 5.3.1F
Gas and Oil Fired Boilers-Minimum Efficiency Requirements

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Minimum Efficiency [b]	Test Procedure [c]
Boilers, Gas-Fired	<300,000 Btu/h	Hot Water	80% AFUE	DOE 10 CFR Part 430
		Steam	75% AFUE	
	≥300,000 Btu/h and ≤2,500,000 Btu/h	Maximum Capacity [d]	75%E_t [b]	H.I. Htg Boiler Std.
	>2,500,000 Btu/h[a]	Hot Water	80%E_c	
	>2,500,000 Btu/h[a]	Steam	80%E_c	
Boilers, Oil-Fired	<300,000 Btu/h		80% AFUE	DOE 10 CFR Part 430
	≥300,000 Btu/h and ≤2,500,000 Btu/h	Maximum Capacity [d]	78%E_t [b]	DOE 10 CFR Part 430 H.I. Htg Boiler Std.
	>2,500,000 Btu/h[a]	Hot Water	83% E_c	
	>2,500,000 Btu/h[a]	Steam	83%E_c	
Oil-Fired (Residual)	≥300,000 Btu/h and ≤2,500,000 Btu/h	Maximum Capacity [d]	78%E_t [b]	H.I. Htg Boiler Std.
	>2,500,000 Btu/h[a]	Hot Water	83%E_c	
	>2,500,000 Btu/h[a]	Steam	83%E_c	

a These requirements apply to boilers with rated input 800,000,000 Btu/h or less that are not packaged boilers, an to all packaged boilers. Minimum efficiency requirements for boilers cover all capacities of packaged boilers.

b Et = thermal efficiency. See reference document for detailed information.

c ASHRAE 90.1-2004 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

d Minimum and maximum ratings as provided for and allowed by the units controls.

TABLE 5.3.1G
Performance Requirements for Heat Rejection Equipment

Equipment Type	Total System Heat Rejection Capacity at Rated Conditions	Subcategory or Rating Condition	Performance Required [a,b]	Test Procedure [c]
Propeller or Axial Fan Cooling Towers	All	95°F Entering Water 85°F Leaving Water 75°F wb *Outdoor air*	≥38.2 gpm/hp	CTI ATC-I05
Centrifugal Fan Cooling Towers	All	95°F Entering Water 85°F Leaving Water 75°F wb *Outdoor air*	≥20.0 gpm/hp	CTI ATC-I05

Equipment Type	Total System Heat Rejection Capacity at Rated Conditions	Subcategory or Rating Condition	Performance Required [a,b]	Test Procedure [c]
Air-Cooled Condensers	All	125°F Condensing Temperature R-22 Test Fluid 190°F Entering Gas Temperature 15°F Subcooling 95°F Entering db	≥176,000 Btu/h.hp	ARI460

a For purposes of this table, cooling tower performance is defined as the maximum flow rating of the tower divided by the fan nameplate rated motor power.

b For purposes of this table, air-cooled condenser performance is defined as the heat rejected from the refrigerant divided by the fan nameplate rated motor power.

c ASHRAE 90.1-2004 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

5.3.2 Recommended Requirements

Compliance shall be demonstrated with the requirements in 5.3.2.1 through 5.3.2.2 for each HVAC system that meets the following criteria:

(a) Serves a single zone,
(b) Cooling (if any) is provided by a unitary packaged or split-system air conditioner or heat pump,
(c) Heating (if any) is provided by a unitary packaged or split-system heat pump, fuel-fired furnace, electric resistance heater, or baseboards connected to a boiler, and
(d) Outside air quantity is less than 3000 cfm (1,400 l/s) and less than 70% of supply air at design conditions.

Other HVAC systems shall comply with ASHRAE 90.1-2004.

5.3.2.1 Economizers

5.3.2.1.1 Air Side Economizer

Each individual cooling fan system that has a design supply capacity over 2,500 cfm (1,200 l/s) and a total mechanical cooling capacity over 75,600 Btu/hr (22.2 kW or 6.3 tons) shall include either:

a) An air economizer capable of modulating outside-air and return-air dampers to supply 100 percent of the design supply air quantity as outside-air; or
b) A water economizer capable of providing 100% of the expected system cooling load at outside air temperatures of 50°F (10°C) dry-bulb/45°F (7.2°C) wet-bulb and below.

5.3.2.1.2 Testing Air Side Economizer

Air-side economizers shall be tested in the field to ensure proper operation.

Exception to 5.3.2.1.2:

Air economizers installed by the HVAC system equipment manufacturer and certified to the building department as being factory calibrated and tested per relevant ASHRE/ARI Standard procedures.

5.3.2.2 Hydronic Variable Flow Systems

(i) HVAC pumping systems that include control valves shall be designed for variable fluid flow and shall be capable of reducing pump flow rates to:

(a) 50% of the design flow rate, or
(b) less of the design flow rates for proper operation of the chillers or boilers.

(ii) Water cooled air-conditioning or heat pump units with a circulation pump motor greater than or equal to 5 hp (3.7 kW) shall have control devices on each water cooled air-conditioning or heat pump unit that are interlocked with the compressor to shut off condenser water flow when the compressor is not operating.

(iii) Chilled water or condenser water systems that shall comply with either 5.3.2.2 (i) or 5.3.2.2 (ii) and that have pump motors greater than or equal to 5 hp (3.7 kW) shall be controlled by variable speed drives.

5.2 Recommended Voluntary Adoption

5.4.1 Natural Ventilation

Natural ventilation shall comply with the design guidelines as per ASHRAE.

5.4.2 Alternate Energy

The use of energy recovery system, geothermal energy, solar systems and other renewable energy systems is encouraged for adoption in buildings as an alternative to conventional heating, ventilating and cooling systems.

5.5 Compliance Documentation

The authority having jurisdiction would develop the required documents for implementation.

SECTION – 6

6. SERVICE WATER HEATING

6.1 General

All service water heating equipment and systems shall comply with the mandatory Provisions of this Section.

6.2 Mandatory Requirements

6.2.1 Piping Insulation

Piping insulation shall comply with Table 6.2.1:

TABLE 6.2.1
Minimum Pipe Insulation Thickness [a]

Fluid Design Operating Temp. Range (°F)	Insulation Conductivity		Nominal Pipe or Tube Size (In.)				
	Conductivity Btu. in./ (h.ft^2.°F)	Mean Rating Temp. °F	<1	1 to < 1-1/2	1-1/2 to <4	4 to < 8	≥ 8
Heating Systems (Steam, Steam Condensate, and Hot Water) [b, c]							
> 350	0.32 – 0.34	250	2.5	3.0	3.0	4.0	4.0
251 – 350	0.29 – 0.32	200	1.5	2.5	3.0	3.0	3.0
201 – 250	0.27 – 0.30	150	1.5	1.5	2.0	2.0	2.0
141 – 200	0.25 – 0.29	125	1.0	1.0	1.0	1.5	1.5
105 – 140	0.22 – 0.28	100	0.5	0.5	1.0	1.0	1.0
Domestic and Service Hot Water Systems							
105+	0.22 – 0.28	100	0.5	0.5	1.0	1.0	1.0
Cooling Systems (Chilled Water, Brine, and Refrigerant)[d]							
40 – 46	0.22 – 0.28	100	0.5	0.5	1.0	1.0	1.0
< 40	0.22 – 0.28	100	0.5	1.0	1.0	1.0	1.5

a) For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows:

$$T = r\{1 + t/r)^{K/k} - 1\}$$

where T= minimum insulation thickness (in.), r = actual outside radius of pipe (in.), t = insulation thickness listed in this table for applicable fluid temperature and pipe size, K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu·in.[h-ft^2.°F]); and k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.

b) These thicknesses are based on energy efficiency considerations only. Additional insulation is sometimes required relative to safety issues/surface temperature.

c) Piping insulation is not required between the control valve and coil on run-outs when the control valve is located within 4 ft of the coil and the pipe size is I in. or less.

d) These thicknesses are based on energy efficiency considerations only. Issues such as water vapor permeability or surface condensation sometimes require vapor retarders or additional insulation.

6.2.2 Equipment Efficiency

Service water heating equipment shall meet or exceed the minimum efficiency requirements presented in Table 6.2.2:

TABLE 6.2.2
Performance Requirements for Water Heating Equipment

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Performance Required[a]	Test Procedure[b]
Electric Water Heaters	≤12kW	Resistance ≥20 gal	0.93-0.00132V EF	DOE 10CFR Part 430
	>12kW	Resistance≥20 gal	20 + 35 $\sqrt{V}$ SL, Btu/h	ANSI Z21.10.3
	≤24 Amps and ≤250 Volts	Heat Pump	0.93-0.00 132V EF	DOE 10CFR Part 430
Gas Storage Water Heaters	≤75,000 Btu/h	≥20 gal	0.62-0.0019V EF	DOE 10 CFR Part 430
	>75,000 Btu/h	<4000 (Btu/h)/gal	*80% E,* (Q/800 + 110 $\sqrt{V}$) SL, Btu/h	ANSI Z21.1 0.3
Gas Instantaneous Water Heaters	>50,000 Btu/h and <200,000 Btu/h	≥4000 (Btu/h)/gal and <2 gal	0.62-0.0019V EF	DOE 10CFR Part 430
	≥200,000 Btu/h[c]	≥4000 (Btu/h)/gal and <10 gal	*80%E_t*	ANSI Z21.10.3
	≥200,000 Btu/h	≥4000 (Btu/h)/gal and ≥10 gal	*80% E_t* (Q/800 + 110 $\sqrt{V}$) SL, Btu/h	
Oil Storage Water Heaters	≤105,000 Btu/h	≥20 gal	0.59-0.0019V EF	DOE 10 CFR Part 430
	>105,000 Btu/h	≥4000 (Btu/h)/gal	*78% E_t* (Q/800 + 110 $\sqrt{V}$) SL, Btu/h	ANSI Z21.10.3
Oil Instantaneous Water Heaters	≤21 0,000 Btu/h	≥4000 (Btu/h)/gal and <2 gal	0.59-0.00 19V EF	DOE 10CFR Part 430
	>210,000 Btu/h	≥4000 (Btu/h)/gal and <10 gal	*80%E_t*	ANSI Z21.1 0.3
	>210,000 Btu/h	≥4000 (Btu/h)/gal and ≥ 10 gal	*78% E_t* (Q/800 + 110 $\sqrt{V}$) SL, Btu/h	
Hot Water Supply Boilers, Gas and Oil	≥300,000 Btu/h and <12,500,000 Btu/h	≥4000 (Btu/h)/gal and <10 gal	80%E_t	ANSI Z21.10.3
Hot Water Supply Boilers, Gas		≥4000 (Btu/h)/gal and ≥ 1O gal	*80% E_t* (Q/800 + 110 $\sqrt{V}$) SL, Btu/h	
Hot Water Supply Boilers, Oil		≥4000 (Btu/h)/gal and ≥10 gal	78% E_t (Q/800 + 110 $\sqrt{V}$) SL, Btu/h	
Pool Heaters Oil and Gas	All		78%E_t	ASHRAE 146

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Performance Required[a]	Test Procedure[b]
Heat Pump Pool Heaters	All		4.0 COP	ASHRAE 146
Unfired Storage Tanks	All		R-12.5	(none)

[a] Energy factor (EF) and thermal efficiency (El) are minimum requirements, while standby loss (SL) is maximum Btu/h based on a 70°F temperature difference between stored water and ambient requirements. In the EF equation, V is the rated volume in gallons. In the SL equation, V is the rated volume in gallons and Q is the nameplate input rate in Btu/h.

[b] ASHRAE 90.1-2004 contains a complete specification, including the year version, of the referenced test procedure.

[c] Instantaneous water heaters with input rates below 200,000 Btu/h must comply with these requirements if the water heater is designed to heat water to temperatures 180°F or higher.

6.2.3 Swimming Pools

6.2.3.1 Pool Covers

Heated pools shall be provided with a vapor retardant pool cover on or at the water surface. Pools are heated to more than 90°F (32°C) shall have a pool cover with a minimum insulation value of R-12 (R-2.1).

Exception to 6.2.3.1:

Pools deriving over 60% of their energy from site-recovered energy or solar energy source are exempt.

6.2.3.2 Pool Heaters

Pool heaters shall be equipped with a readily accessible on-off switch to allow shutting off the heater without adjusting the thermostat setting. Pool heaters fired by natural gas shall not have continuously burning lights.

6.3 Volunteer Adoption

Buildings with a centralized system may have heat recovery units. The use of solar/ renewable energy for water heating is also recommended for adoption by the buildings with centralized and non centralized systems.

Residential facilities of 420 m^2 (4300 sq.ft) or greater plot area, commercial buildings, hotels and hospitals with centralized system may have solar/ renewable energy for water heating at least one fifth of the design capacity.

6.4 Compliance Documentation

The authority having jurisdiction would develop the required documents for implementation.

SECTION – 7

7.0 LIGHTING

7.1 General

Lighting systems and equipment shall comply with the mandatory provisions of this section. The lighting requirements in this section shall apply to:

(a) Interior spaces of buildings,
(b) Exterior building features, including facades, illuminated roofs, architectural features, entrances, exits, loading docks, and illuminated canopies, and,
(c) Exterior building grounds lighting that is provided through the electrical system of building.

Exceptions to 7.1:

(a) Emergency lighting that is automatically off during normal building operation and is powered by battery, generator, or other alternate power source; and,
(b) Lighting not connected to grid.
(c) Lighting that is specially designated as required by a health or life safety stature or ordinance.

7.2 Mandatory Requirements

7.2.1 Lighting Control

7.2.1.1 Interior Space Control

Each space enclosed by ceiling-height partitions shall have at least one control device to independently control the general lighting within the space. The device can be a switch which is activated either manually or automatically by sensing an occupant sensor. Each control device regardless of the type shall have the following functions;

a) control a maximum of 250 m^2 (2500 ft^2) for space less than or equal to 1,000 m^2 (10,000 ft^2) and maximum of 1,000 m^2 (10,000 ft^2) for a space greater than 1000 m^2 (10,000 ft^2).
b) be capable of overriding the required shut off control for no more than two hours.

c) be readily accessible and located so that occupant can see the control.

7.2.1.2 Exterior Lighting Control

Lighting for all exterior applications not exempted in section 7.3 shall be controlled by a photo sensor or astronomical time switch that is capable of automatically turning off the exterior lighting when day light is available or the lighting is not required.

7.2.1.3 Additional Control

The following specialty lighting spaces shall be equipped with a control device that separates lighting control from that of general lighting:

a) **Display/Accent lighting**: Display/Accent lighting greater than 300 m^2 (3000 ft^2) shall have separate control device.

b) **Case Lighting**: Lighting in cases used for display purposes greater than 30 m^2 (300 ft^2 area shall be equipped with a separate control device.

c) **Hotel and Motel Guest Room Lighting**: Hotel and motel guest rooms and guest suites shall have a master control device at the 0main room entry that controls all permanently installed luminaries and switched receptacles.

d) **Task Lighting**: Supplemental task lighting including permanently installed under shelf or under cabinet lighting shall have control device integral to the luminaries or be controlled by a wall mounted control device provided the control device complies with 7.2.1.1

e) **Non-Visual Lighting**: Lighting for non-visual applications such as plant growth and food warming shall be equipped with space control device.

7.2.2 Exit Signs

Internally-illuminated exit signs shall not exceed 5 W per face.

7.2.3 Exterior Building Grounds Lighting

All exterior building grounds luminaries that operate at greater than 100 watts shall contain lamps having a minimum efficacy of 60 lm/W unless the luminaries is controlled by a motion sensor.

7.2.4 Landscape Lighting

Lighting for landscaping should have a minimum efficacy of 60 lm/ W and should be controlled by photo sensor and astronomic time switch.

7.3 Interior Lighting Power

The installed interior lighting power for a building or a separately metered or permitted portion of a building shall be calculated in accordance with 7.3.3 and shall not exceed the interior lighting power allowance determined in accordance with either 7.3.1 or 7.3.2. Tradeoffs of interior lighting power allowance among portions of the building for which a different method of calculation has been used are not permitted.

Exception to 7.3:

The following lighting equipment and applications shall not be considered when determining the interior lighting power allowance, nor should the wattage for such lighting be included in the installed interior lighting power. However, any such lighting should not be exempted unless it is an addition to general lighting and is controlled by an independent control device.

a) Display or accent lighting that is an essential element for the function performed in galleries, museums, and monuments,
b) Lighting that is integral to equipment or instrumentation and is installed by its manufacturer,
c) Lighting specifically designed for medical or dental procedures and lighting integral to medical equipment,
d) Lighting integral to food warming and food preparation equipment,
e) Lighting for plant growth or maintenance,
f) Lighting in spaces specifically designed for use by the visually impaired,
g) Lighting in retail display windows, provided the display area is enclosed by ceiling height partitions,
h) Lighting in interior spaces that have been specifically designated as a registered interior historic landmark,
i) Lighting that is an integral part of advertising or directional signage,
j) Exit signs,
k) Lighting that is for sale or lighting educational demonstration systems,
l) Lighting for theatrical purposes, including performance, stage, and film or video production, and

m) Athletic playing areas with permanent facilities for television broadcasting.

7.3.1 Building Area Method

Determination of interior lighting power allowance (watts) by building area method shall be in accordance with the following:

a) Determine the allowed lighting power density from table 7.3.1 for each appropriate building area type, however the LPD should be less than or equal to the recommended values. For building area types not listed, selection of a reasonably equivalent type should be permitted.
b) Calculate the gross lighted floor area for each building area type.
c) Multiply the gross lighted floor areas of the building area type(s) times the lighting power density.
d) The interior lighting power allowance for the building is the sum of the lighting power allowances of all building area types. Trade-offs among building area types are permitted provided that the total installed interior lighting power does not exceed the interior lighting power allowance.

TABLE 7.3.1
Interior Lighting Power Densities
Building Area Method

Common Space Type	LPD (W/ft^2)	Building Specific Space Type	LPD (W/ft^2)
Automotive Facility	0.9	Multifamily	0.7
Convention Center	1.2	Museum	1.1
Court House	1.2	Office	1.0
Dining: Bar Lounge/Leisure	1.3	Parking Garage	0.3
Dining: Cafeteria/Fast Food	1.4	Penitentiary	1.0
Dining: Family	1.6	Performing Arts Theater	1.6
Dormitory	1.0	Police/Fire Station	1.0
Exercise Center	1.0	Post Office	1.1
Gymnasium	1.1	Religious Building	1.3
Healthcare-Clinic	1.0	Retail	1.5
Hospital/Health Care	1.2	School/University	1.2
Hotel	1.0	Sports Arena	1.1
Library	1.3	Town Hall	1.1
Manufacturing Facility	1.3	Transportation	1.0
Motel	1.0	Warehouse	0.8
Motion Picture Theater	1.2	Workshop	1.4

In cases where both a general building area type and a specific building area type are listed, the specific building area type shall apply.

7.3.2 Space by Space Method

Determination of interior lighting power allowance by space by space method shall be in accordance with the following:

a) Determine the appropriate building type from Table 7.3.2 and the allowed lighting power density, however LPD should be less than or equal the recommended values. For building type not listed selection of reasonably equivalent type shall be permitted.

b) For each space enclosed by partitions 80% or greater than ceiling height, determine the gross interior floor area by measuring to the center of the partition wall. Include the floor area of balconies or other projections. Retail spaces do not have to comply with the 80% partition height requirements.

c) The interior lighting power allowance is the sum of the lighting power allowances for all spaces. The lighting power allowance for a space is the product of the gross lighted floor area of the space times the allowed lighting power density for that space.

7.3.3 Installed Interior Lighting Power

The installed interior lighting power calculated for compliance with Section-7.4 shall include all power used by the luminaries, including lamps, ballasts, current regulators, and control devices except as specifically exempted in Section-7.1.

Exception to 7.3.3:

If two or more independently operating lighting systems in a space are controlled to prevent simultaneous user operation, the installed interior lighting power should be based solely on the lighting system with the highest power.

TABLE 7.3.2
Interior Lighting Power Densities– Space by Space Method
Space Function LPD (W/ft^2)

Building Area Type	LPD (W/ft^2)	Building Area Type	LPD (W/ft^2)
Office	1.1	Card File & Cataloging	1.1
Conference/Meeting/Multipurpose	1.3	Stacks	1.7
Classroom/Lecture/Training	1.4	Reading Area	1.2
Lobby	1.3	**Hospital**	
For Hotel	1.1	Emergency	2.7
For Performing Arts Theater	3.3	Recovery	0.8
For Motion Picture Theater	1.1	Nurse Station	1.0
Audience/Seating Area	0.9	Exam Treatment	1.5
For Gymnasium	0.4	Pharmacy	1.2
For Exercise Center	0.3	Patient Room	0.7
For Convention Center	0.7	Operating Room	2.2
For Religious Buildings	1.7	Nursery	0.6
For Sports Arena	0.4	Medical Supply	1.4
For Performing Arts Theater	2.6	Physical Therapy	0.9
For Motion Picture Theater	1.2	Radiology	0.4
For Transportation	0.5	Laundry – Washing	0.6
Atrium-first three floors	0.6	Automotive – Service Repair	0.7
Atrium-each additional floor	0.2	**Manufacturing**	
Lounge/Recreation	1.2	Low Bay (<8m ceiling)	1.2
For Hospital	0.8	High Bay (>8m ceiling)	1.7
Dining Area	0.9	Detailed Manufacturing	2.1
For Hotel	1.3	Equipment Room	1.2
For Motel	1.2	Control Room	0.5
For Bar Lounge/Leisure Dining	1.4	Hotel/Motel Guest Rooms	1.1
For Family Dining	2.1	Dormitory – Living Quarters	1.1
Food Preparation	1.2	**Museum**	
Laboratory	1.4	General Exhibition	1,0
Restrooms	0.9	Restoration	1.7
Dressing/Locker/Fitting Room	0.6	Bank Office – Banking Activity Area	1.5
Corridor/Transition	0.5	**Religions Buildings**	
For Hospital	1.0	Worship-pulpit, choir	2.4
For Manufacturing Facility	0.5	Fellowship Hall	0.9
Stairs-active	0.6	**Retail**	
Active Storage	0.8	Sales Area	1.7
For Hospital	0.9	Mall Concourse	1.7
Inactive Storage	0.3	**Sports Arena**	
For Museum	0.8	Ring Sports Area	2.7

Building Area Type	LPD (W/ft^2)	Building Area Type	LPD (W/ft^2)
Electrical/Mechanical	1.5	Court Sports Area	2.3
Workshop	1.9	Indoor Field Area	1.4
Sleeping Quarters	0.3	**Warehouse**	
Convention Center – Exhibit Space	1.3	Fine Material Storage	1.4
		Medium/Bulky Material Storage	0.9
		Parking Garage – Garage Area	0.2
		Transportation	
		Airport – Concourse	0.6
		Air/Train/Bus – Baggage Area	1.0
		Terminal – Ticket Counter	1.5

7.4 Exterior Lighting Power

For building exterior lighting applications specified in Table 7.4, the connected lighting power shall not exceed the specified lighting power limits specified for each of these applications.

TABLE 7.4
Exterior Building Lighting Power

Exterior Lighting Applications	Power Limits
Building entrance (with canopy)	1.3 W/ft^2 (13 W/m^2) of canopied area
Building entrance (without canopy)	30 W/lin ft (90 W/lin m) of door width
Building exit	20 W/lin ft (60 W/lin m) of door width
Building facades	0.2 W/ft^2 (2 W/m^2) of each illuminated wall or surface
Uncovered parking areas	0.15 W/ft^2 (1.5 W/m^2)
Walkways less then 10ft wide	1.0 W/lin ft (3.0 W/lin m)
Walkways 10ft wide or greater	0.2 W/lin ft (0.6 W/lin m)

Exceptions to 7.4:

Lighting used for the follo wing exterior applications is exempted when equipped with an independent control device:

a) Specialized signal, directional, and marker lighting associated with transportation;
b) Lighting used to highlight features of public monuments and registered historic landmark structures or buildings;
c) Lighting that is integral to advertising signage; or
d) Lighting that is specifically designated as required by a health or life safety statute, ordinance, or regulation.
e) Temporary lighting.
f) Lighting for industrial production, material handling, transportation sites, and associated storage areas.
g) Lighting for athletic playing areas.
h) Lighting integral to equipment or instrumentation and installed by its manufacturer.

7.5 Recommended Voluntary Adoption

7.5.1 Lighting Control

7.5.1.1 Automatic Lighting Shutoff

Interior lighting systems in buildings larger than 5,000 ft² (500 m^2) should be controlled with an automatic control device to shut off building lighting in all spaces. Within these buildings, all office areas less than 300 ft^2 (30 m^2) enclosed by walls or ceiling-height partitions, all meeting and conference rooms, all school classrooms, and all storage spaces shall be equipped with occupancy sensors. For other spaces, this automatic control device shall function on either

a) A scheduled basis using a time-of-day operated control device that turn lighting off at specific programmed times – an independent program schedules shall be provided for areas of no more than 25,000 ft² but not more than one floor – or
b) An occupant sensor that shall turn the lighting off within 15 minutes of an occupant leaving the space. Light fixtures controlled by occupancy sensors shall have a wall mounted, manual switch capable of turning off lights when the space is occupied.
c) A signal from another control or alarm system that indicates the area is occupied.

Exception to 7.5.1.1:

The following shall not require an automatic control device.

a) Lighting systems designed for 24-hour use.
b) Lighting in spaces where patient care is rendered.
c) Spaces where an automatic shut off would endanger the security of the room or building occupant (s).

7.5.1.2 Control in Day Lighted Areas

Luminaries in day lighted areas greater than 250 ft^2 (25 m^2) shall be equipped with either a manual or automatic control device that:

a) Is capable of reducing the light output of the luminaries in the day lighted areas by at least 50%, and b) Controls only the luminaries located entirely within the day lighted area.

7.5.1.3. Energy Efficient Lighting

Energy Efficient lighting (environment friendly LED, LVD, Compact Florescent Lighting etc) should be adopted to save energy.

7.5.1.4 Energy Saving Systems:

Certified energy saving systems should be used to save energy.

7.5.1.5 Alternate Energy:

Alternate Energy Options (Solar, wind etc) should be used to enhance the share of alternate energy in energy mix.

7.6 Compliance Documentation

The authority having jurisdiction would develop the required documents for implementation.

SECTION – 8

8.0 ELECTRICAL POWER

8.1 General

Electric equipment and systems shall comply with the mandatory requirements of this section.

8.2 Mandatory Requirements

8.2.1 Transformers

8.2.1.1 Maximum Allowable Power Transformer Losses

Power transformers of the proper ratings and design shall be selected to satisfy the minimum acceptable efficiency at their full load rating. In addition, the transformer must be selected such that it minimizes the total of its initial cost in addition to the present value of the cost of its total lost energy while serving its estimated loads during its respective life span.

Transformers used in buildings shall be constructed with high quality grain oriented low loss silicon steel and virgin electrolytic grade copper and the manufacturer's certificate to this effect should be obtained.

Table 8.2.1.1
Maximum Allowable Losses of 11 kVA Transformers

Transformer Capacity, kVA	Maximum Allowable Losses at Full Load in % Rating
100	2.5
160	2.3
250	2.1
400	1.5
630	1.4
800	1.4
1000	1.2

Reference conditions: 100% of nameplate load at temperature of 75 ^{o}C

8.2.1.2 Measurement and Reporting of Transformer Losses

All measurement of losses shall be carried out by certified persons by using calibrated digital meters of class 0.5 or better accuracy. All transformers of capacity of 500 kVA and above would be equipped with

additional metering class current transformers (CTs) and potential

transformers (PTs) additional to requirements of Utilities so that periodic loss monitoring study may be carried out.

8.2.2 Energy Efficient Motors

Motors shall comply with the following:

(a) Permanently wired poly-phase motors of 0.375 kW or more serving the building should have a minimum acceptable nominal full load motor efficiency not less than shown in Table 8.2.2 for energy efficient motors.

(b) Motors of horsepower differing from those listed in the table should have efficiency greater than that of the next listed kW motor.

(c) Motor horsepower ratings should not exceed 200% of the calculated maximum load being served.

(d) Motor nameplates should list the nominal full-load motor efficiencies and the full-load power factor.

(e) Motor users should insist on proper rewinding practices for any rewound motors. If the proper rewinding practices cannot be assured, the damaged motor should be replaced with a new, efficient one.

(f) Certificates should be obtained and kept on record indicating the motor efficiency. Whenever a motor is rewound, appropriate measures should be taken so that the core characteristics of the motor is not lost due to thermal and mechanical stress during removal of damaged parts. After rewinding, a new efficiency test should be performed and a similar record shall be maintained.

TABLE 8.2.2
Minimum Acceptable Motor Efficiencies

Motor Size (kW)	Efficiency (%)	
	2 Pole	4 Pole
1.1 (1.5 hp)	82.2	83.8
1.5 (2 hp)	84.1	85
2.2 (3 hp)	85.6	86.4
3.0 (4 hp)	86.7	87.4
4.0 (5.5 hp)	87.6	88.3
5.5 (7.5 hp)	88.5	89.2
7.5 (10 hp)	89.5	90.1
11.0 (15 hp)	90.6	91
15.0 (20 hp)	91.3	91.8
18.5 (25 hp)	91.8	92.2
22.0 (30 hp)	92.2	92.6
30.0 (40 hp)	92.9	93.2
37.0 (50 hp)	93.3	93.6
45.0 (60 hp)	93.7	93.9
55.0 (75 hp)	94	94.2
75.0 (100 hp)	94.6	94.7

8.2.3 Power Factor Correction

All electricity supplies exceeding rating of 100 A/ 3 phase, shall maintain their power factor between 0.90 lag and unity at the point of connection.

8.2.4 Check-Metering

(a) Buildings having approved demand greater than 75 kVA shall have the electrical distribution system with their energy metering as under;

- Voltmeter and current meter
- Maximum Demand Indicator (kVA) meter
- kW meter
- kWh meter
- Total Power factor meter

8.2.5 Power Distribution Systems

8.2.5.1 Power Distribution System Losses

The power cabling shall be adequately sized as to maintain the distribution losses less than 1% of the total power usage. Record of design calculation for the losses should be maintained.

8.3 Compliance Documentation

The authority having jurisdiction would develop the required documents for implementation.

SECTION-9

9. DEFINITIONS, ABBREVIATIONS & ACRONYMS

9.1 General

Certain terms, abbreviations, and acronyms are defined in this section for the purposes of this standard. These definitions are applicable to all sections of this code. Terms that are not defined shall have their ordinarily accepted meanings within the context in which they are used. Ordinarily accepted meanings shall be based upon American standard English language usage as documented in an unabridged dictionary accepted by the adopting authority.

9.2 Definitions

Addition: an extension or increase in floor area or height of a building outside of the existing building envelope.

Alteration: any replacement, change, rearrangement, or addition to a building or its systems and equipment; any modification in construction or building equipment; maintenance, repair or change in the building usage shall not constitute an alteration.

Area: see roof and wall, conditioned floor, day lighted, facade, fenestration and lighted floor.

Authority having jurisdiction: the agency or agent responsible for enforcing this Code.

Automatic: self-acting, operating by its own mechanism when actuated by some non-manual influence, such as a change in current strength, pressure, temperature or mechanical configuration.

Automatic control device: a device capable of automatically turning loads off and on without manual intervention.

Balancing, air system: adjusting airflow rates through air distribution system devices, such as fans and diffusers, by manually adjusting the position of dampers, splitters vanes, extractors, etc., or by using automatic control devices, such as constant air volume or variable air volume boxes.

Balancing, hydronic system: adjusting water flow rates through hydronic distribution system devices, such as pumps and coils, by manually adjusting the position valves or by using automatic control devices, such as automatic flow control valves.

Ballast: a device used in conjunction with an electric-discharge lamp to cause the lamp to start and operate under proper circuit conditions of voltage, current, waveform, electrode heat, etc.

Boiler: a self-contained low-pressure appliance for supplying steam or hot water.

Boiler, packaged: a boiler that is shipped complete with heating equipment, mechanical draft equipment, and automatic controls; usually shipped in one or more sections. A packaged boiler includes factory-built boilers manufactured as a unit or system, is disassembled for shipment, and reassembled at the site.

Building: a structure wholly or partially enclosed within exterior walls, or within exterior and party walls, and a roof, affording shelter to persons, animals, or property.

Building, existing: a building or portion thereof that was previously occupied or approved for occupancy by the authority having jurisdiction.

Building complex: a group of buildings in a contiguous area under single ownership.

Building entrance: any doorway, set of doors, turnstiles, or other form of portal that is ordinarily used to gain access to the building by its users and occupants.

Building envelope: the exterior plus the semi-exterior portions of a building. For the purposes of determining building envelope requirements, the classifications are defined as follows:

(a) Building envelope, exterior: the elements of a building that separate conditioned spaces from the exterior.

(b) Building envelope, semi-exterior: the elements of a building that separate conditioned space from unconditioned space or that encloses semi-heated spaces through which thermal energy may be transferred to or from the exterior, or to or from unconditioned spaces, or to or from conditioned spaces.

Building exit: any doorway, set of doors, or other form of portal that is

ordinarily used only for emergency egress or convenience exit.

Building grounds lighting: lighting provided through a building's electrical service for parking lot, site, roadway, pedestrian pathway, loading dock, and security applications.

Building material: any element of the building envelope through which heat flows and that heat is included in the component U-factor calculations other than air films and insulation.

Circuit breaker: a device designed to open and close a circuit by non-automatic means and to open the circuit automatically at a predetermined over-current without damage to itself when properly applied within its rating.

Class of construction: for the building envelope, a subcategory of roof, wall, floor, slab-on-grade floor, opaque door, vertical fenestration, or skylight.

Coefficient Of Performance (COP) – cooling: the ratio of the rate of heat removal to the rate of energy input, in consistent units, for a complete refrigerating system or some specific portion of that system under designated operating conditions.

Coefficient Of Performance (COP) – heating: the ratio of the rate of heat delivered to the rate of energy input, in consistent units, for a complete heat pump system, including the compressor and, if applicable, auxiliary heat, under designated operating conditions.

Commercial building: all buildings except for multi-family buildings of three stories or fewer above grade and single-family buildings.

Construction documents: drawings and specifications used to construct a building, building systems, or portions thereof.

Control: to regulate the operation of equipment.

Control device: a specialized device used to regulate the operation of equipment.

Cool roof: a property of a surface that describes its ability to reflect and reject heat. Cool roof surfaces have both a light color (high solar reflectance) and a high emittance (can reject heat back to the environment).

Vertical fenestration: all fenestration other than skylights. Trombe wall

assemblies, where glazing installed within 12 inch (30 mm) of a mass wall, are considered walls, not fenestration.

Dead band: the range of values within which a sensed variable can vary without initiating a change in the controlled process.

Demand: the highest amount of power (average Btu/h over an interval) recorded for a building or facility in a selected time frame.

Design capacity: output capacity of a system or piece of equipment at design conditions.

Design conditions: specified environmental conditions, such as temperature and light intensity, required to be produced and maintained by a system and under which the system must operate.

Distribution system: conveying means, such as ducts, pipes, and wires, to bring substances or energy from a source to the point of use. The distribution system includes such auxiliary equipment as fans, pumps, and transformers.

Door: all operable opening areas (which are not fenestration) in the building envelope, including swinging and roll-up doors, fire doors, and access hatches. Doors that are more than one-half glass are considered fenestration. For the purposes of determining building envelope requirements, the classifications are defined as follows:

(a) non-swinging: roll-up sliding, and all other doors that are not swinging doors.

(b) swinging: all operable opaque panels with hinges on one side and opaque revolving doors.

Door area: total area of the door measured using the rough opening and including the door slab and the frame.

Dwelling unit: a single unit providing complete independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, coking, and sanitation

Economizer, air: a duct and damper arrangement and automatic control system that together allow a cooling system to supply outdoor air to reduce or eliminate the need for mechanical cooling during mild or cold weather.

Economizer, water: a system by which the supply air of a cooling

system is cooled indirectly with water that is itself cooled by heat or mass transfer to the environment without the use of mechanical cooling

Efficacy: the lumens produced by a lamp/ballast system divided by the total watts of input power (including the ballast), expressed in lumens per watt.

Efficiency: performance at specified rating conditions.

Emittance: the ratio of the radiant heat flux emitted by a specimen to that emitted by a blackbody at the same temperature and under the same conditions.

Enclosed building: a building that is totally enclosed by walls, floors, roofs and openable devices such as doors and operable windows.

Energy: the capacity for doing work. It takes a number of forms that may be transformed from one into another such as thermal (heat), mechanical (work), electrical, and chemical. Customary measurement units are: kilojoules (kJ) or British thermal units (Btu) in this document.

Energy Efficiency Ratio (EER): the ratio of net cooling capacity in Btu/h to total rate of electric input in watts under designated operating conditions.

Energy Factor (EF): a measure of water heater overall efficiency.

Equipment: devices for comfort conditioning, electric power, lighting, transportation, or service water heating including, but not limited to furnaces, boilers, air conditioners, heat pumps, chillers, water heaters, lamps, luminaires, ballasts, elevators, escalators or other devices or installations.

Existing equipment: equipment previously installed in an existing building.

Facade area: area of the facade, including overhanging soffits, cornices, and protruding columns, measured in elevation in a vertical plane, parallel to the plane of the face of the building. Non-horizontal roof surfaces shall be included in the calculations of vertical facade area by measuring the area in a plane parallel to the surface.

Fan system power: the sum of the nominal power demand (nameplate horse power) of motors of all fans that are required to operate at design conditions to supply air from the heating or cooling source to the conditioned space(s) and return it to the source of exhaust it to the

outdoors.

Fenestration: all areas (including the frames) in the building envelope that let in light including windows, plastic panels, clerestories, skylights, glass doors that are more than one half glass and glass block walls.

(a) Skylight: a fenestration surface having a slope of less than 60 degrees from the horizontal plane. Other fenestration, even if mounted on the roof of a building, is considered vertical fenestration.

(b) Vertical fenestration: all fenestration other than skylights. Trombe wall assemblies, where glazing is installed within 12 in. of a mass wall, are considered walls, not fenestration.

Fenestration area: total area of the fenestration measured using the rough opening and including the glazing, sash, and frame. For doors where the glazed vision area is less than 50% of the door area, the fenestration area is the glazed vision area. For all other doors, the fenestration area is the door area.

Floor area gross: the sum of the floor areas of the spaces within the building including basements, mezzanine and intermediate-floored tiers and penthouses with headroom height of 7.5 ft or greater. It is measured from the exterior faces of exterior walls or from the centerline of walls separating buildings, but excluding covered walkways, open roofed over areas, porches and similar spaces, pipe trenches, exterior terraces or steps, chimneys, roof overhangs and similar features.

(a) Gross building envelope floor area: the gross floor area of the building envelope, but excluding slab-on-grade floors.

(b) gross conditioned floor area: the gross floor area of conditioned spaces.

(c) Gross lighted floor area: the gross floor area of lighted spaces.

(d) Gross semi-heated floor area: the gross floor area of semi-heated spaces.

Flue damper: a device in the flue outlet or in the inlet of or upstream of the draft control device of an individual, automatically operated, fossil fuel-fired appliance that is designed to automatically open the flue outlet during appliance operation and to automatically close the flue outlet when then appliance is in standby condition.

Fossil fuel: fuel derived from a hydrocarbon deposit such as petroleum, coal, or natural gas derived from living matter of a previous geologic time.

Fuel: a material that may be used to produce heat or generate power by combustion.

Grade: the finished ground level adjoining a building at all exterior walls.

Guest room: any room or rooms used or intended to be used by a guest for sleeping purposes.

Heat capacity: the amount of heat necessary to raise the temperature of a given mass 1°F. Numerically, the heat capacity per unit area of surface (Btu/ft^2-°F) is the sum of the products of the mass per unit area of each individual material in the roof, wall or floor surface multiplied by its individual specific heat.

Heating Seasonal Performance Factor (HSPF): the total heating output of a heat pump during its normal annual usage period for heating (in Btu) divided by the total electric energy input during the same period.

Historic: a building or space that has been specifically designed as historically significant.

HVAC system: the equipment, distribution systems, and terminals that provide, either collectively or individually, the processes of heating, ventilating or air conditioning to a building or portion of a building.

Infiltration: the uncontrolled inward air leakage through cracks and crevices in any building element and around windows and doors of a building caused by pressure differences across these elements due to factors such as wind, inside and outside temperature differences (stack effect), and imbalance between supply and exhaust air systems.

Installed interior lighting power: the power in watts of all permanently installed general, task, and furniture lighting systems and luminaries.

Integrated part-load value (IPLV): a single number figure of merit based on part-load EER, COP, or KW/ton expressing part-load efficiency for air-conditioning and heat pump equipment on the basis of weighted operation at various load capacities for the equipment.

Kilovolt-ampere (kVA): where the term “kilovolt-ampere” (kVA) is used in this code, it is the product of the line current (amperes) times the

nominal system voltage (kilovolts) times 1.732 for three-phase currents. For single-phase applications, kVA is the product of the line current (amperes) times the nominal system voltage (kilovolts).

Kilowatt (kW): the basic unit of electric power, equal to 1000 W.

Labeled: equipment or materials to which a symbol or other identifying mark has been attached by the manufacturer indicating compliance with specified standard or performance in a specified manner.

Lamp: a generic term for man-made light source often called bulb or tube. Generally followings types are used.

(a) Compact fluorescent lamp.
(b) Fluorescent lamp.
(c) General service lamp.
(d) high-intensity discharge (HID) lamp.
(e) Incandescent lamp.
(f) Reflector lamp.

Lighted floor area, gross: the gross floor area of lighted spaces.

Lighting, decorative: lighting that is purely ornamental and installed for aesthetic effect. Decorative lighting shall not include general lighting.

Lighting, emergency: lighting that provides illumination only when there is a general lighting failure.

Lighting, general: lighting that provides a substantially uniform level of illumination throughout an area. General lighting shall not include decorative lighting or lighting that provides a dissimilar level of illumination to serve a specialized application or feature within such area.

Lighting Efficacy (LE): the quotient of the total lumens emitted from a lamp or lamp/ballast combination divided by the watts of input power, expressed in lumens per watt.

Lighting system: a group of luminaires circuited or controlled to perform a specific function.

Lighting power allowance:

(a) Interior lighting power allowance: the maximum lighting power in watts allowed for the interior of a building

(b) Exterior lighting power allowance: the maximum lighting power in watts allowed for the exterior of a building

Lighting Power Density (LPD): the maximum lighting power per unit of area of a building classification of space function.

Low-rise residential: single-family houses, multi-family structures of three stories or fewer above grade, manufactured houses (mobile homes), and manufactured houses (modular).

Luminaire: a complete lighting unit consisting of a lamp or lamps together with the housing designed to distribute the light, position and protect the lamps, and connect the lamps to the power supply.

Manual (non-automatic): requiring personal intervention for control. Non-automatic does not necessarily imply a manual controller, only that personal intervention is necessary.
Manufacturer: the company engaged in the original production and assembly of products or equipment or a company that purchases such products and equipment manufactured in accordance with company specifications.

Mean temperature: one-half the sum of the minimum daily temperature and maximum daily temperature.

Mechanical cooling: reducing the temperature of a gas or liquid by using vapor compression, absorption, desiccant dehumidification combined with evaporative cooling, or another energy-driven thermodynamic cycle. Indirect or direct evaporative cooling alone is not considered mechanical cooling.

Metering: instruments that measure electric voltage, current, power, etc.

Multifamily high-rise: multifamily structures of four or more stories above grade.

Multifamily low-rise: multifamily structures of three or less stories above grade.

Multiplication factor (M): indicates the relative reduction in annual solar cooling load from overhangs and/or side fins with given projection factors, relative to the respective horizontal and vertical fenestration dimensions.

Non-automatic: see manual.

Occupant sensor: a device that detects the presence or absence of people within an area and causes lighting, equipment or appliances to be regulated accordingly.

Opaque: all areas in the building envelope, except fenestration and building service openings such as vents and grilles.

Orientation: the direction an envelope element faces, i.e., the direction of a vector perpendicular to and pointing away from the surface outside of the element. For vertical fenestration, the two categories are north-oriented and all other.

Outdoor (outside) air: air that is outside the building envelope or is taken from outside the building that has not been previously circulated through the building.

Overcurrent: any current in excess of the rated current of the equipment of the ampacity of the conductor. It may result form overload, short circuit or ground fault.

Packaged Terminal Air Conditioner (PTAC): a factory-selected wall sleeve and separate unencased combination of heating and cooling components, assemblies or sections. It may include heating capability by hot water, steam or electricity and is intended for mounting through the wall to service a single room or zone.

Party wall: a firewall on an interior lot line used or adapted for joint service between two buildings.

Permanently installed: equipment that is fixed in place and is not portable or movable.

Plenum: a compartment or chamber to which one or more ducts are connected, that forms a part of the air distribution system and that is not used for occupancy or storage. A plenum often is formed in part or in total by portions of the building.

Pool: any structure, basin, or tank containing an artificial body of water for swimming, diving or recreational bathing. The terms include, but not limited to swimming pool, whirlpool, spa, hot tub.

Process load: the load on a building resulting form the consumption or release of process energy.

Projection factor: the ratio of the horizontal depth of the external

shading projection divided by the sum of the height of the fenestration and the distance from the top of the fenestration to the bottom of the farthest point of the external shading projection, in consistent units.

Projection factor, sidefin: the ratio of the horizontal depth of the external shading projection divided by the distance from the window jamb to the farthest point of the external shading projection, in consistent units.

Rated R-value of insulation: the thermal resistance of the insulation alone as specified by the manufacturer in units of $h \cdot ft^2 \, ^oF/Btu$ at a mean temperature of 75°F. Rated R-value refers to the thermal resistance of the added insulation in framing cavities or insulated sheathing only and does not include the thermal resistance of other building materials or air films. (See thermal resistance.)

Readily accessible: capable of being reached quickly for operation, renewal, or inspections without requiring those to whom ready access is requisite to climb over or remove obstacles or to resort to portable ladders, chairs, etc. In public facilities, accessibility may be limited to certified personnel through locking covers or by placing equipment in locked rooms.

Recirculating system: a domestic or service hot water distribution system that includes a close circulation circuit designed to maintain usage temperatures in hot water pipes near terminal devices (e.g., lavatory faucets, shower heads) in order to reduce the time required to obtain hot water when the terminal device valve is opened. The motive force for circulation is either natural (due to water density variations with temperature) or mechanical (recirculation pump).

Reflectance: the ratio of the light reflected by a surface to the light incident upon it.

Resistance, electric: the property of an electric circuit or of any object used as part of an electric circuit that determines for a given circuit the rate at which electric energy is converted into heat or radiant energy and that has a value such that the product of the resistance and the square of the current gives the rate of conversion of energy.

Reset: automatic adjustment of the controller set point to a higher or lower value.

Residential: spaces in buildings used primarily for living and sleeping. Residential spaces include, but are not limited to, dwelling units, hotel/motel guest rooms, dormitories, nursing homes, patient rooms in

hospitals, lodging houses, fraternity/sorority houses, hostels, prisons and fire stations.

Roof: the upper portion of the building envelope, including opaque areas and fenestration, that is horizontal or tilted at an angle of less than 60° from horizontal.

Roof area, gross: the area of the roof measured from the exterior faces of walls or from the centerline of party walls.

Service: the equipment for delivering energy from the supply or distribution system to he premises served.

Service water heating: heating water for domestic or commercial purposes other than space heating and process requirements.

Set point: point at which the desired temperature (°F) of the heated or cooled space is set.

Shading Coefficient (SC): the ratio of solar heat gain at normal incidence through glazing to that occurring through 1/8 in thick clear, double-strength glass. Shading coefficient, as used herein, does not include interior, exterior or integral shading devices.

Simulation program: a computer program that is capable of simulating the energy performance of building systems.

Single-zone system: an HVAC system serving a single HVAC zone.

Site-recovered energy: waste energy recovered at the building site that is used to offset consumption of purchased fuel or electrical energy supplies.

Slab-on-grade floor: that portion of a slab floor of the building envelope that is in contact with ground and that is either above grade or is less than or equal to 24 in below the final elevation of the nearest exterior grade.

Solar energy source: source of thermal, chemical, or electrical energy derived from direct conversion of incident solar radiation at the building site.

Solar Heat Gain Coefficient (SHGC): the ratio of the solar heat gain entering the space through the fenestration area to the incident solar radiation. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation, which is then reradiated, conducted, or

convected into the space.

Space: an enclosed space within a building. The classifications of spaces are as follows for the purpose of determining building envelope requirements.

(a) **Conditioned space:** a cooled space, heated space, or directly conditioned space.

(b) **Semi-heated space:** an enclosed space within a building that is heated by a heating system whose output capacity is greater or equal to 3.4 Btu/h-ft^2 of floor area but is not a conditioned space.

(c) **Unconditioned space:** an enclosed space within a building that is not conditioned space or a semi-heated space. Crawlspaces, attics, and parking garages with natural or mechanical ventilation are not considered enclosed spaces.

Storey: portion of a building that is between one finished floor level and the next higher finished floor level or the roof, provided, however, that a basement or cellar shall not be considered a story.

System: a combination of equipment and auxiliary devices (e.g., controls, accessories, interconnecting means, and terminal elements) by which energy is transformed so it performs a specific function such as HVAC, service water heating or lighting.

System, existing: a system or systems previously installed in an existing building.

Terminal: a device by which energy form a system is finally delivered, e.g., registers, diffusers, lighting fixtures, faucets, etc.

Thermal block: a collection of one or more HVAC zones grouped together for simulation purposes. Spaces need not be contiguous to be combined within a single thermal block.

U-factor (Thermal Transmittance): heat transmission in unit time through unit area of a material or construction and the boundary air films, induced by unit temperature difference between the environments on each side. Units of U are Btu/h-ft^2-°F or Watts /(m^2.°C).

Thermostat: an automatic control device used to maintain temperature at a fixed or adjustable set point.

Tinted (as applied to fenestration): Bronze, green, or grey coloring

that is integral with the glazing material. Tinting does not include surface applied films such as reflective coatings, applied either in the field or during the manufacturing process.

Transformer: a piece of electrical equipment used to convert electric power from one voltage to another voltage.

(a) **Dry-type transformer:** a transformer in which the core and coils are in a gaseous or dry compound.
(b) **liquid-immersed transformer:** a transformer in which the core and coils are immersed in an insulating liquid.

Variable Air Volume (VAV) system: HVAC system that controls the dry-bulb temperature within a space by varying the volumetric flow of heated or cooled supply air to the space.

Vent damper: a device intended for installation in the venting system or an individual, automatically operated, fossil fuel-fired appliance in the outlet or downstream of the appliance draft control device, which is designed to automatically open the venting system when the appliance is in operation and to automatically close off the venting system when the appliance is in standby or shutdown condition.

Ventilation: the process of supplying or removing air by natural or mechanical means to or from any space. Such air is not required to have been conditioned.

Wall: that portion of the building envelope, including opaque area and fenestration, that is vertical or tilted at an angle of 60° from horizontal or greater. This includes above- and below-grade walls, between floor spandrels, peripheral edges of floors, and foundation walls. For the purpose of determining building envelope requirements, the classifications are defined as follows:

(a) above-grade wall: a wall that is not below grade wall.

(b) below-grade wall: that portion of a wall in the building envelope that is entirely below the finish grade and in contact with the ground.

Wall area, gross: the overall area off a wall including openings such as windows and doors, measured horizontally from outside surface to outside service and measured vertically from the top of the floor to the top of the roof. The gross wall area includes the area between the ceiling and the floor for multi-story buildings.

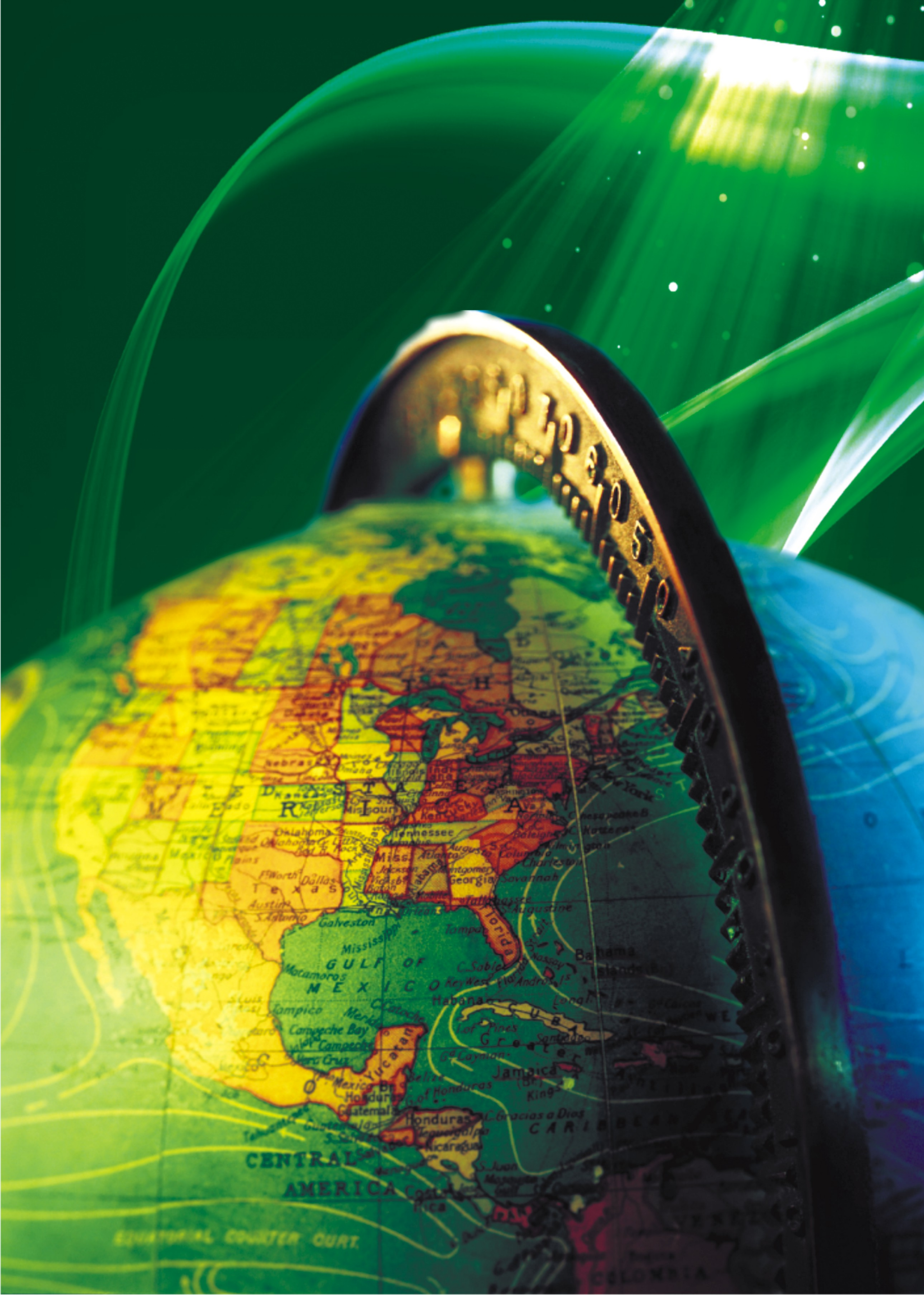
Water heater: vessel in which water is heated and is withdrawn for use external to the system.

Zone, HVAC: A space or group of spaces within a building with heating and cooling requirements that are sufficiently similar so that desired conditions (e.g., temperature) can be maintained throughout using a single sensor (e.g., thermostat or temperature sensor).

9.3 Abbreviations and Acronyms

AFUE	Annual fuel utilization efficiency
ANSI	American National Standards Institute
ARI	Air-Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc.
ASTM	American Society for Testing and Materials
Btu	British thermal unit
Btu/h	British thermal units per hour
Btu/ft^2-°F	British thermal units per square foot per degree Fahrenheit
Btu/h- ft^2	British thermal units per hour per square foot
Btu/h- ft^2-°F	British thermal units per hour per lineal foot per degree Fahrenheit
^{o}C	Celsius
cfm	cubic feet per minute
cm	centimeter
COP	coefficient of performance
EER	energy efficiency ratio
EF	energy factor
^{o}F	Fahrenheit
ft	foot
h	hour
HC	heat capacity
h-ft^2-°F/Btu	hour per square foot per degree Fahrenheit per British thermal unit
h-m^2-°C/W	hour per square meter per degree Celsius per Watt
hp	horsepower (746 W)
HSPF	heating seasonal performance factor
HVAC	heating, ventilating, and air conditioning
I-P	inch-pound
in.	inch
IPLV	integrated part-load value
J	joule;
kJ	kilojoule
kVA	kilovolt-ampere
kW	kilowatt;(power)
kWh	kilowatt-hour; (energy)
LE	lighting efficacy
lin ft	linear foot
lin m	linear meter
lm	lumen
LPD	lighting power density
m	meter
mm	millimeter

NAECA	National Appliance Energy Conservation Act
PF	power factor
PTAC	packaged terminal air conditioner
R	R-value (thermal resistance)
SC	shading coefficient
SHGC	solar heat gain coefficient
SL	standby loss
VAV	variable air volume
VLT	visible light transmission
W	watt
W/ft^2	watts per square feet
W/m^2	watts per square meter
W/m^2K	watts per square meter per degree kelvin
W/m-K	watts per lineal meter per degree kelvin
Wh	watthour



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