GREEN BUILDING CODE OF PAKISTAN 2023

Pakistan Engineering Council

Pakistan Engineering Council (PEC)
2023

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The Green Building Code of Pakistan - 2023 is dedicated to hundreds of innocent people who died, injured or displaced due to the heavy rainfalls and devastating flash floods of August, 2022 in Pakistan.

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PART II

Statutory Notifications (S.R.O.)

GOVERNMENT OF PAKISTAN

MINISTRY OF SCIENCE AND TECHNOLOGY

NOTIFICATION

Islamabad, the 11th August, 2025

S.R.O. 1531 (I)/2025.— In exercise of the powers conferred by section 25 of the Pakistan Engineering Council Act, 1975 (V of 1976), the Governing Body of the Pakistan Engineering Council, with the previous sanction of the Federal Government, is pleased to direct that the following further amendments shall be made in the Pakistan Engineering Council (Conduct and Practice of Consulting Engineers) Bye-Laws, 1986, namely:—

Price: Rs. 10.00

[1634(2025)/Ex.Gaz.]

In the aforesaid Bye-Laws, after bye-law 13, the following new bye-laws shall be added, namely:–

"**14. Application of Green Building Code of Pakistan - 2023**.–(1) The Green Building Code of Pakistan-2023 (herein after referred to as "this Code") provides rules and minimum requirements for the siting, design, construction and plans for operation of *high-performance green buildings* to:

(a) comply with the site sustainability;

(b) reduce emissions from building and building systems;

(c) enhance building occupant health and comfort;

(d) conserve water and energy resources;

(e) protect local biodiversity, and ecosystem services;

(f) promote sustainable and regenerative materials cycles;

(g) enhance building indoor environment and air quality; and

(h) enhance resilience to natural, technological, and human-caused hazards.

(2) The provisions of this Code shall,-

(a) apply to the design, construction, addition, alteration, equipment, change of occupancy, relocation, replacement, demolition and removal of every building or structure or any appurtenances connected or attached to such buildings or structures and to the building site on which the building is located. Occupancy classifications shall be determined in accordance with the Building Code of Pakistan-2021; and

(b) not apply to the following:

(a) single-family dwellings;

(b) multiple-family dwellings of three stories or fewer above grade;

(c) manufactured houses (mobile homes);

(d) manufactured houses (modular); and

(e) building projects that use none of the following:

(i) electricity;

(ii) fossil fuels; and

(iii) water.

(3) This Code shall be adopted by the federal and provincial governments, organizations, authorities, both public and private, as and when notified.

(4) Construction and modification of high performance buildings in violation of this Code shall be considered as violation of professional engineering work as specified under clause (xxv) of section 2 of the Pakistan Engineering Council Act, 1975 (V of 1976).

(5) The implementation and enforcement of this bye-law shall vest with the authority having jurisdiction (AHJ) within their respective jurisdiction and circles as follows:

(a) building control, housing and development authorities;

(b) district administration;

(c) tehsil or town administration;

(d) municipal administration;

(e) station headquarters (army, air force and navy) ;

(f) cantonment administration;

(g) housing authorities;

(h) union council administration;

(i) autonomous bodies;

(j) industrial estates;

(k) directorates of civil defense;

(l) export processing zones; and

(m) other federal or provincial authorities as and when notified.

(6) All the concerned AHJs shall implement this bye-law immediately in respective jurisdiction within the prescribed manner under their respective legal regime.

(7) All relevant AHJs shall ensure compliance and implementations of this bye-law and accordingly adopt or amend their relevant regulations, bye-laws or rules, if needed, as the case may be.

(8) This bye-law shall apply to both new, and existing buildings subject to the required retrofitting as approved by the AHJs:

(a) high performance buildings permitted for construction after the adoption of these green provisions shall comply with the provisions stated herein for new buildings forthwith;

(b) existing buildings may adopt these green provisions subject to prior approval by the concerned AHJ such as, efficient use of water and energy, green design

modifications, retrofitting of building envelope, green roof, rainwater harvesting provisions etc.;

(c) site sustainability requirements for building projects that pertain to site selection, site development, mitigation of heat island effect, light pollution reduction, mitigation of transportation impacts and shall be uniformly applicable on all buildings;

(d) the building site shall be physically accessible, environmentally suitable and compliant to master plan as approved by AHJ;

(e) the indoor space of the green buildings shall be naturally ventilated. Natural ventilation may be achieved by cross ventilation or passive ventilation; and

(f) any person who fails to comply with this bye-law or fails to carry out an order made pursuant to these provisions, or violates any condition attached to a permit, approval, or certificate shall be subject to the penalties in accordance with the regulations of AHJ.

(9) The provisions of this bye-law shall first be reviewed and updated after five years of notification, and thereafter every five years or earlier, on the basis of data and feedback received by the committee, as constituted by the Council.

15. Application of rainwater harvesting provisions - Building Code of Pakistan - 2023.– (1) The rainwater harvesting provisions - Building Code of Pakistan – 2023 provides rules and minimum standard requirements for rainwater harvesting systems that provide water for both new and existing buildings and building-like structures:

(a) single-family residential building applications;
(b) multi-story residential building applications;
(c) non-residential buildings applications for all commercial buildings or farmhouses; and
(d) industrial or manufacturing units.

(2) The provisions of this bye-law shall cover the use of rainwater and stormwater as the source of harvested rainwater.

(3) Rainwater includes all forms of water from natural precipitation including but not limited to rain, snowmelt etc. The term "rainwater harvesting" is used generically and shall refer to the harvesting of either rooftop, runoff, surface runoff, or stormwater.

(4) These provisions shall apply to the design, materials, installation, and operation of rainwater harvesting systems for potable and non-potable applications.

(5) Rainwater harvesting provisions for Building Code of Pakistan-2023 shall be adopted by the federal and provincial governments, organizations, and authorities, both public and private, as and when notified.

(6) The implementation and enforcement of this bye-law shall vest with the authority having jurisdiction (AHJ) within their respective jurisdictions and circles as follows:

(a) all building control, housing and development authorities;
(b) district Administration;
(c) tehsil or town administration;
(d) municipal administration;
(e) water and sanitation agencies (WASA);
(f) water and sanitation services companies (WSSC);
(g) metropolitan corporations (MC);
(h) solid waste management companies (SWMC);
(i) water boards;
(j) station headquarters (army, air force and navy);
(k) cantonment administration;
(l) union council administration;
(m) autonomous bodies;
(n) industrial estates;
(o) directorates of civil defence;
(p) export processing zones; and
(q) other federal/provincial authorities as and when notified.

(7) All the concerned AHJs shall implement this bye-law immediately in respective jurisdiction within the prescribed manner under their respective regime.

(8) All relevant AHJs shall amend their relevant regulations, bye-laws or rules, if needed, as the case may be.

(9) This bye-law shall apply to both new, and existing buildings subject to required retrofitting as approved by the AHJs:

(a) the buildings permitted for construction after the adoption of these rainwater harvesting provisions shall comply with the provisions stated herein for new buildings forthwith;

(b) existing buildings constructed prior to adoption of these rainwater harvesting provisions shall adapt these provisions subject to prior approval by the concerned AHJ, and

(c) any person who fails to comply with this bye-law or fails to carry out an order made pursuant to these provisions, or violates any condition attached

to a permit, approval, or certificate shall be subject to the penalties in accordance with the regulations of AHJ.

(10) The provisions of this bye-law shall be reviewed and updated after every five years of notification, or earlier, on the basis of data and feedback received by the committee, as constituted by the Council.".

[No. PEC/P&S/RWHP-SRO/2024.]

ENGR. WASEEM NAZIR ,
Chairman.
Pakistan Engineering Council

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PART II

Statutory Notifications (S.R.O.)

GOVERNMENT OF PAKISTAN

MINISTRY OF SCIENCE AND TECHNOLOGY

NOTIFICATION

Islamabad, the 11th August, 2025

S.R.O. 1532 (I)/2025.— In exercise of the powers conferred by section 25 of the Pakistan Engineering Council Act, 1975 (V of 1976), the Governing Body of the Pakistan Engineering Council, with the previous sanction of the Federal Government, is pleased to direct that the following further amendments shall be made in the Pakistan Engineering Council (Construction and Operation of Engineering Works) Bye-Laws, 1987, namely:—

2347 (1—6)

Price: Rs. 10.00

[1635(2025)/Ex.Gaz.]

In the aforesaid Bye-Laws, after bye-law 11, the following new bye-laws shall be added, namely:–

"**12. Application of Green Building Code of Pakistan - 2023**.–(1) The Green Building Code of Pakistan-2023 (herein after referred to as "this Code") provides rules and minimum requirements for the siting, design, construction and plans for operation of *high-performance green buildings* to:

(a) comply with the site sustainability;

(b)reduce emissions from building and building systems;

(c) enhance building occupant health and comfort;

(d) conserve water and energy resources;

(e) protect local biodiversity, and ecosystem services;

(f) promote sustainable and regenerative materials cycles;

(g) enhance building indoor environment and air quality; and

(h) enhance resilience to natural, technological, and human-caused hazards.

(2) The provisions of this Code shall,-

(a) apply to the design, construction, addition, alteration, equipment, change of occupancy, relocation, replacement, demolition and removal of every building or structure or any appurtenances connected or attached to such buildings or structures and to the building site on which the building is located. Occupancy classifications shall be determined in accordance with the Building Code of Pakistan-2021; and

(b) not apply to the following:

(a) single-family dwellings;

(b) multiple-family dwellings of three stories or fewer above grade;

(c) manufactured houses (mobile homes);

(d) manufactured houses (modular); and

(e) building projects that use none of the following:

(i) electricity;

(ii) fossil fuels; and

(iii) water.

(3) This Code shall be adopted by the federal and provincial governments, organizations, authorities, both public and private, as and when notified.

(4) Construction and modification of high performance buildings in violation of this Code shall be considered as violation of professional engineering work as specified under clause (xxv) of section 2 of the Pakistan Engineering Council Act, 1975 (V of 1976).

(5) The implementation and enforcement of this bye-law shall vest with the authority having jurisdiction (AHJ) within their respective jurisdiction and circles as follows:

(a) building control, housing and development authorities;

(b) district administration;

(c) tehsil or town administration;

(d) municipal administration;

(e) station headquarters (army, air force and navy) ;

(f) cantonment administration;

(g) housing authorities;

(h) union council administration;

(i) autonomous bodies;

(j) industrial estates;

(k) directorates of civil defense;

(l) export processing zones; and

(m) other federal or provincial authorities as and when notified.

(6) All the concerned AHJs shall implement this bye-law immediately in respective jurisdiction within the prescribed manner under their respective legal regime.

(7) All relevant AHJs shall ensure compliance and implementations of this bye-law and accordingly adopt or amend their relevant regulations, bye-laws or rules, if needed, as the case may be.

(8) This bye-law shall apply to both new, and existing buildings subject to the required retrofitting as approved by the AHJs:

(a) high performance buildings permitted for construction after the adoption of these green provisions shall comply with the provisions stated herein for new buildings forthwith;

(b) existing buildings may adopt these green provisions subject to prior approval by the concerned AHJ such as, efficient use of water and energy, green design

modifications, retrofitting of building envelope, green roof, rainwater harvesting provisions etc.;

(c) site sustainability requirements for building projects that pertain to site selection, site development, mitigation of heat island effect, light pollution reduction, mitigation of transportation impacts and shall be uniformly applicable on all buildings;

(d) the building site shall be physically accessible, environmentally suitable and compliant to master plan as approved by AHJ;

(e) the indoor space of the green buildings shall be naturally ventilated. Natural ventilation may be achieved by cross ventilation or passive ventilation; and

(f) any person who fails to comply with this bye-law or fails to carry out an order made pursuant to these provisions, or violates any condition attached to a permit, approval, or certificate shall be subject to the penalties in accordance with the regulations of AHJ.

(9) The provisions of this bye-law shall first be reviewed and updated after five years of notification, and thereafter every five years or earlier, on the basis of data and feedback received by the committee, as constituted by the Council.

13. Application of rainwater harvesting provisions - Building Code of Pakistan - 2023.– (1) The rainwater harvesting provisions - Building Code of Pakistan – 2023 provides rules and minimum standard requirements for rainwater harvesting systems that provide water for both new and existing buildings and building-like structures:

(a) single-family residential building applications;
(b) multi-story residential building applications;
(c) non-residential buildings applications for all commercial buildings or farmhouses; and
(d) industrial or manufacturing units.

(2) The provisions of this bye-law shall cover the use of rainwater and stormwater as the source of harvested rainwater.

(3) Rainwater includes all forms of water from natural precipitation including but not limited to rain, snowmelt etc. The term "rainwater harvesting" is used generically and shall refer to the harvesting of either rooftop, runoff, surface runoff, or stormwater.

(4) These provisions shall apply to the design, materials, installation, and operation of rainwater harvesting systems for potable and non-potable applications.

(5) Rainwater harvesting provisions for Building Code of Pakistan-2023 shall be adopted by the federal and provincial governments, organizations, and authorities, both public and private, as and when notified.

(6) The implementation and enforcement of this bye-law shall vest with the authority having jurisdiction (AHJ) within their respective jurisdictions and circles as follows:

(a) all building control, housing and development authorities;
(b) district Administration;
(c) tehsil or town administration;
(d) municipal administration;
(e) water and sanitation agencies (WASA);
(f) water and sanitation services companies (WSSC);
(g) metropolitan corporations (MC);
(h) solid waste management companies (SWMC);
(i) water boards;
(j) station headquarters (army, air force and navy);
(k) cantonment administration;
(l) union council administration;
(m) autonomous bodies;
(n) industrial estates;
(o) directorates of civil defence;
(p) export processing zones; and
(q) other federal/provincial authorities as and when notified.

(7) All the concerned AHJs shall implement this bye-law immediately in respective jurisdiction within the prescribed manner under their respective regime.

(8) All relevant AHJs shall amend their relevant regulations, bye-laws or rules, if needed, as the case may be.

(9) This bye-law shall apply to both new, and existing buildings subject to required retrofitting as approved by the AHJs:

(a) the buildings permitted for construction after the adoption of these rainwater harvesting provisions shall comply with the provisions stated herein for new buildings forthwith;

(b) existing buildings constructed prior to adoption of these rainwater harvesting provisions shall adapt these provisions subject to prior approval by the concerned AHJ, and

(c) any person who fails to comply with this bye-law or fails to carry out an order made pursuant to these provisions, or violates any condition attached

to a permit, approval, or certificate shall be subject to the penalties in accordance with the regulations of AHJ.

(10) The provisions of this bye-law shall be reviewed and updated after every five years of notification, or earlier, on the basis of data and feedback received by the committee, as constituted by the Council.".

[No. PEC/P&S/RWHP-SRO/2024.]

ENGR. WASEEM NAZIR ,
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Preface

Pakistan Engineering Council (PEC) is a Statutory Regulatory Body established under PEC Act 1976 and regulating the Engineering Profession and Education in totality across Pakistan. The Government of Pakistan has mandated PEC to act as a national "Think Tank" and provide necessary assistance to the Federal Government on various national policies, development plans, engineering disciplines, engineering codes, and allied standardization. Similarly, PEC in collaboration and technical assistance of reputed international organizations successfully developed and published the following national Codes:

- Building Code of Pakistan (2021)
- Standardization of Building Codes, Standards, and Specifications for Low-Cost (Affordable) Units (2021)
- Building Code of Pakistan - Fire Safety Provisions (2016)
- Pakistan Electric and Telecommunication Safety Code (2014)
- Building Code of Pakistan - Energy Provisions (2011)
- Building Code of Pakistan - Seismic Provisions (2007)

Currently, Pakistan prevails 5th largest population size of 240 million with an annual growth rate of 2.55 % including 35% of urban and 65% of rural population as reported by Pakistan Bureau of Statistics. 35% of people are associated with the housing and construction industry. As per housing estimates of the World Bank, over 700,000 new housing units are required to be built annually in the country, but the existing conventional-construction capacity is limited to 300,000 units per year, therefore, in the last twenty years, the shortage of housing units accumulated an enormous deficit of 12 million housing units as of to date. To address the situation, the Government of Pakistan envisioned and initiated Pakistan Housing Program (PHP) to deliver affordable housing units with allied amenities to all citizens, especially focusing on the financially underserved and middle-income communities, as a measure of comprehensive socio-economic uplift. This national challenge of acute shortage of houses can easily be converted into an opportunity. The Ministry of Climate Change and Environmental Coordination in collaboration with PEC, NED University, UN Environment, UN-HABITAT, and Switch Asia jointly developed: (i) *Model Green Building Code Provisions for the Five Million Housing Programme in Pakistan,* and *(ii) Policy Guidelines for Green Building Code (2020).* On the recommendations of the Ministry of Climate Change and Environmental Coordination's policy guidelines, PEC Policy and Strategy Department realized that it is a need of the hour to transform conventional construction with new green building interventions. For the purpose, the PEC one step further under the auspices of Ministry of Science and Technology in collaboration with the Ministry of Climate Change and Environmental Coordination, UN-Habitat, NED-University, Karachi and the World Bank notified a PEC Technical Committee headed by Prof. Dr. Engr. Sarosh H. Lodi, Vice Chancellor, NED University, Karachi to develop first-ever *Green Building Code of Pakistan-2023*. The technical committee in its first meeting held on 13 May 2022 selected the *2021 International Green Constriction Code (IgCC-2021)* as the base document for the development of the *Green Building Code of Pakistan-2023*. In fact, green economy is rapidly transforming green construction technologies, which are helping remarkably to reduce the adverse impacts of buildings on the environment due to existing conventional construction practices. The green construction technologies are focusing on site sustainability, energy efficiency, water conservation, reduction in waste, and the use of sustainable green design and materials having the following salient features:

i. ***Site sustainability:*** *The building site shall be physically accessible, environmentally suitable and compliant to master plan as approved by AHJ. All types of building construction within the flood limit of rivers, natural streams (Nallahs) and natural drainage systems are prohibited. Appropriate demarcation mapping of flood-plains should be done for the site sustainability, as per the flood inundation map developed by Federal Flood Commission adhered by the AHJ.*

ii. ***Passive solar design****: the passive solar design uses the sun's energy to heat and cool buildings. It involves the placement of windows, walls, and floors in a way that maximizes natural light and minimizes the need for heating and cooling systems as integrated advanced green technologies.*

iii. ***Indoor Air Quality:*** *The indoor space should be naturally ventilated. Natural ventilation can be achieved by cross ventilation, which occurs when dwellings have openings in different orientations so that breeze can flow through the room or building to flush out hot or stale air, and passive ventilation.*

iv. ***Green roofs****: green roofs or bio-roofs are special roofs that are covered with vegetation or bio-films. They help to reduce the urban heat island effect, improve air quality, and provide insulation.*

v. ***Energy-efficient lighting****: energy-efficient building envelop design, lighting uses less electricity and lasts longer than traditional lighting. this includes LED and compact fluorescent bulbs as per global competitiveness towards LEED-certified buildings.*

vi. ***Renewable energy:*** *renewable energy sources such as solar, wind, geothermal power, bio-gas, waste to energy and allied alternates form of Alternate and Renewable Energy (ARE) technologies, which can be used to build energy-efficient buildings.*

vii. ***Water-saving technologies****: water-saving technologies include low-flow toilets, faucets, and showers, as well as rainwater harvesting systems, reuse of grey water by maintaining a balance between groundwater extraction and recharge technologies, etc.*

viii. ***Sustainable materials:*** *sustainable materials such as bamboo, recycled steel, reclaimed wood, and fly ash can be used in construction to reduce adverse environmental impacts.*

ix. ***Building information modeling:*** *(BIM) systems can help to optimize energy usage and reduce energy waste. These systems can control lighting, heating, cooling, and ventilation systems based on occupancy and environmental conditions. Overall, green construction technologies offer a range of benefits, including reduced energy costs, improved indoor air quality, and a smaller carbon footprint.*

GBCP-2023 is an internationally recognized integration of all building codes developed so far to reduce the adverse impacts of buildings on environment by transforming modernized green products and efficient technologies. The principal aim is sustainable production and consumption of natural resources starting from building design, construction, operation, maintenance, renovation or demolition. The scope of GBCP-2023 is to use environmentally responsible and resource-efficient processes throughout the life cycle of the building i.e. (1) Energy efficiency and the use of renewable energy (2) Water efficiency (3) Use of environmentally friendly building materials (4) Waste and toxic reduction (5) Smart and sustainable growth (6) Enhancement of air quality.

GBCP-2023 is one major step towards green-economy, it provides green eco-friendly practices for building design, construction & operation stages; and ensures the utilization of sustainable sites, green construction materials to save energy, conserve water, improve indoor environmental quality, and lower GHG emissions in line with the Sustainable Development Goals 3, 6, 7, 8, 11, 12, 13, 14, 15, 17 for developing the green buildings and cities based on integrated approaches. It is determined that National Action Plan is developed for strengthening Pakistan's national policy frameworks to promote green-economy and ensure sustainable consumption and production of natural resources. The main objectives of green buildings are to minimize environmental disturbances and waste generation, minimize energy and other resources utilization, boost renewable energy usage, improve human health and comfort, and reduce the negative impacts of buildings on human health/ natural environment. Substantial savings can be achieved through integrated planning and adopting environmentally friendly designs in terms of materials and energy savings.

The Government of Pakistan has notified the GBCP-2023 after the prolong consultation process which conducted through the Ministry of Science and Technology by taking on board all the Chief Secretaries of Government of Sindh, Punjab, Baluchistan, Khyber-Pakhtunkhwa, Azad Jammu & Kashmir, and Gilgit Baltistan. The Federal Cabinet approved the GBCP-2023 vide Cabinet decision No. 486/Rule-19/2025/672 dated 28.07.2025 in the PEC Bye-Laws. Accordingly, Ministry of Science and Technology, Government of Pakistan notified GBCP-2023 vide the Gazette Statutory Notifications: S.R.O. 1531 (I)/2025 (Conduct and Practice of Consulting Engineers) Bye-Laws, 1986 and S.R.O. 1532 (I)/2025 (Construction and Operation of Engineering Works) Bye-Laws, 1987 dated 11th August 2025.

ACKNOWLEDGEMENTS

Pakistan Engineering Council (PEC) acknowledges the significant role of the International Code Council (ICC) in the development of the "1st *Edition of Green Building Code of Pakistan (GBCP-2023)"*. PEC admires the vital role of Engr. Dr. Professor Sarosh Hashmat Lodi, Convener, PEC Technical Committee/ Vice Chancellor, NED University of Engineering and Technology, Karachi. The PEC Technical Committee has performed dedicated hard work keeping in view various technical parameters, data sets, and allied expertise regarding the development of the "*Green Building Code of Pakistan-2023" based on the* "*2021 International Green Construction Code, (IgCC-2021)"*. In this regard, PEC management acknowledges the important role of Mark Johnson, Executive Vice President/ Director of Business Development, ICC and Faiz ul Sibtain, Member and Secretary to the PEC Technical Committee on GBCP-2023, both contributed in an extraordinary way and initiated ***"ICC Development License Agreement"*** inked between PEC and ICC in August-2022 for the development of GBCP-2023. Engr. Dr. Nasir Mahmood Khan, Secretary/ Registrar, PEC admired the leadership of the Convener and the contribution of the expert Members of the PEC Technical Committee who worked with due diligence and accomplished this task of national importance. PEC also admires the key role of Mr. Muhammad Azim Khoso, Director Urban Affairs, Ministry of Climate and Environmental Coordination in the acceptance of green building interventions for sustainable urban development in Pakistan. Accordingly, PEC has notified a Technical Committee for the development of ***Green Building Code of Pakistan - (GBCP-2023)*** by taking on board all the relevant stakeholders.

PEC Task Force Experts Working Group:

1.	Engr. Dr. Prof. Sarosh Hashmat Lodi Vice Chancellor, NED University of Engineering and Technology, Karachi	Convener
2.	Engr. Dr. Prof. Muhammad Masood Rafi Chairman, Department of Earthquake Engineering, NED University of Engineering and Technology, Karachi	Deputy Convener
3.	Engr. Dr. Prof. Brig. Aqeel Ahmed Director (Design & Consultancy), GHQ, Rawalpindi	Group Lead/ Member
4.	Arch. Irfan Tariq Registrar, Pakistan Council of Architect and Town Planners, Islamabad	Group Lead/ Member
5.	Engr. Faiz Muhammad Bhutta Senior Energy Consultant and CEO Techfa Consulting, Lahore	Group Lead/ Member
6.	Syed Zaheer Hussain Shah Gardezi Director Planning, Women University, AJK-Bagh	Group Lead / Member
7.	Engr. Asad Mehmood Former, Manager Technical, NEECA, Islamabad	Group Lead / Member
8.	Arch. Aqrab Ali Rana Architect, LEED-AP CEO, Pakistan Green Building Council, Lahore	Group Lead / Member
9.	Engr. Dr. Nasir Mahmood Khan Secretary/ Registrar, Pakistan Engineering Council, Islamabad	Member
10.	Mr. Jawed Ali Khan Country Programme Manager - Pakistan, UN Habitat, Islamabad	Member
11.	Engr. Dr. Prof. Brig. Shahid Iqbal Director (Research and Support), Engineer-in-Chief Branch, GHQ, Rawalpindi	Member
12.	Engr. Dr. Ashfaq Ahmed Sheikh Senior Additional Registrar, PEC, Islamabad	Member
13.	Engr. Dr. Farrukh Arif Associate Professor, Department of Civil Engineering NED University of Engineering and Technology, Karachi	Member

14.	Engr. Muhammad Riaz Baig HVAC Expert, Former-President HVACR Society- Pakistan	Member
15.	Engr. Muhammad Anwar Hussain Ch. Senior Chief (Technical), Physical Planning and Housing Section Ministry of Planning, Development and Special initiatives, Islamabad.	Member
16.	Engr. Ghulam Karim Additional Registrar, Pakistan Engineering Council, Islamabad	Member
17.	Engr. Ishtiaq Ahmad Assistant Scientific Advisor/ Director to Federal Minister Ministry of Science and Technology, Islamabad	Member
18.	Engr. Shoaib Ahmed Assistant Professor, Department of Civil Engineering, NED UET Karachi	Member
19.	Arch. Fahad Hassan Sr. Architect, NESPAK, Islamabad	Member
20.	Arch. Dr. Waqas Ahmed Mahar Chairperson, Department of Architecture, BUITEMS, Quetta.	Member
21.	Engr. Muhammad Azim Khoso Director, Urban Affairs, Ministry of Climate Change and Environmental Coordination, Islamabad	Member
22.	Arch. Plan. Abdul Qayyum Former Chief (P&D), Ministry of Planning and Development, Islamabad	Member
23.	Lt. Col. Shahid Naveed (Retd.) Joint Executive Director (Monitoring), NAPHDA, Islamabad	Member
24.	Engr. Amir Abbas CEO, Captive Air, Islamabad	Member
25.	Engr. Wajahat Makhdoom Senior Engineer, Head-Electrical, NESPAK, Islamabad	Member
26.	Engr. Faisal Naeem Director, BCS, Capital Development Authority, Islamabad	Member
27.	Engr. Rida Nasir Assistant Registrar, Policy and Strategy Department, PEC, Islamabad	Assistant Registrar
28.	Mr. Faiz ul Sibtain Assistant Director, Policy and Strategy Department, Pakistan Engineering Council, HQ, Islamabad	Member & Secretary to Committee

Editorial Committee:

1.	Engr. Dr. Prof. Muhammad Masood Rafi Chairman, Department of Earthquake Engg. NED UET, Karachi	Deputy Convener
2.	Engr. Dr. Farrukh Arif Associate Professor, Department of Civil Engineering, NED UET, Karachi	Member
3.	Engr. Faiz Muhammad Bhutta Senior Energy Consultant and CEO Techfa Consulting, Lahore	Member
4.	Engr. Rida Nasir Assistant Registrar, PEC, Islamabad	Member
5.	Mr. Faiz ul Sibtain Assistant Director, Pakistan Engineering Council, HQ, Islamabad	Member & Secretary to Committee

PEC appreciates the significant role and hard work of Engr. Ashfaque Ahmed Memon, Joint Technological Advisor, and Engr. Sadaqat Khan, Assistant Technological Advisor, Ministry of Science and Technology, Islamabad for carrying out robust exercise and obtaining comments on GBCP-2023 from relevant stakeholder Ministries and Line departments.

PEC highly admires significant role of all the Chief Secretaries of Government of Sindh, Punjab, Baluchistan, Khyber-Pakhtunkhwa, Azad Jammu & Kashmir, and Gilgit Baltistan in soliciting the valued comments and feedback from all provincial and state governments while development and notification process of GBCP-2023. In this regard, PEC appreciates the valued inputs/comments obtained by the Ministry of Science and Technology on GBCP-2023 from the key stakeholders through their nominated technical representatives such as; (i) Mr. Abdul Sadiq, Section Officer (Development), Works Department, Government of Gilgit Baltistan; (ii) Ms. Shakila Begum, Section Officer (C.A-II), Ministry of Energy (Power Division), Islamabad; (iii) Arc. Zulfiqar Ali Tariq, Principal Architect, Architecture & Planning Division, NESPAK, Lahore; (iv) Mr. Muhammad Yousuf Iqbal, Deputy Director Policy & O.D., Ministry of Railway, Islamabad; (v) Ms. Muneeza Hamid, Deputy Secretary (IF), Ministry of Industries & Production, Islamabad; (vi) Mr. Sohail Ahmed, Section Officer (Cord), Ministry of Communication, Islamabad; (vii) Ms. Saima Mukhtar, Director (Dev.), Pakistan Post, Islamabad; (viii) Dr. Asif Khan, Project Director, Gwadar Safe City Project, Gwadar; (ix) Mr. Riaz ul Haque, Director (Policy), Board of Investment Prime Minister's Office, Islamabad; (x) Mr. Muhammad Bilal Nawaz, Research Officer, National Transport Research Center, Ministry of Communication, Islamabad; (xi) Ms. Nosheen Yaqoob Butt, Deputy Director (Environment), National Highway Authority, Islamabad; (xii) Mr. Sardar Ahsan Ul Haq Khan, D.G. Engineering/ Chief Engineer, Central Design Office, Government of AJK, Muzaffarabad; (xiii) Engr. Zeeshan Ullah, Director Buildings, NEECA, Islamabad; (xiv) Mr. Muhammad Saleem Khan, Secretary General, Constructors Association of Pakistan (CAP), Islamabad; (xv) Engr. Altaf Hussain, Assistant Manager (SDG), Engineering Development Board, Islamabad; (xvi) Ms. Tayyeba Suhail, Assistant Director (Tech), Ministry of Water Resources, Islamabad; (xvii) Mr. Iqbal Ahmed, Deputy Chief, Physical Planning and Housing Section, Ministry of Planning, Development and Special Initiatives, Islamabad; (xviii) Mr. Abdul Rehman, Assistant Director (Technical), Environmental Protection Agency, Government of Sindh, Karachi; (xix) Mr. Amna Bashir, Assistant Director Architecture (CAD), Local Government and Community Development Department, Government of Punjab, Lahore; (xx) Dr. Sohrab Ahmed Marri, Consultant Architect, Science and Information Technology Department, Government of Baluchistan, Quetta; (xxi) Mr. Abul Rauf Baloch, Secretary, Local Government and Rural Development and Agrovilles, Government of Baluchistan, Quetta; (xxii) Mr. Yahya Bakhtiar, Section Officer, (FW&E), Planning and Development Department, Government of Gilgit Baltistan, Gilgit; (xxiii) Engr. Amir Hussain, Chief Engineer, Communication and Works Department, Skardu; (xxiv) Engr. Dr. Prof. Asad Ullah Qazi, Head of Structural Engineering Division, Department of Civil Engineering, UET, Lahore; (xxv) Dr. Maryam Siddiq, Assistant Prof, Department of Architecture, UET Lahore; (xxvi) Prof. Amir Ikhlaq, Institute of Environmental Engineering and Research, UET, Lahore; (xxvii) Engr. Babar Majeed, Deputy Director and (xxviii) Dr. Azmatullah, Deputy Director, Planning and Development Department, Government of Khyber Pakhtunkhwa, Peshawar.

The comments/ inputs of the above-mentioned stakeholder federal ministries, provincial departments, public and private sector organizations were encouraging and appreciated. The PEC Technical Committee experts evaluated/ reviewed each comment, and relevant comments were already addressed in various chapters of the GBCP-2023. Further, a comprehensive Code Commentary/Practice Handbook on GBCP-2023 also developed by PEC in collaboration with ICC. The code commentary/ practice handbook describes the technical terms of the GBCP-2023 and illustrations with practical examples for a better understanding/ application of standardized designing, execution, and implementation of the Code in letter and spirit across Pakistan.

Contents

CHAPTER 1

SCOPE AND ADMINISTRATION

PART 1—SCOPE AND APPLICATION

SECTION 101

SCOPE AND GENERAL REQUIREMENTS

101.1 Title. These regulations shall be known as the *Green Building Code* of Pakistan (GBCP), hereinafter referred to as "this code."

101.2 *(2.3) General.* This code is intended to provide minimum requirements to be used in conjunction with the other codes and standards adopted by the Authority Having Jurisdiction (*AHJ*). The requirements in this code shall not be used to circumvent any applicable safety, health or environmental requirements.

101.3 Scope. The provisions of this code shall apply to the design, construction, addition, alteration, equipment, change of occupancy, relocation, replacement, demolition and removal of every building or structure or any appurtenances connected or attached to such buildings or structures and to the building site on which the building is located. Occupancy classifications shall be determined in accordance with the Building Code of Pakistan-2021**.**

101.3.1 ***(2.2)*** *Applicability.* The provisions of this code do not apply to the following:

1. Single-family dwellings.
2. Multiple-family dwellings of three stories or fewer above grade.
3. Manufactured houses (mobile homes).
4. Manufactured houses (modular).
5. *Building projects* that use none of the following:
    1. Electricity.
    2. Fossil fuels.
    3. Water.

101.4 ***(1.1)*** **Intent.** The intent of this code is to provide minimum requirements for the siting, design, construction and plans for operation of *high-performance green buildings* to: reduce emissions from buildings and building systems; enhance building occupant health and comfort; conserve water resources; protect local biodiversity and ecosystem services; promote sustainable and regenerative materials cycles; enhance building quality; enhance resilience to natural, technological, and human-caused hazards; and support the goal of development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

101.5 (4.1 & 4.2*)* *Compliance***.** *Building projects* shall comply with this code. Within each of Chapters 5 through 9, *building projects* shall comply with all mandatory provisions (x.3) and, where offered, either the:

1. Prescriptive Option (x.4) or
2. Performance Option (x.5).

Building projects shall also comply with all provisions of Chapter 10.

Exceptions:

1. Compliance shall not be required with sections that are listed in Table 101.5.1 where *AHJ* has opted out by checking "No" in the corresponding cell in the jurisdictional requirement column.
2. Where *AHJ* has indicated a diversion percentage for Section 501.3.8.1 in Table 101.5.1, that percentage shall replace the diversion percentage indicated in Section 501.3.8.1.

101.5.1 Jurisdictional options. The jurisdictional options listed in Table 101.5.1 provide *AHJ* the flexibility to adopt the code in a manner that is best suited to meet their unique environmental and regional goals and needs. The informative symbol [JO] after the section number indicates jurisdictional option provisions.

Table 101.5.1 may be used for the code adoption ordinance:

1. Where "No" boxes are provided, *AHJ* checks the box to indicate where that section is not to be enforced as a requirement in the jurisdiction. Where the "No" box is not checked, that section is adopted.
2. Where a numerical value is listed to specify the level of performance, *AHJ* shall indicate the required value to be adopted. Where a numerical value is not indicated, the value in the text is adopted without change.

In addition to the jurisdictional options listed in Table 101.5.1, the code also provides for optional jurisdictional adoption of Informative Appendix H, Option for Energy Efficiency Using the IECC Prescriptive Compliance Path and Informative Appendix M, Option for Residential Compliance Using the National Green Building Standard. Where *AHJ* adopts Appendix H, compliance with Sections 7.3 and 7.4 of this code shall be as specified in Appendix H.

TABLE 101.5.1
REQUIREMENTS DETERMINED BY THE JURISDICTION

SECTION	SECTION TITLE	JURISDICTIONAL REQUIREMENT
Chapter 5—Site Sustainability		
501.3.5.2 (5.3.5.2)	Mitigation of Heat Island Effect—Walls	__ No
501.3.6 (5.3.6)	Reduction of Light Pollution	__ No
501.3.7.2.2 (5.3.7.2.2)	Bicycle Parking Location	__ No
501.3.7.2.3 (5.3.7.2.3)	Bicycle Parking, Horizontal Parking Racks	__ No
501.3.7.2.5 (5.3.7.2.5)	Bicycle Parking, Security and Visibility	__ No
501.3.8.1 (5.3.8.1)	Building Site Waste Management—Diversion Percentage	__ 75% __ 50%
Chapter 6—Water Use Efficiency		
601.3.1.2.1(a,3) [6.3.1.2.1(a,3)]	Irrigation System Design, Master Valve	__ No
601.3.1.2.1(a,4) [6.3.1.2.1(a,4)]	Irrigation System Design, Flow Sensors	__ No
601.3.4 (6.3.4)	Special Water Features	__ No
601.3.5.2 (6.3.5.2)	Consumption Data Collection	__ No
601.3.5.3 (6.3.5.3)	Data Storage and Retrieval	__ No
601.3.9 (6.3.9)	Dual Water Supply Plumbing	__ No
Chapter 7—Energy Efficiency		
701.4.2.1 (7.4.2.1)	Building Envelope Requirements	__ No
701.4.2.3 (7.4.2.3)	Single Rafter Roof Insulation	__ No
701.4.2.4 (7.4.2.4)	High-speed Doors	__ No
701.4.2.7 (7.4.2.7)	Permanent Projections	__ No
701.4.2.10 (7.4.2.10)	Orientation	__ No
701.4.3.2 (7.4.3.2)	Ventilation Controls for Densely Occupied Spaces	__ No
701.4.3.4 (7.4.3.4)	Economizers	__ No
701.4.3.5 (7.4.3.5)	Zone Controls	__ No
701.4.3.7 (7.4.3.7)	Exhaust Air Energy Recovery	__ No
701.4.3.8 (7.4.3.8)	Kitchen Exhaust Systems	__ No
701.4.4.3 (7.4.4.3)	Insulation for Spa Pools	__ No
701.4.6.3.1 (7.4.6.3.1)	Occupancy Sensor Controls in Commercial and Industrial Storage Stacks	__ No
701.4.6.3.2 (7.4.6.3.2)	Automatic Controls for Egress and Security Lighting	__ No
SECTION	**SECTION TITLE**	**JURISDICTIONAL REQUIREMENT**
701.4.7.2 (7.4.7.2)	Supermarket Heat Recovery	__ No

701.4.7.4 (7.4.7.4)	Programmable Thermostats	__ No
701.4.7.5 (7.4.7.5)	Refrigerated Display Cases	__ No
701.5.4 (7.5.4)	Energy Simulation Aided Design	__ No
Chapter 8—Indoor Environmental Quality		
801.3.1.3(b) [8.3.1.3(b)]	Outdoor Air Ozone Removal	__ No
801.3.1.4.2 (8.3.1.4.2)	Exfiltration	__ No
801.3.3.4 (8.3.3.4)	Interior Sound Reverberation	__ No
801.3.9 [8.3.9]	Exterior Views	__ No
801.4.1.3 (8.4.1.3)	Shading for Offices	__ No
Chapter 9—Materials and Resources		
901.3.1.2 (9.3.1.2)	Total Waste	__ No
Chapter 10—Construction and Plans for Operation		
1001.4.4 (10.4.4)	Construction Activity Pollution Prevention: Protection of Occupied Areas	__ No
1001.7 (10.7)	Postconstruction Building Flush-out and Air Monitoring	__ No
1001.10 (10.10)	Service Life Plan	__ No
1001.11.2 (10.11.2)	Transportation Management Plan, Owner-occupied Building Projects or Portions of Building Projects	__ No
1001.11.3 (10.11.3)	Transportation Management Plan, Building Tenant	__ No

101.5.2 **(4.3.2) Normative appendices.** The normative appendices to this code are considered to be integral parts of the mandatory requirements of this code, which for reasons of convenience are placed apart from all other normative elements.

101.5.3 **(4.3.3) Informative appendices.** The informative appendices to this code, and informative notes located within this code, contain additional information and are not mandatory or part of this code except where specifically adopted by *AHJ*.

Informative note: Informative Appendices H and M are written in mandatory language suitable for inclusion in local codes where specifically adopted by the jurisdiction.

101.5.4 **(4.3.4) Referenced standard reproduction annexes.** The referenced standard reproduction annexes contain material that is cited in this code but that is contained in another standard. The referenced standard reproduction annexes are not part of this code but are included in its publication to facilitate its use.

SECTION 102

APPLICABILITY

102.1 Code conflicts. Where there is a conflict between a general requirement and a specific requirement of this code, the specific requirement shall be applicable. Where, in any specific case, different sections of the code specify different materials, methods of construction or other requirements, the most practical requirement to meet the intent of the code shall govern.

102.2 Other laws. The provisions of this code shall not be deemed to nullify any provisions of local, provincial or federal law.

102.3 Application of references. References to chapter or section numbers, or to provisions not specifically identified by number, shall be construed to refer to such chapter, section or provision of this code.

102.4 Referenced codes and standards. Where adopted by *AHJ*, the following codes shall be considered to be part of the requirements of this code: *Building Code of Pakistan-2021*, *International Code Council Performance Code*, *Building Code of Pakistan – Energy Provisions 2011*, *International Existing Building Code*, *Building Code of Pakistan – Fire Safety Provisions 2016*, *International Fuel Gas Code*, *International Mechanical Code*, *International Plumbing Code*, *International Property Maintenance Code*, and *International Residential Code*.

102.4.1 Conflicting provisions. Where the extent of the reference to a referenced code or standard includes subject matter that is within the scope of this code or the International Codes as adopted by *AHJ* listed in Section 102.4, the provisions of this code or the International Codes listed in Section 102.4, as applicable, shall take precedence over the provisions in the referenced code or standard.

102.4.2 Application of referenced standards. The standards referenced in this code and listed in Chapter 11 shall be considered to be part of the requirements of this code to the prescribed extent of such reference. Where differences exist between the provisions of this code and a referenced standard, the provisions of this code shall apply. Informative references in Informative Appendix G are cited to acknowledge sources and are not part of this code.

102.5 Partial invalidity. In the event that any part or provision of this code is held to be illegal or void, this shall not have the effect of making void or illegal any of the other parts or provisions.

102.6 Existing structures. The legal occupancy of any structure existing on the date of adoption of this code shall be permitted to continue without change, except as is specifically covered in this code; and where adopted by *AHJ*, the *Building Code of Pakistan-2021*, the *International Existing Building Code*, the *International Property Maintenance Code* or the *Building Code of Pakistan – Fire Safety Provision 2016*; or as is deemed necessary by *AHJ* for the general safety and welfare of building occupants and the public.

102.7 Mixed occupancy buildings. In mixed occupancy buildings, each portion of a building shall comply with the specific requirements of this code applicable to each specific occupancy.

PART 2—ADMINISTRATION AND ENFORCEMENT

SECTION 103

CODE COMPLIANCE AGENCY

103.1 General. The provisions of this code shall be implemented, administered and enforced by *AHJ* using their organizational procedures.

103.2 Appointment. This section is intentionally left blank.

103.3 Deputies. This section is intentionally left blank.

SECTION 104

DUTIES AND POWERS OF THE AUTHORITY HAVING JURISDICTION

104.1 **General.** These Provisions shall apply without restriction, unless specifically exempted. *AHJ* shall have the authority to render interpretations of this code and to adopt policies and procedures in order to clarify the application of its provisions with the help of experts (*Registered design professionals*). Such interpretations, policies and procedures shall be in compliance with the intent and purpose of this code and other applicable codes and ordinances. Such policies and procedures shall not have the effect of waiving requirements specifically provided for in this code or other applicable codes and ordinances.

104.2 **Applications and permits.** *AHJ* shall establish procedures to enforce compliance with the provisions of this code as part of the enforcement of other applicable codes and regulations, including the referenced codes listed in Section 102.4.

104.3 **Notices and orders.** *AHJ* shall issue all necessary notices or orders to ensure compliance with this code.

104.4 **Inspections.** *AHJ* shall make inspections, as required, to determine code compliance. *AHJ* is authorized to engage such expert opinion (by a *Registered design professional*) as deemed necessary to report on unusual technical issues that arise, subject to the approval of the appointing authority.

SECTION 105

APPROVAL

105.1 General. This code is not intended to prevent the use of any material, method of construction, design, system, or innovative approach not specifically prescribed herein, provided that such construction, design, system or innovative approach has been approved by *AHJ* as meeting the intent of this code and all other applicable laws, codes and ordinances.

105.2 Approved materials and equipment. Materials, equipment, devices and innovative approaches *approved* by *AHJ* shall be constructed, installed and maintained in accordance with such approval.

105.2.1 Used materials, products and equipment. Used materials, products and equipment that are to be reused shall meet the requirements of this code for new materials. Used equipment and devices that are to be reused are subject to the approval of *AHJ*.

105.3 Modifications. Where there are practical difficulties involved in carrying out the provisions of this code, *AHJ* shall seek expert opinion (by a *Registered design professional*) to grant modifications for individual cases, upon application of the owner or the owner's authorized agent, provided *AHJ* shall first find that special individual reason makes the strict letter of this code impractical and that the modification is in compliance with the intent and purpose of this code and that such modification does not lessen the minimum requirements of this code. The details of granting modifications shall be recorded and entered in the files of the department.

105.4 Innovative approaches and alternative materials, design, and methods of construction and equipment. The provisions of this code are not intended to prevent the installation of any material or to prohibit any design, innovative approach, or method of construction not specifically prescribed by this code, provided that any such alternative has been *approved*. An alternative material, design, innovative approach or method of construction shall be reviewed and *approved* where *AHJ* takes help from experts (*Registered design professionals*) to review and confirm that the proposed alternative is satisfactory and complies with the intent of the provisions of this code, and that the material, design, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code The details of granting the use of alternative materials, designs, innovative approach and methods of construction shall be recorded and entered in the files of the department. Where the alternative material, design or method of construction is not approved, *AHJ* shall respond in writing, stating the reasons the alternative was not approved.

105.4.1 Research reports. Supporting data, where necessary to assist in the approval of materials or assemblies not specifically provided for in this code, shall consist of valid research reports from *approved* sources.

105.4.2 Tests. Where there is insufficient evidence of compliance with the provisions of this code, or evidence that a material or method does not conform to the requirements of this code, or in order to substantiate claims for alternative

materials or methods, *AHJ* shall have the authority to require tests as evidence of compliance to be made at no expense to *AHJ*. Test methods shall be as specified in this code or by other recognized test standards. In the absence of recognized and accepted test methods, *AHJ* shall approve the testing procedures with the help of experts (*Registered design professionals*). Tests shall be performed by an approved agency. Reports of such tests shall be retained by *AHJ* for the period required for retention of public records.

105.5 Compliance materials. *AHJ* shall be permitted to take help from experts (*Registered design professionals*) to approve specific computer software, worksheets, compliance manuals and other similar materials that meet the intent of this code. *AHJ* may permit the use to innovative materials such as Fiber reinforced polymer (FRP) bars exclusively for NON-STRUCTURAL applications in consultation with experts.

105.6 Approved programs. This section is intentionally left blank.

105.6.1 Specific approval. This section is intentionally left blank.

SECTION 106

PERMITS

106.1 Required. Any owner or owner's authorized agent who intends to construct, enlarge, alter, repair, move, demolish, or change the occupancy of a building or structure, or to erect, install, enlarge, alter, repair, remove, convert or replace any energy, electrical, gas, mechanical or plumbing system, the installation of which is regulated by this code, or to cause any such work to be done, shall first make application to *AHJ* and obtain the required permit under the applicable adopted code or regulation relevant to the intended work. Exemptions from permit requirements shall not be deemed to grant authorization for any work to be done in any manner in violation of the provisions of this code or any other applicable laws, codes or ordinances of *AHJ*.

SECTION 107

CONSTRUCTION DOCUMENTS

107.1 **Information on construction documents.** Where adopted by *AHJ*, the content and format of construction documents shall comply with the *Building Code of Pakistan-2021*.

SECTION 108

FEES

108.1 Payment of fees. A permit shall not be valid until the fees prescribed by law have been paid, nor shall an amendment to a permit be released until the additional fee, if any, has been paid.

108.2 Schedule of permit fees. Where a permit is required, a fee for each permit shall be paid as required, in accordance with the schedule as established by *AHJ*.

108.3 Permit valuations. This section is intentionally left blank.

108.4 Work commencing before permit issuance. Any person who commences any work before obtaining the necessary permits shall be subject to a fee established by *AHJ* that shall be in addition to the required permit fees.

108.5 Related fees. The payment of the fee for the construction, alteration, removal or demolition work done in connection to or concurrently with the work authorized by a permit shall not relieve the applicant or holder of the permit from the payment of other fees that are prescribed by law.

108.6 Refunds. *AHJ* is authorized to establish a refund policy.

SECTION 109

INSPECTIONS

109.1 **General.** Construction or work for which a permit is required shall be subject to inspection by *AHJ* and such construction or work shall remain visible and able to be accessed for inspection purposes until approved. Approval as a result of an inspection shall not be construed to be an approval of a violation of the provisions of this code or of other ordinances of the jurisdiction. Inspections presuming to give authority to violate or cancel the provisions of this code or of other ordinances of the jurisdiction shall not be valid. It shall be the duty of the owner or the owner's authorized agent to cause the work to remain accessible and exposed for inspection purposes. *AHJ* shall not be liable for the expense entailed in the removal or replacement of any material required to allow inspection.

SECTION 110

CERTIFICATE OF OCCUPANCY

110.1 **Violations.** Issuance of a certificate of occupancy shall not be construed as an approval of a violation of the provisions of this code or of other ordinances of the jurisdiction.

SECTION 111

MEANS OF APPEALS

111.1 **General.** The procedures given in the regulations of *AHJ* regarding appeals, hearing of appeals, duration and their decisions shall be followed. The appeal shall be heard by a committee constituted by the next higher body above *AHJ* having members with relevant experience, who are registered with PEC, PCATP or *AHJ*. The committee shall adopt rules of procedure for conducting its business and shall render all decisions and findings in writing to the appellant with a duplicate copy to *AHJ*.

111.2 **Limitations on authority.** An application for appeal shall be based on a claim that the true intent of this code or the rules legally adopted thereunder have been incorrectly interpreted, the provisions of this code do not fully apply, or an equivalent or better form of construction is proposed. The committee shall not have authority to waive requirements of this code or interpret the administration of this code.

111.3 **Qualifications.** The committee of appeals shall consist of members who are qualified by experience and training to pass on matters pertaining to building construction and are not employees of *AHJ*.

111.4 Administration. *AHJ* shall take immediate action in accordance with the decision of the board.

CHAPTER 2

RESERVED

CHAPTER 3

DEFINITIONS, ABBREVIATIONS AND ACRONYMS

301.1 (3.1) General. Certain terms, abbreviations, and acronyms are defined in this section for the purposes of this code. These definitions are applicable to all sections of this code.

Terms that are not defined herein, but that are defined in standards that are referenced herein (***Informative Note:*** e.g., ANSI/ASHRAE/IES Standard 90.1), shall have the meanings as defined in those standards.

Other 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 on American standard English language usage, as documented in an *approved* unabridged dictionary.

301.2 (3.2) Definitions:

agricultural land: land that is, or was, within ten years prior to the date of the building permit application for the *building project*, primarily devoted to the commercial production of horticultural, viticultural, floricultural, dairy, apiary, vegetable, or animal products or of berries, grain, hay, straw, turf, seed, finfish in upland hatcheries, or livestock, and that has long-term commercial significance for agricultural production. Land that meets this definition is *agricultural land* regardless of how the land is zoned by the local government with zoning jurisdiction over that land.

agrifiber product: wheatboard or strawboard.

air, makeup: see ANSI/ASHRAE Standard 62.1.

air, outdoor: see ANSI/ASHRAE Standard 62.1.

air, transfer: see ANSI/ASHRAE Standard 62.1.

airflow, minimum outdoor: the outdoor airflow provided by a ventilation system to meet requirements for indoor air quality, excluding any additional *outdoor air* intake to reduce or eliminate the need for *mechanical cooling*.

alternative daily cover: cover material, other than earthen material, placed on the surface of the active face of a municipal solid-waste landfill at the end of each operating day to control vectors, fires, odors, blowing litter, and scavenging.

annual sunlight exposure (ASE): the percent of an analysis area that exceeds a specified direct-sunlight illuminance level for more than a specified number of hours per year (Source: IES LM 83). *Annual sunlight exposure* is a metric that quantifies the potential for excessive sunlight in interior work environments.

approved: acceptable to the *authority having jurisdiction*.

approved agency: an established and recognized agency that is regularly engaged in conducting tests, furnishing inspection services, or furnishing product certification where such agency has been *approved*.

approved source: an independent person, firm, or corporation, *approved* by *the authority having jurisdiction*, who is competent and experienced in the application of engineering principles to materials, methods, or systems analyses.

Alternate and Renewable Energy: *(ARE)*

attic and other roofs: see ANSI/ASHRAE/IES Standard 90.1.

authority having jurisdiction (AHJ): the agency or agent responsible for enforcing this code.

automatic: see ANSI/ASHRAE/IES Standard 90.1.

automatic shut-off control: a device capable of automatically turning loads off without manual intervention. *Automatic shut-off controls* include devices such as occupancy sensors, vacancy sensors, motion sensors, programmable time switches, or count-down timers.

baseline building design: see ANSI/ASHRAE/IES Standard 90.1.

baseline building performance: see ANSI/ASHRAE/IES Standard 90.1.

Basis of Design (BoD): a document that records the concepts, calculations, decisions, and product selections used to meet the *owner's project requirements* and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process. (See *owner's project requirements*.)

bilevel lighting control: lighting control in a *space* that provides at least one intermediate level of lighting power in addition to fully ON and fully OFF. Continuous dimming systems are covered by this definition.

biobased product: a commercial or industrial product (other than food or feed) that comprises, in whole or in significant part, biological products or renewable agricultural materials (including *plant*, animal, and marine materials) or forestry materials.

biodiverse plantings: nonhomogeneous, multiple-species plantings.

breathing zone: see ANSI/ASHRAE Standard 62.1.

brownfield: a *site* documented as contaminated by means of an ASTM E1903 Phase II Environmental Site Assessment or a *site* classified as a *brownfield* by a local, state, or federal government agency.

building entrance: see ANSI/ASHRAE/IES Standard 90.1.

building envelope: see ANSI/ASHRAE/IES Standard 90.1.

Building information modeling: (BIM)

building project: a building, or group of buildings, and *site* that utilize a single submittal for a construction permit or that are within the boundary of contiguous properties under single ownership or effective control. (See *owner.*)

carbon dioxide equivalent (CO_2e): a measure used to compare the impact of various greenhouse gases based on their global warming potential (GWP). CO_2e approximates the time-integrated warming effect of a unit mass of a given greenhouse gas relative to that of carbon dioxide (CO_2). GWP is an index for estimating the relative global warming contribution of atmospheric emissions of a particular greenhouse gas compared to emissions of an equal mass of CO_2.

classroom: a *space* primarily used for scheduled instructional activities.

combined energy efficiency ratio (CEER* [I-P]*) ($CCOP_C$* [SI]*): the combined energy efficiency is a ratio of the total cooling in one year divided by the total energy from active, stand-by, and OFF modes as defined in AHAM Standard RAC-1, expressed in Btu/h/W (W/W).

combined heat and power system (CHP): an on-site or off-site district energy conversion plant that delivers both electricity and thermal energy, where a portion or all of the thermal energy serves the *building project*.

commissioning (Cx) plan: a document that outlines the organization, schedule, allocation of resources, and documentation requirements of the building *commissioning process*. (See *commissioning* [*Cx*] *process*.)

commissioning (Cx) process: a quality-focused process for enhancing the delivery of a project. The process focuses on verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the *owner's project requirements*. (See *owner's project requirements*.)

commissioning (Cx) provider: an *approved* entity, identified by the *owner*, who manages the commissioning team to implement the building *commissioning process*. (See *commissioning* [*Cx*] *process*.) (***Informative Note:*** This entity is sometimes known as a "commissioning authority," "CxA," or *approved agency*. See *commissioning [Cx] process*.)

community renewable energy facility: a facility that generates electricity energy with photovoltaic, solar thermal, *geothermal energy*, or wind systems, and is qualified as a community energy facility under applicable state and local utility statutes and rules.

composite wood product: hardwood plywood made with a veneer or composite core, particleboard, or medium density fiberboard (MDF).

conditioned space: see ANSI/ASHRAE/IES Standard 90.1.

construction documents: written, graphic, and pictorial documents prepared or assembled for describing the design, location, and physical characteristics of the elements of a project necessary for obtaining a building permit.

contaminant: see ANSI/ASHRAE Standard 62.1.

continuous air barrier: see ANSI/ASHRAE/IES Standard 90.1.

cycles of concentration: the ratio of makeup rate to the sum of the blowdown and drift rates.

daylight area: area in an *enclosed space* that is in the *primary sidelighted area*, *daylight area under roof monitors*, or *daylight area under skylights*.

daylight area under roof monitors: see ANSI/ASHRAE/IES Standard 90.1.

daylight area under skylights: see ANSI/ASHRAE/IES Standard 90.1.

daylight hours: the period from 30 minutes after sunrise to 30 minutes before sunset.

demand control ventilation (DCV): see ANSI/ASHRAE/IES Standard 90.1.

densely occupied space: those *spaces* with a design occupant density greater than or equal to 25 people per 1000 ft^2 (100 m^2).

designated park land: federal-, state-, or local-government-owned land that is formally designated and set aside as park land or a wildlife preserve.

design conditions: see ANSI/ASHRAE/IES Standard 90.1.

dimmer: see ANSI/ASHRAE/IES Standard 90.1.

DISCO: Distribution company

district energy plant: a centralized cooling or heating plant (e.g., centralized chiller or boiler plant) that distributes *district heating or cooling* to multiple buildings and loads, one of which being the *building project*.

district energy system (DES): a thermal energy system made up of one or more *district energy plants* and a *district thermal distribution system*.

district heating or cooling: heat transfer media, such as chilled water, hot water, or steam, produced by a *district energy plant* and transported via a *district thermal distribution system*.

district thermal distribution system: a system for transporting *district heating or cooling* from a *district energy plant* to the *building project*. The system includes all energy consuming equipment involved with transport, including pumps, heat exchangers, water treatment, thermal losses, and pressure control.

dwelling unit: see ANSI/ASHRAE/IES Standard 90.1.

dynamic glazing: see ANSI/ASHRAE/IES Standard 90.1.

electric vehicle supply equipment (EVSE): the conductors—including the ungrounded, grounded, and equipment grounding conductors—and the electric vehicle connectors, attachment plugs, and all other fittings, devices, power outlets, or apparatus installed specifically for the purpose of transferring energy between the premises wiring and the electric vehicle.

electronics: computers and accessories; monitors; printers; and other equipment, such as scanners, fax machines, electric typewriters, cell phones, telephones, answering machines, shredders, postage machines, televisions, VHS/DVD players, portable cassette/CD players with radio devices, and stereo equipment.

emergency ride home: access to transportation home in the case of a personal emergency or unscheduled overtime for employees who commute via transit, carpool, or vanpool.

enclosed space: see ANSI/ASHRAE/IES Standard 90.1.

enthalpy recovery ratio: see ANSI/ASHRAE/IES Standard 90.1.

evapotranspiration (ET): the sum of evaporation from soil and *plant* surfaces and transpiration of water through leaf stomata.

> ***ET_c:*** *evapotranspiration* of the *plant* material derived by multiplying ET_o by the appropriate *plant* factor or coefficient.
>
> ***ET_o:*** reference *evapotranspiration* for a cool-season grass as calculated by the standardized Penman-Monteith equation based on weather station data.

EV ready space: a designated parking space provided with a 50 A, 208/240V dedicated branch circuit for Level 2 *EVSE*. The circuit shall include an overcurrent protective device and shall terminate in a junction box, NEMA 6-50 or NEMA 14-50 receptacle, or EVSE and be located in close proximity to the proposed location of the EV parking spaces.

fan energy index (FEI): the ratio of the electric input power of a reference fan to the electric input power of the actual fan as calculated per AMCA 208.

fenestration: see ANSI/ASHRAE/IES Standard 90.1.

fenestration area: see ANSI/ASHRAE/IES Standard 90.1.

fish and wildlife habitat conservation area: areas with which state or federally designated endangered, threatened, or sensitive species have a primary association.

forest land: all designated state forests, national forests, and all land that is, or was, within ten years prior to the date of the building permit for the *building project*, primarily devoted to growing trees for long-term commercial timber production.

functional and performance testing (FPT): testing performed to ensure that designated systems of the project meet the intended design performance requirements.

functional and performance testing provider (FPT provider): an entity identified by the *owner* who manages the activities needed to implement the building *functional and performance testing (FPT)* activities.

general lighting: see ANSI/ASHRAE/IES Standard 90.1.

generally accepted engineering standard: see ANSI/ASHRAE/IES Standard 90.1.

geothermal energy: heat extracted from the Earth's interior that is used to produce electricity or mechanical power or to provide thermal energy for heating buildings or processes. *Geothermal energy* does not include systems such as heat pumps that use energy independent of the geothermal source to raise the temperature of the extracted heat.

greenfield: a *site* of which 20% or less has been previously developed with impervious surfaces.

greyfield: a *site* of which more than 20% is currently or has been previously developed with impervious surfaces.

gross conditioned floor area: see ANSI/ASHRAE/IES Standard 90.1.

gross roof area: see ANSI/ASHRAE/IES Standard 90.1.

gross wall area: see ANSI/ASHRAE/IES Standard 90.1.

ground cover: plantings other than *turfgrass* that are low-growing and form dense vegetation over the soil area.

hardscape: *site* paved areas, including roads, driveways, parking lots, walkways, courtyards, and plazas.

hardwood plywood: a hardwood or decorative panel that is intended for interior use and composed of (as determined under ANSI/HPVA HP-1) an assembly of layers or plies of veneer, joined by an adhesive with a lumber core, a particleboard core, a medium density fiberboard core, a hardboard core, a veneer core, or any other special core or special back material. Hardwood plywood does not include military-specified plywood, curved plywood, or any plywood specified in PS-1, or PS-2.

heat island effect: the tendency of urban areas to be at a warmer temperature than surrounding rural areas.

high-performance green building: a building designed, constructed, and capable of being operated in a manner that increases environmental performance and economic value over time, seeks to establish an indoor environment that supports the health of occupants, and enhances satisfaction and productivity of occupants through integration of environmentally preferable building materials and water-efficient and energy-efficient systems.

high-speed door: a nonswinging door used primarily to facilitate vehicular access or material transportation, and having an *automatic* closing device with an opening rate of not less than 32 in./s (810 mm/s) and a closing rate of not less than 24 in./s (610 mm/s).

hourly average sound pressure level (L_{eq}): time-mean-square frequency-weighted sound pressure level for one hour.

hydrozone: an irrigated area of landscape in which the *plants* have similar water needs and are irrigated by the same type of emission devices.

improved landscape: any disturbed area of the *site* where new *plant* and/or grass materials are to be used, including green *roofs*, plantings for stormwater controls, planting boxes, and similar vegetative use. *Improved landscape* shall not include *hardscape* areas such as sidewalks, driveways, other paved areas, and swimming pools or decking.

institutional tuning: the process, by authorized personnel, of adjusting the maximum light output of individual luminaires, groups of luminaires, or entire lighting systems to support visual needs or to save energy. *Institutional tuning* is also known as "high-end trim control."

integrated design process: a design process using early collaboration among representatives of each stakeholder and participating consultant on the project. Unlike the conventional, or linear, design process, integrated design requires broad stakeholder/consultant participation.

integrated project delivery**:** see *integrated design process*.

interior projection factor (PF): see *projection factor, interior*.

irrigation adequacy: a representation of how well irrigation meets the needs of the *plant* material. This reflects the percentage of required water for turf or *plant* material supplied by rainfall and controller-scheduled irrigations.

irrigation excess: a representation of the amount of irrigation water applied beyond the needs of the *plant* material. This reflects the percentage of water applied in excess of 100% of required water.

irrigation station: a set of irrigation emission devices supplied water by a single control valve. Also referred to as an "irrigation zone."

isolation devices: see ANSI/ASHRAE/IES Standard 90.1.

labeled: equipment, materials, or products to which has been affixed a label, seal, symbol, or other identifying mark of a nationally recognized testing laboratory, *approved* agency, or other organization concerned with product evaluation that maintains periodic inspection of the production of the above-labeled items and whose labeling indicates either that the equipment, material, or product meets identified standards or has been tested and found suitable for a specified purpose.

laminated product: product in which a wood or woody grass veneer is affixed to a particleboard core or platform, a medium-density fiberboard core or platform, or a veneer core or platform.

landscape establishment period: a time period, beginning on the date of completion of permanent plantings and not exceeding 18 months, intended to allow the permanent landscape to become sufficiently established to remain viable.

Langelier Saturation Index (LSI): a measure of a solution's ability to dissolve or deposit calcium carbonate that is often used as an indicator of the corrosivity of water, calculated using the following formula:

$$LSI = \text{pH} - \text{pH}_s$$

where:

pH = measured water pH

pH_s = pH at saturation in calcium carbonate

Leadership in energy and environmental esign (LEED)

life-cycle assessment (LCA): a compilation and evaluation of the inputs, outputs, and potential environmental impacts of a building system throughout its life cycle. *LCA* addresses the environmental aspects and potential environmental impacts (e.g.,

use of resources and environmental consequences of releases) throughout a building's life cycle, from raw material acquisition through manufacturing, construction, use, operation, end-of-life treatment, recycling, and final disposal (end of life). The purpose is to identify opportunities to improve the environmental performance of buildings throughout their life cycles.

lighting power allowance: see ANSI/ASHRAE/IES Standard 90.1.

lighting quality: the degree to which the luminous environment in a *space* supports the requirements of the occupants.

lighting zone (LZ): an area defining limitations for outdoor lighting.

> ***LZ0:*** undeveloped areas within national parks, state parks, *forest land*, rural areas, and other undeveloped areas as defined by the *AHJ*.
>
> ***LZ1:*** developed areas of national parks, state parks, *forest land*, and rural areas.
>
> ***LZ2:*** areas predominantly consisting of *residential* zoning, neighborhood business districts, light industrial with limited night time use, and *residential* mixed use.
>
> ***LZ3:*** all areas not included in *LZ0*, *LZ1*, *LZ2*, or *LZ4*.
>
> ***LZ4:*** high-activity commercial districts in major metropolitan areas as designated by the local jurisdiction.

liner system (Ls): an insulation system for a metal building *roof* that includes the following components. A continuous membrane is installed below the purlins and is uninterrupted by framing members. Uncompressed, unfaced insulation rests on top of the membrane between the purlins. For multilayer installations, the last rated R-value of insulation is for unfaced insulation draped over purlins and then compressed when the metal *roof* panels are attached. A minimum R-3 (R-0.5) thermal spacer block between the purlins and the metal *roof* panels is required unless compliance is shown by the overall assembly U-factor or otherwise noted.

listed: equipment, materials, products, or services included in a list published by an *approved* organization and concerned with evaluation of products or services that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services and whose listing states either that the equipment, material, product, or service meets identified standards or has been tested and found suitable for a specified purpose.

low-impact trail: erosion-stabilized pathway or track that uses natural groundcover or installed system greater than 50% pervious. The pathway or track is designed and used only for pedestrian and nonmotorized vehicles (excluding power-assisted conveyances for individuals with disabilities).

maintenance plan: see *maintenance program* in ANSI/ASHRAE/ACCA Standard 180.

maximum sound pressure level (L_{max}): greatest frequency-weighted and exponential-time-weighted sound level within a stated time interval.

mechanical cooling: see ANSI/ASHRAE/IES Standard 90.1.

medium-density fiberboard: a panel composed of cellulosic fibers made by dry forming and pressing a resinated fiber mat (as determined under ANSI A208.2).

multilevel lighting control: lighting control in a *space* that provides at least two intermediate levels of lighting power in addition to fully ON and fully OFF. Continuous dimming systems are covered by this definition.

nameplate rating: the design load operating conditions of a device as shown by the *manufacturer* on the nameplate or otherwise marked on the device.

NEPRA: National Electric Power Regulation Authority

networked guest-room control system: an energy management control system, accessible from the hotel/motel front desk or other central location, that is capable of identifying reserved rooms according to a timed schedule and is capable of controlling each hotel/motel guest room separately.

nonresidential: see ANSI/ASHRAE/IES Standard 90.1.

nonstandard part-load value (NPLV): see ANSI/ASHRAE/IES Standard 90.1.

occupant load: the number of persons for which the means of egress of a building or portion thereof is designed.

occupiable space: see ANSI/ASHRAE Standard 62.1.

office furniture system: either a panel-based workstation comprising modular interconnecting panels, hang-on components, and drawer/filing components, or a freestanding grouping of furniture items and their components that have been designed to work in concert.

once-through cooling: the use of water as a cooling medium, where the water is passed through a heat exchanger one time and is then discharged to the drainage system. This also includes the use of water to reduce the temperature of condensate or process water before discharging it to the drainage system.

on-site renewable energy system: photovoltaic, solar thermal, *geothermal energy*, and wind systems used to generate energy and located on any of the following:

a. The building.
b. The property upon which the building is located.
c. A property that shares a boundary with and is under the same ownership or control as the property on which the building is located.
d. A property that is under the same ownership or control as the property on which the building is located and is separated only by a public right-of-way from the property on which the building is located.

open-graded (uniform-sized) aggregate: materials such as crushed stone or decomposed granite that provide 30% to 40% void *spaces*.

outdoor air fault condition: a situation in which the measured *minimum outdoor airflow* of a ventilation system is 10% or more below the set-point value that corresponds to the occupancy and operation conditions at the time of the measurement.

owner: the party in responsible control of development, construction, or operation of a project at any given time.

owner's project requirements (OPR): a document that specifies the functional requirements of a project and the expectations of how it will be used and operated, including project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, training requirements, documentation requirements, and supporting information.

particleboard: a panel composed of cellulosic material in the form of discrete particles (as distinguished from fibers, flakes, or strands) that are pressed together with resin (as determined under ANSI A208.1). Particleboard does not include any product specified in PS-2, *Performance Standard for Wood-Based Structural-Use Panels*.

permanently installed: see ANSI/ASHRAE/IES Standard 90.1.

permeable pavement: pervious concrete or porous asphalt that allows the movement of water and air through the paving material and which is primarily used as paving for roads, parking lots, and walkways. Permeable paving materials have an open-graded coarse aggregate with interconnected voids.

permeable pavers: units that present a solid surface but allow natural drainage and migration of water into the base below by permitting water to drain through the spaces between the pavers.

plants:

a. ***adapted plants:*** *plants* that reliably grow well in a given habitat with minimal attention from humans in the form of winter protection, pest protection, water irrigation, or fertilization once root systems are established in the soil. *Adapted plants* are considered to be low maintenance but not invasive.
b. ***invasive plants:*** species of *plants* that are not native to the *building project site* and that cause or are likely to cause environmental harm. At a minimum, the list of invasive species for a *building project site* includes *plants* included in city, county, and regional lists and state and federal noxious weeds laws.
c. ***native plants:*** *plants* that adapted to a given area during a defined time period and are not invasive. In America, the term often refers to *plants* growing in a region prior to the time of settlement by people of European descent.
d. ***rainfall-ET_c compatible plants:*** *plants* with documented ET_c rates and having all of the following characteristics: (1) not native or invasive to the local geographic area of the *site*; (2) after the *landscape establishment period*, do not require supplemental annual irrigation, based on the ten-year average annual rainfall of the local climate and based on 80% of the *plant*'s ET_c.

porous pavers (open-grid pavers): units where at least 40% of the surface area consists of holes or openings that are filled with sand, gravel, other porous material, or vegetation.

postconsumer recycled content: proportion of *recycled material* in a product generated by households or by commercial, industrial, and institutional facilities in their role as end-users of the product, that can no longer be used for its intended purpose. This includes returns of material from the distribution chain. (See *recycled material*.)

preconsumer recycled content: proportion of *recycled material* in a product diverted from the waste stream during the manufacturing process. Content that shall not be considered preconsumer recycled includes the reutilization of materials such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it. (See *recycled material*.)

primary sidelighted area: see ANSI/ASHRAE/IES Standard 90.1.

projection factor (PF): see ANSI/ASHRAE/IES Standard 90.1.

projection factor (PF), interior: the ratio of the horizontal depth of the interior shading projection divided by the sum of the height of the *fenestration* above the interior shading projection and, if the interior projection is below the bottom of the *fenestration*, the vertical distance from the bottom of the *fenestration* to the top of the farthest point of the interior shading projection, in consistent units.

proposed building performance: see ANSI/ASHRAE/IES Standard 90.1.

proposed design: see ANSI/ASHRAE/IES Standard 90.1.

public way: a street, alley, transit right of way, or other parcel of land open to the outdoors and leading to a street or transit right of way that has been deeded, dedicated, or otherwise permanently appropriated for public use and that has a clear width and height of not less than 10 ft (3 m).

Pump Energy Index (PEI): ratio of the pump energy rating of a given pump type and model divided by the pump energy rating of the same pump type and characteristics minimally compliant with US regulations.

REC: see *renewable energy certificate* (REC).

recovered material: material that would have otherwise been disposed of as waste or used for energy recovery (***Informative Note:*** e.g., incinerated for power generation) but has instead been collected and recovered as a material input, in lieu of new primary material, for a recycling or a manufacturing process.

recycled content: proportion by mass of *recycled material* in a product or packaging. Only preconsumer and postconsumer materials shall be considered as *recycled content*. (See *recycled material*.)

recycled material: material that has been reprocessed from *recovered* (reclaimed) *material* by means of a manufacturing process and made into a final product or into a component for incorporation into a product. (See *recovered material*.)

***registered design professional*:** an individual who is registered or licensed to practice their respective design profession as defined by the statutory requirements of the professional registration laws of the state or jurisdiction in which the project is to be constructed.

regulated energy use: see ANSI/ASHRAE/IES Standard 90.1.

renewable energy certificate (REC): a tradable instrument that represents the environmental attributes of one megawatt-hour of renewable electricity generation and is transacted separately from the electricity generated by the renewable energy source; also known as "energy attribute" and "energy attribute certificate."

residential: see ANSI/ASHRAE/IES Standard 90.1.

roof: see ANSI/ASHRAE/IES Standard 90.1.

roof area, gross: see ANSI/ASHRAE/IES Standard 90.1.

roof monitor: see ANSI/ASHRAE/IES Standard 90.1.

salvaged material: material, component, or assembly removed in a whole form from a structure or site in which it was permanently installed and subsequently reused in the building project.

seating: task and guest chairs used with *office furniture systems*.

secondary sidelighted area: see ANSI/ASHRAE/IES Standard 90.1.

semiheated space: see ANSI/ASHRAE/IES Standard 90.1.

sensible energy recovery ratio: see ANSI/ASHRAE/IES Standard 90.1.

service water heating: see ANSI/ASHRAE/IES Standard 90.1.

sidelighting: daylighting provided by *vertical fenestration* mounted below the ceiling plane.

sidelighting effective aperture: the relationship of daylight transmitted through *vertical fenestration* to the *primary sidelighted areas*. The *sidelighting effective aperture* is calculated according to the following formula:

$$\textit{Sidlighting effective aperature} = \frac{\Sigma\ \textit{Vertical fenetration}\ \text{area} \times \textit{Vertical fenestration}\ \text{VT}}{\text{Area of } \textit{primary sidelighted area}}$$

where *Vertical fenestration* VT is the visible transmittance of *vertical fenestration* as determined in accordance with NFRC 200. For products outside the scope of NFRC 200, VT is the solar photometric transmittance of the glazing materials as determined in accordance with ASTM E972.

single-rafter roof: see ANSI/ASHRAE/IES Standard 90.1.

site: a contiguous area of land that is under the ownership or control of one entity.

skylight: see ANSI/ASHRAE/IES Standard 90.1.

skylight effective aperture: see ANSI/ASHRAE/IES Standard 90.1.

smart controller (weather-based irrigation controller): a device that estimates or measures depletion of water from the soil moisture reservoir and operates an irrigation system to replenish water as needed while minimizing excess.

soil-gas retarder system: a combination of measures that retard vapors in the soil from entering the occupied *space*.

solar energy system: any device or combination of devices or elements that rely on direct sunlight as an energy source, including, but not limited to, any substance or device that collects sunlight for use in

a. heating or cooling of a structure or building;
b. heating or pumping of water;
c. industrial, commercial, or agricultural processes; and
d. generation of electricity.

solar heat gain coefficient (SHGC): see ANSI/ASHRAE/IES Standard 90.1.

solar reflectance index (SRI): a measure of a constructed surface's ability to reflect solar heat, as shown by a small temperature rise. A standard black surface (reflectance 0.05, emittance 0.90) is 0, and a standard white surface (reflectance 0.80, emittance 0.90) is 100.

space: see ANSI/ASHRAE/IES Standard 90.1.

spatial daylight autonomy (sDA): the percent of an analysis area that meets a minimum daylight illuminance level for a specified fraction of the hours per year (Source: IES LM 83). *Spatial daylight autonomy* is a metric quantifying annual sufficiency of ambient daylight levels in interior *spaces*.

specular visible transmittance: the fraction of incident flux (lumens) that passes directly through a surface or medium without scattering.

***SWAT*:** smart water application technology as defined by the Irrigation Association.

task lighting: see ANSI/ASHRAE/IES Standard 90.1.

tubular daylighting device: a means to capture sunlight from a rooftop. Sunlight is then redirected down from a highly reflective shaft and diffused throughout interior *space*.

turfgrass: grasses that are regularly mowed and, as a consequence, form a dense growth of leaf blades, shoots, and roots.

unregulated energy use: see ANSI/ASHRAE/IES Standard 90.1.

variable-air-volume (VAV) system: see ANSI/ASHRAE/IES Standard 90.1.

vendor: a company that furnishes products to project contractors and/or subcontractors for on-site installation.

verification: the process by which specific documents, components, equipment, assemblies, systems, and interfaces among systems are confirmed to comply with the criteria described in the *owner's project requirements*. (See *owner's project requirements*.)

vertical fenestration: see ANSI/ASHRAE/IES Standard 90.1.

view fenestration: *fenestration* that complies with all of the following:

a. It provides building occupants with a view to the outdoors or to an interior daylit atrium.
b. It has undiffused glazing with a haze value less than 3%, as determined in accordance with ASTM D1003.
c. It has a center-of-glass visible transmittance (VT) of not less than 20%.
d. The product of the center-of-glass VT and the openness factor of screens, patterned films, and ceramic frits is not less than 20%.
e. Where *dynamic glazing* is provided, such glazing has a center-of-glass VT of not less than 20% at the highest end of its range.
f. Where nonoperable opaque window treatments are provided, such as blinds, shades, and louvers, such treatments do not obstruct more than 40% of the *fenestration* glazing area.

wall: see ANSI/ASHRAE/IES Standard 90.1.

wall area, gross: see ANSI/ASHRAE/IES Standard 90.1.

***water, alternate on-site sources of*:** *alternate on-site sources of water* include, but are not limited to,

a. rainwater or stormwater harvesting,
b. air-conditioner condensate,
c. greywater from interior applications and treated as required,
d. swimming-pool filter backwash water,
e. cooling-tower blowdown water,
f. foundation drain water,
g. industrial process water, and
h. on-site wastewater treatment *plant* effluent.

water, nonpotable: water that is not *potable water*. (See *water, potable*.)

water, potable: water from public drinking water systems or from natural freshwater sources, such as lakes, streams, and aquifers, where water from such natural sources would or could meet drinking water standards.

water, reclaimed: *nonpotable water* derived from the treatment of waste water by a facility or system licensed or permitted to produce water meeting the jurisdiction's water requirements for its intended uses, including, but not limited to, above-surface landscape irrigation.

water-bottle filling station: a plumbing fixture or fixture fitting that is controlled by the user for the sole intended purpose of dispensing *potable water* into a personal drinking water bottle. Such fixtures and fittings are connected to the *potable water* distribution system of the premises and can be stand-alone fixtures or integrated with another fixture.

water factor (WF):

a. **clothes washer (residential and commercial):** the quantity of water in gallons (liters) used to wash each cubic foot (cubic meter) of machine capacity.

a. **residential dishwasher:** the quantity of water use in gallons (liters) per full machine wash and rinse cycle.

weatherproofing system: a group of components, including associated adhesives and primers, that when installed create a protective envelope against water and wind.

wetlands: those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation adapted for life in saturated soil conditions. This definition incorporates all areas that would meet the definition of "wetlands" under applicable federal or state guidance—regardless of whether they are officially designated, delineated, or mapped—including man-made areas that are designed, constructed, or restored to include the ecological functions of natural *wetlands*.

301.3 (3.3) Abbreviations and acronyms

µg	microgram
AC	alternating current
AHJ	authority having jurisdiction
AHRI	Air-Conditioning, Heating, and Refrigeration Institute
ANSI	American National Standards Institute
ASE	*annual sunlight exposure*
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials International
BIFMA	The Business and Institutional Furniture Manufacturer's Association
BMS	building management system
BoD	*Basis of Design*
BPF	building performance factor
Btu	British thermal unit
Btu/h	British thermal unit per hour
BUG	backlight, uplight, and glare
CAC	ceiling attenuation class
CCOP	combined coefficient of performance
CDPH	California Department of Public Health
CEER	combined energy efficiency ratio
CFC	chlorofluorocarbon
cfm	cubic feet per minute (ft^3/min)
CH_4	methane
CHP	*combined heat and power system*
c.i.	continuous insulation
CIE	Commission Internationale de L'Eclairage (International Commission on Illumination)
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CO_2	carbon dioxide
CO_2e	*carbon dioxide equivalent*
CSA	Canadian Standards Association

cSTC	composite sound transmission class
Cx	commissioning
dB	decibel
db	dry-bulb
dBA	decibel, A-weighting
dBC	decibel, C-weighting
DC	direct current
DCV	*demand control ventilation*
DES	*district energy system*
DR	demand response
EISA	Energy Independence and Security Act
EIA	Environmental Impact Assessment
EMS	Energy Management System
EPAct	US Energy Policy Act
EPD	environmental product declaration
ESC	erosion and sedimentation control
ET_c	*evapotranspiration*
ET_o	reference *evapotranspiration*
ETS	environmental tobacco smoke
fc	footcandle
FF&E	furniture, fixtures, and equipment
FPT	functional and performance testing
ft	foot
gal	gallon
gpm	gallons per minute
h	hour
ha	hectare
HCFC	hydrochlorofluorocarbon
HID	high-intensity discharge
HVAC	heating, ventilation, and air conditioning
HVAC&R	heating, ventilation, air conditioning, and refrigeration
Hz	hertz
IA	Irrigation Association
IAPMO	International Association of Plumbing and Mechanical Officials
IAQ	indoor air quality
IECC	International Energy Conservation Code
IEE	Initial Environmental Examination
IEQ	indoor environmental quality
IES	Illuminating Engineering Society
IIC	impact insulation class
in.	inch
I-P	inch-pound
ISR	impact sound rating
kg	kilogram

km	kilometer
kVA	kilovolt-ampere
kW	kilowatt
kWh	kilowatt-hour
L	liter
lb	pound
LCA	*life-cycle assessment*
LCI	life-cycle inventory
L_{eq}	*hourly average sound pressure level*
L_{max}	*maximum sound pressure level*
LPD	lighting power density
Ls	*liner system*
LSI	*Langelier Saturation Index*
LZ	*lighting zone*
m	meter
MDF	medium density fiberboard
MERV	minimum efficiency reporting value
mg	milligram
mi	mile
min	minute
mm	millimeter
mph	miles per hour
M&V	measurement and *verification*
N_2O	nitrous oxide
NA	not applicable
NAECA	National Appliance Energy Conservation Act
NIC	noise isolation class
NISR	normalized impact sound rating
NNIC	normalized noise isolation class
NPLV	*nonstandard part-load value*
NR	not required
OITC	outdoor-indoor transmission class
O&M	operations and maintenance
OPR	*owner's project requirements*
Pa	Pascal
PCI	Performance Cost Index
PF	*projection factor*
ppm	parts per million
RCR	room cavity ratio
REC	renewable energy certificate
s	second
SCAQMD	South Coast Air Quality Management District
sDA	spatial daylight autonomy
SHGC	*solar heat gain coefficient*

SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SRI	*solar reflectance index*
STC	sound transmission class
SWAT	smart water application technology
T_{60}	reverberation time in seconds
UL	Underwriters Laboratory
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFEMA	United States Federal Emergency Management Agency
USGBC	United States Green Building Council
VAV	variable air volume
VOC	volatile organic compound
VRF	variable refrigerant flow system
VT	visible transmittance
wb	wet-bulb
WF	water factor
yr	year

CHAPTER 4

RESERVED

CHAPTER 5

SITE SUSTAINABILITY

501.1 (5.1) Scope. This section addresses requirements for *building projects* that pertain to *site* selection, *site* development, and mitigation of *heat island effect*, light pollution reduction, and mitigation of transportation impacts-; and shall be uniformly applicable on all buildings. The building site shall be physically accessible, environmentally suitable and compliant to master plan as approved by *AHJ*

501.2 (5.2) Compliance. All of the provisions of Chapter 5 (Section 5) are mandatory provisions.

501.3 (5.3) Mandatory provisions.

501.3.1 (5.3.1) Site selection. The *building project* shall comply with Sections 501.3.1.1 (5.3.1.1) and 501.3.1.2 (5.3.1.2).

501.3.1.1 (5.3.1.1) Allowable sites. The site development for constructing *building project* shall take place in or on one of the following:

a. An existing *building envelope*. A building or groups of buildings on a site that utilize a single submittal for a construction permit or NOC issued by *AHJ* or that are within the boundary of contiguous properties under single effective control.

b. A *brownfield*. A site documented as contaminated by means of an Environmental Impact Assessment (EIA) and Initial Environmental Examination (IEE), or a site classified as a brownfield by a local, provincial, or federal government agency.

c. A *grey-field*. A site, of which more than 20% is currently or has been previously developed with impervious surfaces.

d. A *greenfield* that is within 800 meter of land that is developed, or that has one or more buildings under construction, with an average density of ten *dwelling units* per acre (4 units per ha) unless that *site* is *agricultural land* or *forest land*. Proximity is determined by drawing a circle with an 800 meter radius around the center of the approved building project site on a:

e. Greenfield: where the building complies with relevant provisions of the concerned AHJ; unless that site is agricultural or forest land.

f. Greenfield: that is agricultural or forest land and the purpose of the building are related to the agricultural use of the land.

g. Greenfield: that is forest land, and the purpose of the proposed building is related to the agricultural or forestry use of the land.

h. Greenfield: that is designated park land, and the purpose of the proposed building is related to the use of the land as a park.

501.3.1.2 (5.3.1.2) Prohibited development activity. There shall be no *site* disturbance or development of the following:

a. Previously undeveloped land having an elevation lower than 5 ft (1.5 m) above the elevation of the 100 year flood, as defined by *AHJ*. All types of building construction within the flood limit of rivers, natural streams (Nallahs) and natural drainage systems are prohibited. Appropriate demarcation mapping of floodplains shall be considered for the site sustainability, as per the flood inundation map developed by Federal Flood Commission adhered by the AHJ.

Exceptions:

1. Development of *low-impact trails* shall be allowed anywhere within a flood zone.
2. Development of building structures shall be allowed in alluvial "AO" designated flood zones, provided that such structures include engineered flood proofing up to an elevation that is at least as high as the minimum lowest floor elevation determined by *AHJ*, and provided that the *site* includes drainage paths constructed to guide floodwaters around and away from the structures.

b. Land within 150 ft (50 m) of any *fish and wildlife habitat conservation area*.

Exceptions:

1. Development of *low-impact trails* shall be allowed, provided that such trails are located at least 15 ft (4.5 m) from the area.
2. *Site* disturbance or development shall be allowed for habitat enhancement measures.

c. Land within 100 ft (35 m) of any *wetland*, both in urban and rural areas.

Exceptions:

1. Development of *low-impact trails* shall be allowed, provided that such trails are located at least 15 ft (4.5 m) from the *wetland*.
2. *Site* disturbance or development shall be allowed for habitat enhancement measures or for restoration of the functions of the *wetland*.

501.3.2 (5.3.2) Predesign site inventory and assessment. A predesign inventory and assessment of the natural resources of the *building project site* shall be submitted with the *site* design and *construction documents*. The inventory and assessment shall highlight environment friendly and mitigation measures, including all of the following:

a. Sustainability pre-requisites of proposed site, with reference to the Climatic Conditions as per the Climate Zones / Maps developed by Pakistan Meteorological Department (PMD).
b. The location of site and the proposed layout/design of building project to minimize the Heat Island Effects.
c. Location of any prohibited development areas identified in Sectio**n 501.3.1.2 (5.3.1.2)** that are located on or adjacent to the building project site.
d. Identification of invasive plant species on the site.
e. Identification of native or invasive plant species on the site.
f. Identification of site features designated for preservation of natural habitats and existing cultural or archeological structures.

501.3.3 (5.3.3) Plants.

501.3.3.1 (5.3.3.1) Invasive plants. *Invasive plants* shall be removed from the *building project site* and destroyed or disposed of in a land fill. *Invasive plants* shall not be planted on the *building project site*.

501.3.3.2 (5.3.3.2) Greenfield sites.

a. **More than 20% existing native or adapted plants.** Where more than 20% of the area of the predevelopment *site* has existing *native plants* or *adapted plants*, a minimum of 20% of the area of *native plants* or *adapted plants* shall be retained. The selection of native plants be human friendly, especially the children.
b. **Less than 20% existing native or adapted plants.**
    1. Where 20% or less of the area of the predevelopment *site* has existing *native plants* or *adapted plants*, a minimum of 20% of the *site* shall be developed or retained as vegetated area. Such vegetated areas include bio-retention facilities, rain gardens, filter strips, grass swales, vegetated level spreaders, constructed *wetlands*, planters, and open space with plantings.
    2. A minimum of 60% of the vegetated area shall consist of *bio-diverse planting* of *native plants* or *adapted plants* other than *turf-grass*.

        Exception: The following areas shall not be included in the calculations: dedicated sports fields, driving ranges/roads, burial grounds or graveyards, vegetated pavers, and the minimum fire lanes required by *AHJ*.

501.3.4 (5.3.4) Storm-water management. Storm-water management systems shall be provided on the building *site*. Except to the extent that other storm-water management approaches are required by a local, provincial, or federal jurisdiction, these systems shall be limited to one or more of the following management methods:

a. Infiltration.
b. *Evapotranspiration*.
c. Rainwater harvesting, storage and use.
d. Storm-water collection and use.

501.3.4.1 (5.3.4.1) Projects on green fields. Projects on *green fields* shall comply with at least one of the following:

a. Storm water management systems shall retain on *site* no less than the volume of precipitation during a single 24 hour period equal to the 95th percentile precipitation event. *Building projects* with storm water management systems that are designed to retain volumes greater than that of the 98th percentile precipitation event shall conduct a hydrologic analysis of the building *site* to determine the water balance of the *site* prior to its development, clearing, and filling and to demonstrate that the storm water management system will not cause ecological impairment by starving receiving waters downstream of the *site*.
b. The storm water management system design shall maintain *site* water balance (the combined runoff, infiltration, and *evapotranspiration*) based on a hydrologic analysis of the *site*'s conditions prior to development, clearing, and filling. Post construction runoff rate, volume, and duration shall not exceed rates preceding development, clearing, or filling of the *site*.

501.3.4.2 (5.3.4.2) Projects on grey fields. Projects on *grey fields* shall retain on *site* no less than the volume of precipitation during a single 24 hours period equal to or greater than the 60th percentile precipitation event, or the percentile precipitation as told by *AHJ*.

Exception: Where any fraction of the 60th percentile precipitation event or the percentile precipitation approved by *AHJ* cannot be retained, that fraction shall be treated to limit total suspended solids to 25 milligrams per liter in the remaining discharge.

501.3.4.3 (5.3.4.3) Discharge rate. *Building project sites* shall be designed and constructed to comply with one of the following requirements:

a. The discharge of the design storm shall occur over a period of not less than 48 hours.

b. The discharge flow duration curve at any point in time shall be plus or minus 10% of the flow duration curve for channel-forming discharges for the *site* prior to its development, clearing, or filling.

501.3.4.4 (5.3.4.4) Adjoining lots. The storm water management system shall direct or concentrate off-site discharge to avoid increased erosion or other drainage-related damage to adjoining *lots* or public property.

501.3.4.5 (5.3.4.5) Discharges from contaminated soils. Storm water management systems on areas of *brownfields* where contaminated soils are left in place shall not use infiltration practices that will result in pollutant discharges to groundwater. Storm water discharge from *brownfields* shall be treated to limit total suspended solids as per the National Environmental Quality Standards (NEQS). Storm water management systems shall not penetrate, damage, or otherwise compromise remediation actions at the building *site*.

501.3.4.6 (5.3.4.6) Coal tar sealants. The use of tar sealants shall be prohibited in any application exposed to storm water, wash waters, condensates, irrigation water, snowmelt, or ice-melt.

501.3.5 (5.3.5) Mitigation of heat island effect.

501.3.5.1 (5.3.5.1) Site hardscape. At least 50% of the *site hardscape* that is not covered by *solar energy systems* shall be provided with one or any combination of the following:

a. Existing trees and vegetation or new *bio-diverse plantings* of *native plants* and *adapted plants*, which shall be planted either prior to the final approval by the *AHJ* or in accordance with a contract established to require planting no later than 12 months after the final approval by the *AHJ* so as to provide the required shade no later than ten years after the final approval. The effective shade coverage on the *hardscape* shall be the arithmetic mean of the shade coverage calculated at 10 a.m., noon, and 3 p.m. on the summer solstice.

b. Paving materials with a minimum initial *solar reflectance index* (*SRI*) as indicated by *AHJ*.

c. *Open-graded (uniform-sized) aggregate*, *permeable pavement*, *permeable pavers*, and *porous pavers (open-grid pavers)*. *Permeable pavement* and *permeable pavers* shall have a percolation rate of not less than 2 gal/min • ft^2 (100 L/min • m^2).

d. Shading through the use of structures, provided that the top surface of the shading structure complies with the provisions of Section 501.3.5.3 (5.3.5.3).

e. Parking under a building, provided that the *roof* of the building complies with the provisions of Section 501.3.5.3 (5.3.5.3).

f. Buildings or structures that provide shade to the *site hardscape*. The effective shade coverage on the *hardscape* shall be the arithmetic mean of the shade coverage calculated at 10 a.m., noon, and 3 p.m. on the summer solstice.

501.3.5.2 (5.3.5.2) [JO] Walls. Above-grade building *walls* and retaining walls shall be shaded in accordance with this section. The building is allowed to be rotated up to 45 degrees to the nearest cardinal orientation for purposes of calculations and showing compliance. Compliance with this section shall be achieved through the use of shade-providing *plants*, man-made structures, existing buildings, hillsides, permanent *building projections*, *on-site renewable energy systems*, or a combination of these, using the following criteria:

a. Shade shall be provided on at least 30% of the east and west above-grade *walls* and retaining walls from grade level to a height of 20 ft (6 m) above grade, or the top of the exterior *wall*, whichever is less. Shade coverage shall be calculated at 10 a.m. for the east *walls* and 3 p.m. for the west *walls* on the summer solstice.

b. Where shading is provided by vegetation, such vegetation shall be existing trees and vegetation or new *bio-diverse plantings* of *native plants* and *adapted plants.* Such planting shall occur prior to the final approval by the *AHJ* or in accordance with a contract established to require planting no later than 12 months after the final approval by the *AHJ* so as to provide the required shade no later than ten years after the final approval. Vegetation shall be appropriately sized, selected, planted, and maintained so that it does not interfere with overhead or underground utilities. Trees shall be placed a minimum of 5 ft (1.5 m) from and within 50 ft (15 m) of the building or retaining wall.

Exceptions:

1. The requirements of this section are satisfied if 75% or more of the opaque *wall* surfaces on the east and west have a minimum *SRI* of 29, or as recorded by *AHJ*. Each *wall* is allowed to be considered separately for this exception.

501.3.5.3 (5.3.5.3) Roofs. This section applies to the building and covered parking *roof* surfaces for *building projects* in all Climate Zones of Pakistan. A minimum of 75% of the roof surface area be covered with products that have a minimum solar reflectance index approved for roofs by the competent *AHJ*. The area occupied by one or more of the following shall be excluded from the calculation to assess the roof surface area required to comply with this Section:

a. Roof penetrations and associated equipment.
b. On-site renewable energy systems, including photovoltaic, solar thermal energy collectors, and required access around the panels or collectors.
c. Roof decks and rooftop walkways.
d. Vegetated terrace and roofing systems used to shade or cover parking.
e. Existing buildings undergoing alteration, repair, relocation, or a change in occupancy.

501.3.5.4 (5.3.5.4) Solar reflectance index (SRI). The *SRI* shall be calculated for medium-speed wind conditions using a convection coefficient, as specified by *AHJ*, subject to the condition, that the values for solar reflectance and thermal emittance shall be determined and certified by an independent Third Party.

501.3.5.5 (5.3.5.5) Vegetated terrace and roofing systems. Vegetated terrace and roofing systems, where provided in accordance with Section 501.3.5.3 (5.3.5.3), shall comply with the following:

a. All plantings shall be capable of withstanding the microclimate conditions of the vegetated area, including but not limited to wind, precipitation, and temperature. *Plants* shall be selected and placed to provide foliage coverage of not less than 50% of designed area of vegetation based on the anticipated *plant* growth within two years of the issuance of the final certificate of occupancy. *Construction documents* shall be submitted that show the planting location and anticipated two-year foliage coverage of the plantings. Duplicate coverage shall not be credited where multiple *plants* cover the same area. *Invasive plants* shall not be planted.
b. The growing medium shall be designed for the physical conditions and local climate to support the *plants* selected. The planting design shall include measures to protect the growing medium until the *plants* are established. The maximum wet weight and water-holding capacity of a growing medium shall be approved from *AHJ*.
c. Plantings shall be capable of maintaining the function of the vegetated *roof* or terrace as required by Section 1001.9.1 (10.9.1).
d. Irrigation of the vegetated *roofs* and terraces shall comply with Section 601.3.2.4 (6.3.2.4).
e. Installation of plantings shall be in accordance with the *roof*-covering manufacturer's installation instructions.

501.3.5 (5.3.5.6) Building Envelop Requirements

The exterior building envelope buildings shall be on a prescriptive basis and in accordance with *AHJ* described compliance path, and comply with the following:

a. Opaque portions of the building envelop shall comply with the specific insulation requirements and the thermal requirements of the local solar reflectance value-based method; or the construction material performance standards as prescribed by *AHJ*.
b. Provision or installation of the windows and air-ventilators in building envelope shall be as per the building plans.
c. Where the buildings have a vertical fenestration area or skylight area, the building thermal envelop shall comply with the performance standards as referred to by *AHJ*.

501.3.6 (5.3.6) [JO] Reduction of light pollution.

501.3.6.1 (5.3.6.1) Backlight, uplight, and glare (BUG) ratings. Exterior luminaire backlight, uplight, and glare (BUG) ratings shall be as approved by *AHJ*. All exterior lighting shall comply with items (a) through (c).

a. **Backlight.** Building-mounted exterior lighting with backlight oriented towards the building is not required (NR) to have a maximum backlight rating. All other exterior lighting not building-mounted and building-mounted where backlight is not oriented towards the building shall have a backlight rating that is no greater than the maximum backlighting rating value in Table 501.3.6.1 (5.3.6.1) that is a function of the horizontal distance between the luminaire and closest property line in multiples of luminaire mounting height and the *lighting zone*. Luminaires not building mounted and located within two (2) mounting heights of the nearest property line shall be oriented so the backlight portion of light output is oriented perpendicular toward the closest property line.
b. **Uplight.** Exterior luminaires shall have an uplight rating that is no greater than the maximum uplight rating value in Table 501.3.6.1 (5.3.6.1) for the *lighting zone*.
c. **Glare.** Building-mounted exterior lighting with forward light oriented toward the building is not required (NR) to have a maximum glare rating. All other building-mounted lighting shall have a glare rating that is no greater than the maximum glare rating value in Table 501.3.6.1 (5.3.6.1) as a function of the horizontal distance between

the luminaire and closest property line in multiples of luminaire mounting height and the *lighting zone*. All exterior lighting not building-mounted shall have a glare rating that is no greater than the maximum glare rating value in Table 501.3.6.1 (5.3.6.1) for the *lighting zone*.

Exceptions:

1. Specialized signal, directional, and marker lighting associated with transportation.
2. Advertising signage or directional signage.
3. Lighting integral to equipment or instrumentation and installed by its manufacturer.
4. Lighting for theatrical purposes, including performance, stage, film production, and video production.
5. Lighting for athletic playing areas.
6. Lighting that is in use for no more than 60 continuous days and is not reinstalled any sooner than 60 days after being uninstalled.
7. Lighting for industrial production, material handling, transportation *sites*, and associated storage areas.
8. Theme elements in theme/amusement parks.
9. Roadway lighting required by governmental authorities.
10. Lighting classified for and used in hazardous locations as specified by *AHJ*.
11. Lighting for swimming pools and water features.

TABLE 501.3.6.1 (TABLE 5.3.6.1)
MAXIMUM ALLOWABLE BACKLIGHT, UPLIGHT, AND GLARE (BUG) RATINGS [a, b, c, d]

LIGHTING ZONE	LZ0	LZ1	LZ2	LZ3	LZ4
Allowed Backlight Rating—Building Mounted and Backlight Oriented Towards Building[e]	NR	NR	NR	NR	NR
Allowed Backlight Rating—All Other Luminaires					
> 2 mounting heights from property line	B1	B3	B4	B5	B5
> 1 to 2 mounting heights from property line	B1	B2	B3	B4	B4
0.5 to 1 mounting height to property line	B0	B1	B2	B3	B3
< 0.5 mounting height to property line	B0	B0	B0	B1	B2
Allowed Uplight Rating—All Exterior Lighting	U0	U1	U2	U3	U4
Allowed Glare Rating—Building-Mounted and Forward Light Oriented Towards Building[e]	NR	NR	NR	NR	NR
Allowed Glare Rating—All Other Building-Mounted Lighting					
> 2 mounting heights from property line	G0	G1	G2	G3	G4
> 1 to 2 mounting heights from property line	G0	G0	G1	G1	G2
0.5 to 1 mounting height to property line	G0	G0	G0	G1	G1
<0.5 mounting height to property line	G0	G0	G0	G0	G1
Allowed Glare Rating—All Other Luminaires	G0	G1	G2	G3	G4

a. Except where installed on a building surface, luminaires that are located at a distance of two times the mounting height of the luminaire or less from a property line shall have the backlight of the luminaire aimed toward and perpendicular to the nearest property line. Backlight is that part of the luminaire's lumen output that was used to determine the backlight rating in its final angular position.

b. For property lines that abut public walkways, bikeways, plazas, and parking lots, the property line may be considered to be 1.5 m beyond the actual property line for the purpose of determining compliance with this section. For property lines that abut public roadways and public transit corridors, the property line may be considered to be the centerline of the public roadway or public transit corridor for the purpose of determining compliance with this section.

c. If the luminaire is installed in other than the intended manner, or is an adjustable luminaire for which the aiming is specified, the rating shall be determined by the actual photometric geometry in the aimed orientation.

d. Backlight, uplight, and glare ratings are defined based on specific lumen limits per IES TM-15 Addendum A.

e. NR = Not Required.

501.3.7 (5.3.7) Mitigation of transportation impacts. In addition to the vehicular roads or driveways and adequate provision for car parking, the following be provided in building projects.

501.3.7.1 (5.3.7.1) Pedestrian and bicycle connectivity.

501.3.7.1.1 (5.3.7.1.1) Pedestrian walkways. Each *primary building entrance* shall be provided with a pedestrian walkway that extends to either a *public way* or a transit stop. Walkways shall not be less than 5 ft (1.5 m) in width and shall be clearly delineated.

A public-use walkway shall be provided along the length of the adjoining public-way frontage of the *building project site*, and such walkways shall connect to adjacent or nearest public-use walkways.

501.3.7.1.2 (5.3.7.1.2) Bicycle and motorcycle paths. On-site bicycle and motorcycle paths shall be designed to connect bicycle parking areas to existing and planned off-site bicycle paths adjacent to the *building project*.

501.3.7.2 (5.3.7.2) Bicycle and motorcycle parking.

501.3.7.2.1 (5.3.7.2.1) Minimum number of spaces. Bicycle and motorcycle parking spaces shall be provided for at least 5% of the *occupant load* of each building but not less than two parking spaces. Occupants who are non-ambulatory, under restraint, or under custodial care need not be included in the total *occupant load* for the building. *Building projects* with *dwelling units* shall be provided with at least 0.5 parking spaces per bedroom for each building but not less than two parking spaces.

Exceptions:

1. *Building projects* with *dwelling units* that provide each unit with a private garage or private, locked storage *space* of sufficient size to store a bicycle.
2. The number of bicycle and motorcycle parking spaces shall be allowed to be reduced where a transportation plan, prepared by a *registered design professional*, that demonstrates the likelihood that building occupants will use public transportation and/or walk to the *building project site* has been *approved*.

501.3.7.2.2 (5.3.7.2.2) [JO] Location. Not fewer than two bicycle or motorcycles parking spaces shall be located within 50 ft (15.2 m) of, and be visible from, the *building entrance* being served. All other bicycle parking spaces shall be located inside the building, or the nearest point of the bicycle parking areas shall be within 50 ft (15.2 m) of the *building entrance* being served. Bicycle and motorcycle parking shall not obstruct pedestrian access to the building.

501.3.7.2.5 (5.3.7.2.3) [JO] Security and visibility. All bicycle and motorcycle parking spaces shall be visible from the entrance being served; secured in a locker, cage, or room; or provided with valet service or security cameras. Signage shall be provided to identify parking that is not visible from the *building entrance*.

501.3.7.2.6 (5.3.7.2.4) Documentation. *Construction documents* shall include plans and details showing compliance with Sections 501.3.7.2.1 (5.3.7.2.1) through 501.3.7.2.5 (5.3.7.2.3).

501.3.8 (5.3.8) Building site waste management.

501.3.8.1 (5.3.8.1) Building site waste management Plan. A building *site* waste management plan shall be developed and implemented for excavated soil, rock, and land-clearing debris. Land-clearing debris is limited to stumps and vegetation. Diverted land-clearing debris and removed rock and soil shall not be sent to *sites* where development activity is prohibited by Section 501.3.1.2 (5.3.1.2) or to *green fields* other than those being used for agricultural purposes or being developed as part of a *building project*.

Not less than 90% [JO] of the land-clearing debris, excluding *invasive plant* materials, shall be diverted from disposal in landfills and incinerators other than waste-to-energy systems with an energy-recovery efficiency rate higher than 60%. Land-clearing debris calculations shall be based on either weight or volume but not both. Receipts or other documentation related to diversion shall be maintained through the course of construction.

The plan shall address all of the following:

a. Land-clearing debris, rock, and soil to be diverted from disposal by composting, recycling, or reuse.
b. Waste materials that will be diverted on-site.
c. The locations to which waste materials will be diverted off-site.
d. Soils to be stockpiled for future use at any location.
e. Woody waste to be used as fuel.
f. The destruction and disposal of *invasive plant* materials.
g. The methods of removal of any contaminated soils.
h. The treatment of vegetation to comply with the rules of government-designated quarantine zones for invasive insect species.

CHAPTER 6

WATER USE EFFICIENCY

601.1 (6.1) Scope. This section specifies requirements for *potable water* and *nonpotable water* use efficiency, both for the *site* and for the building, and water monitoring.

601.2 (6.2) Compliance. All provisions of Chapter 6 are mandatory provisions.

601.3 (6.3) Mandatory provisions.

601.3.1 (6.3.1) Site water use reduction.

601.3.1.1 (6.3.1.1) Landscape design. A minimum of 60% of the area of the *improved landscape* shall be in *biodiverse planting* of *native plants* and *rainfall-ET_c compatible plants*.

Exceptions:

1. The area of dedicated athletic fields, golf courses, driving ranges, and areas dedicated for production of food for human consumption shall be excluded from the calculation of the *improved landscape* for schools, *residential* common areas, or public recreational facilities.
2. Landscape areas irrigated solely with *alternate on-site sources of water* shall be exempted from these requirements.
3. Where average annual rainfall is less than 12 in. (300 mm), *plants* other than *turf-grass*, with an annual ET_c of 15 in. (380 mm) or less, shall be deemed equivalent to *rainfall-ET_c compatible plants*.

601.3.1.2 (6.3.1.2) Horticulture. For landscaped areas, not greater than one-third of *improved landscape* area is allowed to be irrigated with *potable water*. The area of dedicated athletic fields shall be excluded from the calculation of the *improved landscape* for schools, *residential* common areas, and public recreational facilities. All other irrigation shall be provided from alternate sources of water.

Exception: *Potable water* is allowed to be used on such newly installed landscape for the *landscape establishment period*. The amount of *potable water* allowed to be applied to the newly planted areas during the *landscape establishment period* shall not exceed 70% of ET_o for *turf-grass* and 55% of ET_o for other plantings.

601.3.1.2.1 (6.3.1.2.1) Irrigation system design. The design of the irrigation system shall be performed by an accredited or certified irrigation professional and shall be in accordance with the following:

a. Irrigation systems:
    1. Shall be based on *hydro zones*. *Turf-grass* areas shall be on their own *irrigation stations*.
    2. Shall have backflow prevention in accordance with the plumbing code (***Informative note:*** e.g., *International Plumbing Code)*.
    3. Shall have a master valve on municipally supplied water sources that allows pressurization of the irrigation mainline only when irrigation is scheduled.
    4. Shall have a flow sensor and monitoring equipment that will shut off the control valve if the flow exceeds normal flow from an *irrigation station*.
    5. Shall prevent piping from draining between irrigation events.
b. Irrigation emission devices shall comply with ASABE/ICC 802, *Landscape Irrigation Sprinkler and Emitter Standard*.
c. Irrigation sprinklers:
    1. Shall not spray water directly on buildings or *hardscape* area.
    2. Shall have matched precipitation rate nozzles within an *irrigation station*.
    3. Shall be prohibited on landscape areas having any dimension less than 4 ft (1.2 m).
    4. Shall have an application rate less than or equal to 0.75 in. (19 mm) per hour on slopes greater than 1 unit vertical in 4 units horizontal.
    5. Shall be limited to use with *turf-grass* or *ground cover* areas with vegetation maintained at 8 in. (200 mm) or less in height.
    6. Where of the pop-up configuration, shall have a pop-up height of not less than 4 in. (100 mm).
d. Micro-Horticulture zones:
    1. Shall be equipped with pressure regulators, filters, and flush assemblies.
    2. Shall have indicators that allow confirmation of operation by visual inspection.

3. Drip emitters shall be of pressure-compensating type.

601.3.1.2.2 (6.3.1.2.2) Controls. Where any irrigation system for the project *site* uses an *automatic* controller, the system shall be controlled by a qualifying *smart controller* that uses *evapotranspiration* (*ET*) and weather data to adjust irrigation schedules and complies with the minimum requirements. Alternatively, the system shall be controlled by an on-site rain or moisture sensor that automatically shuts off the system after a predetermined amount of rainfall or sensed moisture in the soil. Qualifying *smart controllers* shall be *labeled* according to respect (Federal / Provincial / Territorial) EPAs of Pakistan *Water Sense Specification for Weather-Based Irrigation Controllers Smart controllers* that use *ET* data shall provide the following irrigation amounts:

a. *Irrigation adequacy* — 80% minimum ET_c.

b. *Irrigation excess*—not to exceed 10% of ET_c.

Exception: A temporary irrigation system used exclusively for the establishment of new landscape shall be exempt from this requirement. Temporary irrigation systems shall be removed or permanently disabled at such time as the *landscape establishment period* has expired.

601.3.1.2.2.1 (6.3.1.2.2.1). The following settings and schedule for the irrigation control system shall be posted on or adjacent to the controller:

a. Precipitation rate of each *irrigation station*.

b. *Plant* factors for each *hydrozone*.

c. Soil type.

d. Rain sensor settings.

e. Soil moisture sensor settings, where installed.

f. Peak demand schedule, including run times, cycle starts, and soak times.

g. Maximum runtimes to prevent water runoff.

601.3.1.2.3 (6.3.1.2.3) Irrigation of rainfall-ET_c compatible plants. The use of *potable water* or *reclaimed water* for irrigation of *adapted plants* is prohibited after the *landscape establishment period*. In-ground irrigation systems for *rainfall-ET_c compatible plants* using *potable water* or off-site treated *reclaimed water* are prohibited. After the *landscape establishment period* of *adapted plants*, the irrigation system using *potable water* or *reclaimed water* shall be permanently disabled or removed from *site*. However, Rainwater Harvesting Systems *(Rooftop, Ponds or underground storage, as may be appropriate)* would be designed and installed to cater far water requirements as well.

Exception: *Plants* deemed equivalent to *rainfall-ET_c compatible plants* by Section 601.3.1.1 (6.3.1.1), Exception 3, shall be exempt from the requirements of Section 601.3.1.2.3 (6.3.1.2.3).

601.3.2 (6.3.2) Building water use reduction.

601.3.2.1 (6.3.2.1) Plumbing fixtures and fittings. Plumbing fixtures (water closets and urinals) and fittings (faucets and showerheads) shall comply with the following requirements, as shown in Table 601.3.2.1 (6.3.2.1):

a. **Water closets (toilets)—flushometer valve type.** For single-flush, maximum flush volume shall be determined in accordance with ASME A112.19.2/CSA B45.1 and shall not exceed 1.28 gal (4.8 L). For dual-flush, the full-flush volume shall not exceed 1.28 gal (4.8 L) per flush. Dual-flush fixtures shall also comply with the provisions of ASME A112.19.14.

b. **Water closets (toilets)—tank-type.** Tank-type water closets shall be certified to the performance criteria of the respect (Federal / Provincial / Territorial) EPAs of Pakistan Water Sense Tank-Type High-Efficiency Toilet Specification and shall have a maximum full-flush volume of 1.28 gal (4.8 L). Dual-flush fixtures shall also comply with the provisions of ASME A112.19.14.

c. **Urinals.** Maximum flush volume, when determined in accordance with ASME A112.19.2/CSA B45.1, shall not exceed 0.5 gal (1.9 L). Flushing urinals shall comply with the performance criteria of the respect (Federal / Provincial / Territorial) EPAs of Pakistan Water Sense Specification for Flushing Urinals. Non-water urinals shall comply with ASME A112.19.19 (vitreous china) or IAPMO Z124.9 (plastic) as appropriate.

d. **Public lavatory faucets.** Maximum flow rate shall not exceed 0.5 gpm (1.9 L/min) when tested in accordance with ASME A112.18.1/CSA B125.1.

e. **Public metering self-closing faucet.** Maximum water use shall not exceed 0.25 gal (1.0 L) per metering cycle when tested in accordance with ASME A112.18.1/CSA B125.1.

f. **Residential bathroom lavatory sink faucets.** Maximum flow rate shall not exceed 1.5 gpm (5.7 L/min) when tested in accordance with ASME A112.18.1/CSA B125.1. *Residential* bathroom lavatory sink faucets shall comply with the performance criteria of the respect (Federal / Provincial / Territorial) EPAs of Pakistan Water Sense High-Efficiency Lavatory Faucet Specification.

TABLE 601.3.2.1 (TABLE 6.3.2.1)
PLUMBING FIXTURES AND FITTINGS REQUIREMENTS

PLUMBING FIXTURE	MAXIMUM
Water closets (toilets)—flushometer single-flush valve type	Single-flush volume of 1.28 gal (4.8 L)
Water closets (toilets)—flushometer dual-flush valve type	Full-flush volume of 1.28 gal (4.8 L)
Water closets (toilets)—single-flush tank-type	Single-flush volume of 1.28 gal (4.8 L)
Water closets (toilets)—dual-flush tank-type	Full-flush volume of 1.28 gal (4.8 L)
Urinals	Flush volume 0.5 gal (1.9 L)
Public lavatory faucets	Flow rate—0.5 gpm (1.9 L/min)
Public metering self-closing faucet	0.25 gal (1.0 L) per metering cycle
Residential bathroom lavatory sink faucets	Flow rate—1.5 gpm (5.7 L/min)
Residential kitchen faucets	Flow rate—1.8 gpm (6.8 L/min) [a]
Residential showerheads	Flow rate—2.0 gpm (7.6 L/min)
Residential shower compartment (stall) in *dwelling units* and guest rooms	Flow rate from all shower outlets total of 2.0 gpm (7.6 L/min)

a. With provision for a temporary override to 2.2 gpm (8.3 L/min) as specified in Section 601.3.2.1(g) [6.3.2.1(g)].

g. **Residential kitchen faucets.** Maximum flow rate shall not exceed 1.8 gpm (6.8 L/min) when tested in accordance with ASME A112.18.1/CSA B125.1. Kitchen faucets shall be permitted to temporarily increase the flow greater than 1.8 gpm (6.8 L/min) but shall not exceed 2.2 gpm (8.3 L/min) and must automatically revert to the established maximum flow rate of 1.8 gpm (6.8 L/min) upon physical release of the activation mechanism or closure of the faucet valve.

h. **Residential showerheads.** Maximum flow rate shall not exceed 2.0 gpm (7.6 L/min) when tested in accordance with ASME A112.18.1/CSA B125.1. *Residential* showerheads shall comply with the performance requirements of the respect (Federal / Provincial / Territorial) EPAs of Pakistan Water Sense Specification for Showerheads.

i. **Residential shower compartment (stall) in dwelling units and guest rooms.** The allowable flow rate from all shower outlets (including rain systems, waterfalls, body-sprays, and jets) that can operate simultaneously shall be limited to a total of 2.0 gpm (7.6 L/min).

Exception: Where the area of a shower compartment exceeds 2600 in.^{2} (1.7 m^2), an additional flow of 2.0 gpm (7.6 L/min) shall be permitted for each multiple of 2600 in.^{2} (1.7 m^2) of floor area or fraction thereof.

j. **Water-bottle filling stations.** *Water-bottle filling stations* shall be an integral part of, or shall be installed adjacent to, not less than 50% of all drinking fountains installed indoors on the premises.

601.3.2.2 (6.3.2.2) Appliances.

a. Clothes washers and dishwashers installed within *dwelling units* shall comply with the best international (or equivalent national) practices approved by *AHJ*. Maximum water use shall be as follows:

1. Clothes washers (residential)—Maximum *water factor* (*WF*) of 5.4 gal/ft^3 of drum capacity (0.72 L/L of drum capacity).
2. Dishwashers—Standard-size dishwashers shall have a maximum *WF* of 3.8 gal/full operating cycle (14.3 L/full operating cycle). Compact sizes shall have a maximum *WF* of 3.5 gal/full operating cycle (13.2 L/full operating cycle). Standard and compact size shall be defined by the criteria given in the best international (or equivalent national) practices approved by *AHJ*. [See also the energy efficiency requirements in Section 701.4.7.3 (7.4.7.3).]

b. Clothes washers installed in publicly accessible *spaces* (***Informative Note:*** e.g., multifamily and hotel common areas), and coin- and card-operated clothes washers of any size used in laundromats, shall have a maximum *WF* of 4.0 gal/ft^3 of drum capacity normal cycle (0.53 L/L of drum capacity normal cycle). [See also the energy efficiency requirements in Section 701.4.7.3 (7.4.7.3).]

c. Commercial dishwashers in commercial food-service facilities shall meet all the requirements as listed in the best international (or equivalent national) practices approved by *AHJ*.

601.3.2.3 (6.3.2.3) HVAC systems and equipment.

a. *Once-through cooling* with *potable water* is prohibited.

b. The design of open-circuit cooling towers for air-conditioning systems, including the materials used to construct them and their water treatment systems, shall not allow water exchange (blowdown) until one or more of the parameters in Table 601.3.2.3 (6.3.2.3) reaches 90% or more of the maximum value specified in Table 601.3.2.3 (6.3.2.3). The system shall be tolerant of pH levels between 7.0 and 9.2.

c. The materials of construction for the water cooling system that comes in contact with cooling tower water shall be of the type that can operate and be maintained within the limits set in Table 601.3.2.3 (6.3.2.3).

d. Open-circuit cooling towers, closed-circuit cooling towers, and evaporative condensers shall be equipped with makeup and water meters, conductivity controllers, and overflow alarms in accordance with the thresholds listed in Table 601.3.4.1B (6.3.4.1B). Cooling towers shall be equipped with drift eliminators that reduce drift to 0.002% or less of the recirculated water flow for counter flow towers and 0.005% or less of the recirculated water flow for cross-flow towers.

e. *Building projects* located in regions where the ambient mean coincident wet-bulb temperature at 1% design cooling conditions is greater than or equal to 72°F (22°C) shall have a system for collecting condensate from air-conditioning units with a capacity greater than 65,000 Btu/h (19 kW), and the condensate shall be recovered for reuse.

TABLE 601.3.2.3 (TABLE 6.3.2.3)
RECIRCULATING WATER PROPERTIES FOR OPEN-CIRCUIT COOLING-TOWER CONSTRUCTION

RECIRCULATING WATER PARAMETERS	MAXIMUM VALUE
Conductivity (micro-ohms)	3300
Total dissolved solids (ppm)	2050
Total alkalinity as $CaCO_3$ (ppm) excluding galvanized steel	600
Total alkalinity as $CaCO_3$ (ppm) galvanized steel (passivated)	500
Calcium hardness as $CaCO_3$ (ppm)	600
Chlorides as Cl (ppm)	300
Sulfates (ppm)	250
Silica (ppm)	150
Langelier Saturation Index (*LSI*)	+2.8

601.3.2.4 (6.3.2.4) Roofs.

a. The use of *potable water* or *reclaimed water* for *roof* spray systems to thermally condition the *roof* shall be prohibited.

Exception: Where *approved*, on-site treated *reclaimed water* or Harvested rainwater may be used for *roof* spray systems.

b. In-ground irrigation systems on vegetated *roofs* using *potable water* or off-site treated *reclaimed water* shall be prohibited.

c. The use of *potable water* or *reclaimed water* for irrigation of vegetated (green) *roofs* is prohibited after the vegetation establishment period or 18 month after the initial installation, whichever is less. After the landscape *plants* are established, the irrigation system using *potable water* or *reclaimed water* shall be removed from *site*.

Exception: Where *approved*, on-site treated *reclaimed water* or Harvested rainwater may be used for vegetated *roof* irrigation systems during and after the vegetation establishment period.

601.3.2.5 (6.3.2.5) Commercial food service operations. (***Informative Note:*** e.g., restaurants, cafeterias, food preparation kitchens, caterers, etc.). Commercial food service operations:

a. Shall use high-efficiency pre-rinse spray valves (i.e., valves that function at 1.3 gpm [4.9 L/min] or less and comply with a 26 second performance requirement when tested in accordance with ASTM F2324),

b. Shall use dishwashers that comply with the requirements of the best international (or equivalent national) practices approved by *AHJ* for Commercial Dishwashers,

c. Shall use boiler-less/connectionless food steamers that consume no more than 2.0 gal/h (7.5 L/h) in the full operational mode,

d. Shall use combination ovens that consume not more than 10 gal/h (38 L/h) in the full operational mode,

e. Shall use air-cooled ice machines that comply with the requirements of the best international (or equivalent national) practices approved by *AHJ* for Commercial Ice Machines, and

f. Shall be equipped with hands-free faucet controllers (foot controllers, sensor activated, or other) for all faucet fittings within the food preparation area of the kitchen and the dish room, including pot sinks and washing sinks.

601.3.2.6 (6.3.2.6) Medical and laboratory facilities. Medical and laboratory facilities, including clinics, hospitals, medical centers, physician and dental offices, and medical and nonmedical laboratories of all types shall:

a. Use only water-efficient steam sterilizers equipped with (1) water-tempering devices that allow water to flow only when the discharge of condensate or hot water from the sterilizer exceeds 140°F (60°C), and (2) mechanical vacuum equipment in place of venturi-type vacuum systems for vacuum sterilizers.

b. Use film processor water-recycling units where large-frame X-ray films of more than 6 in. (150 mm) in either length or width are processed. Small dental X-ray equipment is exempt from this requirement.

c. Use digital imaging and radiography systems where the digital networks are installed.

d. Use a dry-hood scrubber system or, if the applicant determines that a wet-hood scrubber system is required, the scrubber shall be equipped with a water recirculation system. For perchlorate hoods and other applications where a hood wash-down system is required, the hood shall be equipped with self-closing valves on those wash-down systems.

e. Use only dry vacuum pumps unless fire and safety codes (***Informative Note:*** e.g., *Building Code of Pakistan – Fire Safety Provisions 2016*) for explosive, corrosive, or oxidative gases require a liquid ring pump.

f. Use only efficient water treatment systems that comply with the following criteria:

   1. For all filtration processes, pressure gages shall determine and display when to backwash or change cartridges.

   2. For all ion exchange and softening processes, recharge cycles shall be set by volume of water treated or based on conductivity or hardness.

   3. For reverse osmosis and nano-filtration equipment with capacity greater than 27 gal/h (100 L/h), reject water shall not exceed 60% of the feed water and shall be used as scrubber feed water or for other beneficial uses on the project *site*.

   4. Simple distillation is not acceptable as a means of water purification.

g. With regard to food service operations within medical facilities, comply with Section 601.3.2.5 (6.3.2.5).

601.3.3 (6.3.3) Hot-water distribution. Hot-water distribution pipes shall be in accordance with Section 601.3.3.1 (6.3.3.1) and Section 601.3.3.2 (6.3.3.2).

601.3.3.1 (6.3.3.1) Maximum allowable pipe volume. The maximum volume of water in the pipes between the source of hot or tempered water and the fixtures shall be 64 oz (1.9 L) where the source of hot or tempered water is a water heater, and shall be 24 oz (0.71 L) where the source of hot or tempered water is a circulation loop pipe or an electrically heat-traced pipe. For the purpose of Section 601.3.3 (6.3.3), the source of hot or tempered water shall be the point of connection to a water heater, heat-traced pipe, or a circulation loop.

The volume shall be the sum of the internal volumes of pipe, fittings, valves, meters, and manifolds between the source of hot or tempered water and the termination of the fixture supply pipe. The volume shall be determined using Table 601.3.3.1 (6.3.3.1). The volume contained within fixture shutoff valves, flexible water supply connectors to a fixture fitting, or within a fixture fitting shall not be included in the water volume determination. Where the source of hot or tempered water is a circulation loop pipe or an electrically heat-traced pipe, the volume shall include the portion of the fitting on the source pipe that supplies water to the fixture. Where the type of pipe is unknown or not specifically included in the table, the generic pipe column shall be used to determine the volume.

Exception: Public lavatory fixtures.

TABLE 601.3.3.1 (TABLE 6.3.3.1)
INTERNAL VOLUME OF PIPE OR TUBE IN I-P (SI)

OUNCES (LITERS) OF WATER PER FOOT (METER) OF PIPE				
NOMINAL SIZE, IN. (DIMENSION NOMINAL [DN], MM)	GENERIC PIPE	COPPER TYPE L	CPVC CTS SDR 11	PEX CTS SDR 9
1/4 (8)	0.33 (0.03)	0.52 (0.05)	0.37 (0.04)	0.33 (0.03)
5/16 (9)	0.5 (0.05)	NA (NA)	NA (NA)	0.48 (0.05)
3/8 (10)	0.75 (0.07)	0.97 (0.09)	0.75 (0.07)	0.68 (0.07)
1/2 (15)	1.5 (0.15)	1.55 (0.15)	1.25 (0.12)	1.18 (0.11)
5/8 (18)	2 (0.19)	2.23 (0.22)	NA (NA)	1.78 (0.17)
3/4 (20)	3 (0.29)	3.22 (0.31)	2.67 (0.26)	2.35 (0.23)
1 (25)	5 (0.49)	5.47 (0.53)	4.43 (0.43)	3.91 (0.38)
1 1/4 (32)	8 (0.78)	8.36 (0.81)	6.61 (0.64)	5.81 (0.56)
1 1/2 (40)	11 (1.07)	11.83 (1.15)	9.22 (0.89)	8.09 (0.78)
2 (50)	18 (1.75)	20.58 (2.00)	15.79 (1.53)	13.86 (1.34)

NA = No value provided based on lack of availability of pipe in this size.

601.3.3.2 (6.3.3.2) Maximum length. The maximum pipe length from the source of hot or tempered water to the termination of the fixture supply pipe serving any plumbing fixture or appliance shall not exceed 50 ft (15 m) of developed length.

601.3.4 (6.3.4) Special water features. Water use shall comply with the following:

a. Ornamental fountains and other ornamental water features shall be supplied either by *alternate on-site sources of water (Like Harvested Rainwater)* or by municipally *reclaimed water* delivered by the local water utility. Fountains and other features equipped with *automatic* water refilling valves shall be equipped with (1) makeup water meters, (2) leak detection devices that shut off water flow if a leak of more than 1.0 gal/h (3.8 L/h) is detected, and (3) equipment to recirculate, filter, and treat all water for reuse within the system.

   Exception: Where *alternate on-site sources of water* or municipally *reclaimed water* are not available within 500 ft (150 m) of the *building project site*, *potable water* is allowed to be used for water features with less than 10,000 gal (38,000 L) capacity.

b. Pools and spas:

   1. Recover filter backwash water for reuse on landscaping or other applications, or treat and reuse backwash water within the system.
   2. For filters with removable cartridges, only reusable cartridges and systems shall be used. For filters with backwash capability, use only pool filter equipment that includes a pressure drop gage to determine when the filter needs to be backwashed and a sight glass enabling the operator to determine when to stop the backwash cycle.
   3. Pool splash troughs, if provided, shall drain back into the pool system.

601.3.5 (6.3.5) Water consumption measurement.

601.3.5.1 (6.3.5.1) Consumption management. Measurement devices with remote communication capability shall be provided to collect water consumption data for the domestic water supply to the building. Both potable and *reclaimed water* entering the *building project* shall be monitored or sub-metered. In addition, for individual leased, rented, or other tenant or subtenant *space* within any building totaling in excess of 50,000 ft^2 (5000 m^2), separate sub-meters shall be provided. For subsystems with multiple similar units, such as multicell cooling towers, only one measurement device is required for the subsystem. Any project or building, or tenant or subtenant *space* within a project or building, such as a commercial car wash or aquarium, shall be sub metered where consumption is projected to exceed 1000 gal/day (3800 L/day).

Measurement devices with remote capability shall be provided to collect water use data for each water supply source (***Informative Note:*** e.g., *potable water*, *reclaimed water*, rainwater) to the *building project* that exceeds the thresholds listed in Table 601.3.5.1A (6.3.5.1A). Utility company service entrance/interval meters are allowed to be used.

Provide sub-metering with remote communication measurement to collect water use data for each of the building subsystems if such subsystems are sized above the threshold levels listed in Table 601.3.5.1B (6.3.5.1B).

601.3.5.2 (6.3.5.2) Consumption data collection. All building measurement devices, monitoring systems, and sub meters installed to comply with the threshold limits in Section 601.3.5.1 (6.3.5.1) shall be configured to communicate water consumption data to a meter data management system. At a minimum, meters shall provide daily data and shall record hourly consumption of water.

601.3.5.3 (6.3.5.3) Data storage and retrieval. The meter data management system shall be capable of electronically storing water meter, monitoring systems, and sub meter data and creating user reports showing calculated hourly, daily, monthly, and annual water consumption for each measurement device and sub meter and provide alarm notification capabilities as needed to support the requirements of the water user efficiency plan for operation in Section 1001.9.2 (10.9.2).

TABLE 601.3.5.1A (TABLE 6.3.5.1A)
WATER SUPPLY SOURCE MEASUREMENT THRESHOLDS

WATER SOURCE	MAIN MEASUREMENT THRESHOLD
Potable water	1000 gal/day (3800 L/day)
Municipally *reclaimed water*	1000 gal/day (3800 L/day)
Alternate sources of water	500 gal/day (1900 L/day)

TABLE 601.3.5.1B (TABLE 6.3.5.1B)
SUBSYSTEM WATER MEASUREMENT THRESHOLDS

SUBSYSTEM	SUBMETERING THRESHOLD
Cooling towers (meter on makeup water and blowdown)	Cooling tower flow through tower > 500 gpm (30 L/s)
Evaporative coolers	Makeup water > 0.6 gpm (0.04 L/s)
Steam and hot-water boilers	> 500,000 Btu/h (150 kW) input
Total irrigated landscape area with controllers	> 25,000 ft^2 (2500 m^2)
Separate campus or project buildings	Consumption > 1000 gal/day (3800 L/day)
Separately leased or rental *space*	Consumption > 1000 gal/day (3800 L/day)
Any large water-using process	Consumption > 1000 gal/day (3800 L/day)

601.3.6 (6.3.6) Water softeners. Water softeners shall comply with Sections 601.3.6.1 (6.3.6.1) through 601.3.6.4 (6.3.6.4).

601.3.6.1 (6.3.6.1) Demand-initiated regeneration. Water softeners shall be equipped with demand-initiated regeneration control systems. Timer-based control systems shall be prohibited.

601.3.6.2 (6.3.6.2) Water consumption. During regeneration, water softeners shall have a maximum water consumption of 4 gal (15.1 L) per 1000 gr (17.1 g/L) of hardness removed, as measured in accordance with NSF 44.

601.3.6.3 (6.3.6.3) Waste connections. Waste water from water softener regeneration shall not discharge to *reclaimed water* collection systems and shall discharge in accordance with the *Pakistan Plumbing Code*.

601.3.6.4 (6.3.6.4) Efficiency and listing. Water softeners that regenerate in place, that are connected to the water system they serve by piping not exceeding $1^1/_4$ in. (31.8 mm) in diameter, or that have a volume of 3 ft^3 (0.085 m^3) or more of cation exchange media shall have a rated salt efficiency of not less than 4000 gr of total hardness exchange per pound of salt (571 g of total hardness exchange per kilogram of salt), based on sodium chloride equivalency, and shall be *listed* and *labeled* in accordance with NSF 44. All other water softeners shall have a rated salt efficiency of not less than 3500 gr of total hardness exchange per pound of salt (500 g of total hardness exchange per kilogram of salt), based on sodium chloride equivalency.

601.3.7 (6.3.7) Reverse osmosis water treatment systems. Reverse osmosis systems shall be equipped with an *automatic* shutoff valve that prevents the production of reject water when there is no demand for treated water. Point-of-use reverse osmosis treatment systems for drinking water shall be *listed* and *labeled* in accordance with NSF 58.

601.3.8 (6.3.8) On-site reclaimed water treatment systems. On-site *reclaimed water* treatment systems, including grey-water reuse treatment systems and waste water treatment systems, used to produce *nonpotable water* for use in water closet and urinal flushing, surface irrigation, and similar applications shall be *listed* and *labeled* in accordance with NSF 350.

601.3.9 (6.3.9) [JO] Dual water supply plumbing. Where sufficient supply of *reclaimed water* or *alternate on-site sources of water* is available, or planned to be available, within five years of completed building construction, the water supply system within the building shall be installed to allow the supply of reclaimed or alternative water to all urinals and water closets.

Exceptions:

1. Existing buildings under renovation, where the water supply to the urinals and water closets within the building is to remain intact, shall not be required to supply *nonpotable water* to urinals and water closets.
2. Urinals and water closets designed to operate without the use of water shall not be required to have alternate or *reclaimed water* supply to the fixture.

CHAPTER 7

ENERGY EFFICIENCY

701.1 (7.1) Scope. This section specifies requirements for energy efficiency for buildings and appliances, for *on-site renewable energy systems*, and for energy measuring.

701.2 (7.2) Compliance. The energy systems shall comply with Section 701.3 (7.3), "Mandatory Provisions," and either:

a. Section 701.4 (7.4), "Prescriptive Option," or

b. Section 701.5 (7.5), "Performance Option."

701.3 (7.3) Mandatory provisions.

701.3.1 (7.3.1) General. *Building projects* shall be designed to comply with Sections 5.2.1, 6.2.1, 7.2.1, 8.2.1, 9.2.1, and 10.2.1 of ANSI/ASHRAE/IES Standard 90.1.

701.3.1.1 (7.3.1.1) Climate zones. The assigned climate zone shall be determined using the information available from the Pakistan Metrological Department or any other national agency approved by *AHJ*. As a simplification, Pakistan can be divided into two climate zones as Climate Zone 1 and Climate Zone 2. These zones are equivalent to ASHRAE Standard Climate Zone 0B and Zone 3, respectively. Arid and hot pat in the South and South West of Pakistan fall in Climate Zone 1 whereas Northern Pakistan with temperate and humid climate is included in Climate Zone 2.

701.3.2 (7.3.2) On-site renewable energy systems. *Building projects* shall contain on-site photovoltaic systems with a PV modules capacity equal to 9 Wp/ft^2 (96.8 Wp/m^2) multiplied by the unshaded horizontal *gross roof area for solar radiations varying from 4 to 6 KWh/m²/day*. For Onsite Solar Systems connected with the Public Grid requires License from the Electricity Regulator for Generation of Power. Building owner with electricity meter at its name will engage solar entity licensed by Pakistan Engineering Council (PEC) and Alternate Energy Development Board (AEDB) for installation and commissioning of Solar system and then after commissioning of Solar System by Solar Entity as per DISCO SOPs, the Owner will apply for permission from Regulator/DISCO to Generate Power and Energy through an agreement. After inspection of the solar system by electric inspector as per its SOP, DISCO will issue demand note and will provide connectivity of solar system with Public Grid. The solar PV mounting structure height should not be more than 12 ft (3.5 m) above the rooftop. Solar PV modules must be tested as per IEC 61215: 2021and IEC 61730: 2021 and Solar PV Inverters must comply with IEC 61683, IEC 62116 and IEC 61727 and Cables for photovoltaic applications must comply with IEC 62930:2017 and Solar PV mounting structures must withstand minimum 150 KM/hour wind load and must be free from rusting, sagging and vibrations.

The building *gross roof area* used for calculation in Section 701.3.2 (7.3.2) excludes the following:

a. Shaded areas that are defined as *roof* area where direct-beam sunlight is blocked bystructures or natural objects for more than 1500 annual hours between 8 a.m. and 4 p.m.

b. Areas of vegetated terrace and roofing systems compliant with Section 501.3.5.5 (5.3.5.5).

d. Areas designated for helipads.

701.3.3 (7.3.3) Energy consumption management.

701.3.3.1 (7.3.3.1) Consumption management. Measurement devices with remote communication capability shall be provided to collect energy consumption data for each energy supply source to the building (including gas, electricity, and district energy) that exceeds the thresholds listed in Table 701.3.3.1A (7.3.3.1A). The measurement devices shall have the capability to automatically communicate the energy consumption data to a data acquisition system.

For all buildings that exceed the threshold in Table 701.3.3.1A (7.3.3.1A), subsystem measurement devices with remote capability (including current sensors or flowmeters) shall be provided to measure energy consumption data of each subsystem for each use category that exceeds the thresholds listed in Table 701.3.3.1B (7.3.3.1B).

The energy consumption data from the subsystem measurement devices shall be automatically communicated to the data acquisition system.

TABLE 701.3.3.1A (TABLE 7.3.3.1A)
ENERGY SOURCE THRESHOLDS

ENERGY SOURCE	THRESHOLD
Electrical service	> 200 kVA
On-site renewable electric power	All systems > 1 kVA (peak)
Gas and district services	> 1,000,000 Btu/h (300 kW)
Geothermal energy	> 1,000,000 Btu/h (300 kW) heating

On-site renewable thermal energy	> 100,000 Btu/h (30 kW)

TABLE 701.3.3.1B (TABLE 7.3.3.1B)
SYSTEM ENERGY USE THRESHOLDS

USE (TOTAL OF ALL LOADS)	SUBSYSTEM THRESHOLD
HVAC system	Connected electric load > 100kVA
	Connected gas or district services load > 500,000 Btu/h (150 kW)
People moving	Sum of all feeders > 50 kVA
Lighting	Connected load > 50 kVA
Process and plug process	Connected load > 50 kVA
	Connected gas or district services load > 250,000 Btu/h (75 kW)

701.3.3.2 (7.3.3.2) Energy consumption data collection and display. All building measurement devices shall be configured to automatically communicate the energy data to the data acquisition system. Measurement devices shall provide daily data and shall record hourly energy profiles. Such hourly energy profiles shall be capable of being used to assess building performance at least monthly. The hourly energy profiles shall be displayed.

701.3.3.3 (7.3.3.3) Data storage and retrieval. The data acquisition system shall be capable of electronically storing the data from the measurement devices and other sensing devices for a minimum of 36 months and creating user reports showing hourly, daily, monthly, and annual energy consumption.

Exception: Portions of buildings used as *residential.*

701.3.4 (7.3.4) Automated demand response. Where a demand response (DR) program is available to the *building project*, the building controls shall be designed with automated DR infrastructure capable of receiving DR requests from the utility, electrical system operator, or third-party DR program provider and automatically implementing load adjustments to the HVAC and lighting systems.

Exceptions:

1. Buildings with a *gross conditioned floor area* less than 5000 ft^2 (500 m^2).
2. Buildings that employ a thermal or electrical energy storage system with a total storage capacity that complies with one of the following:
   a. For thermal energy storage, the system shall be capable of displacing the HVAC design cooling coil capacity for not less than the equivalent of three hours.
   b. For electrical energy storage, the capacity shall be not less than the requirements of the following formula:

      Minimum kWh capacity =
      Gross conditioned floor area (ft^2) ×
      5.0 W/ft^2 × 1.0 h × (1 kW/1000 W) (I-P)

      Minimum kWh capacity =
      Gross conditioned floor area (m^2) ×
      50 W/m^2 × 1.0 h × (1 kW/1000 W) (SI)

701.3.4.1 (7.3.4.1) HVAC systems zone set points. *The building project's* HVAC systems shall be programmed to allow centralized demand reduction in response to a signal from a centralized contact or software point in accordance with the following:

a. The controls shall be programmed to automatically adjust upward the zone operating cooling set points by a minimum of 3°F (1.7°C).
b. The controls shall programmed to automatically adjust downward the zone operating heating set points by a minimum of 3°F (1.7°C).
c. The controls shall be programmed to automatically adjust downward the zone operating cooling set points by a minimum of 2°F (1.1°C).
d. The automated DR strategy shall include both ramp-up and ramp-down logic to prevent the building peak demand from exceeding that expected without the DR implementation.

Exception: Systems serving areas deemed by the *owner* to be critical in nature.

701.3.4.2 (7.3.4.2) Variable-speed equipment. For HVAC equipment with variable-speed control, the controls shall be programmed to allow *automatic* adjustment of the maximum speed of the equipment to 90% of design speed during automated DR events. Airflow adjustments shall not decrease the supply airflow rate below the level that would result in outdoor airflow being below the *minimum outdoor airflow rates* specified in Section 801.3.1.1 (8.3.1.1), or that would cause adverse building pressurization problems.

701.3.4.3 (7.3.4.3) Lighting. For *building projects* with interior lighting control systems controlled at a central point, such systems shall be programmed to allow automated DR. The programming shall reduce the total connected lighting power demand during a DR event by not less than 15% but no more than 50% of the baseline power level. The baseline lighting power shall be determined in accordance with Section 701.4.6.1.1 (7.4.6.1.1). For *building projects* without central lighting controls, DR capabilities for lighting systems shall not be required.

For *spaces* not in the *daylight area* and not connected to automated daylighting control, the lighting levels shall be uniformly reduced throughout the *space*.

Exceptions:

1. Luminaires or signage on emergency circuits.
2. Luminaires located within a *daylight area* that are dimmable and connected to automated daylighting control systems.
3. Lighting systems, including dimming systems, claiming a *lighting power allowance* for *institutional tuning* in accordance with to Section 701.4.6.1.1(f) [7.4.6.1.1(f)].

701.3.5 (7.3.5) Fault detection and diagnostics (FDD). A fault detection and diagnostics (FDD) system shall be installed in new buildings to monitor the performance of the building's HVAC system and detect faults in the system. The FDD system shall:

a. Include *permanently installed* devices to monitor HVAC system operation;
b. Sample the HVAC system performance not less than once per hour;
c. Automatically identify, display, and report system faults;
d. Automatically notify service personnel of identified fault conditions;
e. Automatically provide prioritized recommendations for fault repair based on analysis of collected data; and
f. Be capable of tracking and recording a history of identified faults, from identification through repair completion.

Exceptions:

1. Buildings with gross floor area less than 25,000 ft^2 (2500 m^2).
2. Individual tenant *spaces* with gross floor area less than 10,000 ft^2 (1000 m^2).
3. *Dwelling units* and hotel/motel guest rooms.
4. *Residential* buildings with less than 10,000 ft^2 (1000 m^2) of common area.
5. Emergency smoke control systems.

701.4 (7.4) Prescriptive option. Where a requirement is provided in this section, it supersedes the requirement in ANSI/ASHRAE/IES Standard 90.1. For all other criteria, the *building project* shall comply with the requirements of ANSI/ASHRAE/IES Standard 90.1, Sections 5 through 10.

701.4.1 (7.4.1) On-site renewable energy systems. *Building projects* shall comply with either the Standard Renewables Approach or the Alternate Renewables Approach in Section 701.4.1.1 (7.4.1.1) and Table 701.4.1.1 (7.4.1.1).

701.4.1.1 (7.4.1.1) Renewable energy systems. The adjusted renewable energy provided to the project shall be equal to or greater than the gross floor areas of the *building project* multiplied by the renewable energy requirement from Table 701.4.1.1 (7.4.1.1). For allocations to multiple tenants within a *building project*, the requirements shall be assigned to each tenant based on the total of *gross floor area* of each tenant space.

Building projects complying with the Alternate Renewables Approach shall comply with the applicable equipment efficiency requirements in Normative Appendix B, the water-heating efficiency requirements in Section 701.4.4.1 (7.4.4.1), equipment efficiency requirements in Section 701.4.7.1 (7.4.7.1), the applicable requirements in Section 701.4.7.3.2 (7.4.7.3.2) and the best international (or equivalent national) practices approved by *AHJ*. For equipment listed in Section 701.4.7.3.2 (7.4.7.3.2) that are also contained in Normative Appendix B, the installed equipment shall comply by meeting or exceeding both requirements. The Alternate Renewables Approach shall apply only to *building projects* where the sum of the *gross floor areas* of the *building project* are less than 25,000 ft^2 (2300 m^2).

Documentation shall be provided to the *AHJ* that substantiates procurement of renewable energy systems, of *renewable energy contracts*, or of a quantity of Tradable Renewable Energy Certificates (*RECs) or* System Ownership Documents (*SODs*) required to meet the Exception to Section 701.4.1.1 (7.4.1.1). Tradable Renewable Energy Certificates (*RECs)* or System Ownership Documents (*SODs*) shall be tracked in accordance with Section 1001.9.8 (10.9.8).

Qualifying renewable energy systems are as follows:

a. *On-site renewable energy system*.

b. Off-site renewable energy system.

1. Self-generation (an off-site renewable energy system owned by the *building project owner*); the system shall comply with Section 701.4.1.3 (7.4.1.3).
2. *Community renewable energy facility*; the system shall comply with Section 701.4.1.3 (7.4.1.3).
3. Purchase contract; the system shall comply with Section 701.4.1.3 (7.4.1.3).

Exception: *Building projects* that demonstrate to the *AHJ* that they cannot comply with Section 7.4.1.1 shall contract for renewable electricity products complying with the Renewable Energy Policy and Renewable Grid Code of not less than 1.2 MWh/ft^2 (12.6 MWh/m^2) of *gross floor area*, or an amount equal to 100% of the modeled annual energy use multiplied by 20 years, whichever is less. A combination of renewable electricity products and renewable energy systems shall be permitted to demonstrate compliance. Tradable Renewable Energy Certificates (*RECs)* or System Ownership Documents (*SODs*) shall be tracked per Section 1001.9.8 (10.9.8).

TABLE 701.4.1.1 (TABLE 7.4.1.1)
RENEWABLE ENERGY REQUIREMENT

BUILDING TYPE	STANDARD RENEWABLES APPROACH		ALTERNATE RENEWABLES APPROACH	
	kBtu/ft^2 • y	kWh/m^2 • y	kBtu/ft^2 • y	kWh/m^2 • y
Office	14	44	13	40
Retail	24	74	21	67
School	19	61	17	55
Health care	40	126	36	113
Restaurant	40	126	36	113
Hotel	34	108	31	98
Apartment	22	68	20	62
Warehouse	8	26	7	23
All others	25	80	23	72

701.4.1.2 (7.4.1.2) Adjustable renewable energy. Each source of renewable energy delivered to or credited to the *building project* shall be multiplied by the factors in Table 701.4.1.2 (7.4.1.2) when determining compliance with Section 701.4.1.1 (7.4.1.1).

TABLE 701.4.1.2 (TABLE 7.4.1.2)
MULTIPLIERS FOR RENEWABLE ENERGY PROCUREMENT METHODS

LOCATION	RENEWABLE ENERGY SOURCE	RENEWABLE ENERGY FACTOR
On-site	On-site renewable energy system	1.00
Off-site	Directly owned off-site renewable energy system	0.75
	Community renewable energy facility	0.75
	Virtual PPA	0.75

701.4.1.3 (7.4.1.3) Off-site renewable energy requirements. Off-site renewable energy delivered or credited to the *building project* to comply with Section 701.4.1.1 (7.4.1.1) shall be subject to a legally binding contract to procure qualifying off-site renewable energy. Qualifying off-site renewable energy shall meet the following requirements:

a. Documentation of off-site renewable energy procurement shall be submitted to the *AHJ.*

b. The purchase contract shall have a duration of not less than 15 years. The contract shall be structured to survive a partial or full transfer of ownership of the building property.

c. *RECs* or *SOD* associated with the purchase contract from an off-site renewable energy system shall be assigned exclusively to the building *owner* for a period of not less than 15 years and tracked in accordance with Section 1001.9.8 (10.9.8).

d. The energy source shall produce electricity from solar, wind, or *geothermal energy*.

Exceptions:

1. Captured methane from feed lots and landfills are permitted to be used to generate electricity for the purposes of this section.
2. Hydropower from new generation capacity on a nonimpoundment or new generation capacity on an existing impoundment that meets one of the following conditions:
   a. The hydropower facility complies with the *Low Impact Hydropower Certification Handbook* and is certified by a nationally recognized accreditation organization.
   b. The hydropower facility complies with UL 2854 and is certified by an organization that has the standard in its ISO 17065 scope of accreditation.
   c. The hydropower facility consists of a turbine in a pipeline or a turbine in an irrigation canal.

For facilities falling under Exception 2(a) or 2(b), only output generated during the period of certification is eligible for *RECs* sale in accordance with the provisions of this section. Renewables from new impoundments of water are not eligible.

e. The generation source shall be located where the energy can be delivered to the building *site* by any of the following:
   1. Direct connection to the off-site renewable energy facility.
   2. The local utility or distribution entity.
   3. An interconnected electrical network where energy delivery capacity between the generator and the building *site* is available. (***Informative Note:*** Examples of interconnected electrical networks include regional power pools and regions served by National System Operator or National Transmission System Operator).

f. Records on renewable power purchased by the building *owner* from the off-site renewable energy generator that specifically assign the *RECs* or *SODs* to the building *owner* shall be retained or retired by the building *owner* on behalf of the entity demonstrating financial or operational control over the building seeking compliance to this code and made available for inspection by the *AHJ* upon request. [***Informative Note:*** Refer to Sections 1001.9.8 (10.9.8) and 1001.9.9 (10.9.9) for tracking and allocation requirements.]

g. Where multiple buildings in a *building project* are allocated energy procured by a contract subject to this section, the *owner* shall allocate for not less than 15 years the energy procured by the contract to the buildings in the *building project*. [***Informative Note***: Refer to Section 1001.9.9 (10.9.9) for allocation requirements.]

701.4.2 (7.4.2) Building envelope. The *building envelope* shall comply with ANSI/ASHRAE/IES Standard 90.1, Section 5, with the following modifications and additions.

701.4.2.1 (7.4.2.1) [JO] Building envelope requirements. The *building envelope* shall comply with the requirements in ANSI/ASHRAE/IES Standard 90.1, Tables 5.5-0 through 5.5-8, with the following modifications to values in each table. For the opaque elements, each U-factor, C-factor, and F-factor in Tables 5.5-4 through 5.5-8 shall be reduced by 5%. The "Insulation Min. R-Value" column in ANSI/ASHRAE/IES Standard 90.1, Tables 5.5-4 through 5.5-8, shall not apply. For *vertical fenestration* and *skylights*, each U-factor shall be reduced by 5%. For *skylights* and east- and west-oriented *vertical fenestration*, each *solar heat gain coefficient* (*SHGC*) in Tables 5.5-0 through 5.5-8 shall be reduced by 5%.

Exceptions:

1. The U-factor, C-factor, or F-factor shall not be modified where the corresponding R-value requirement is designated as "NR" (no requirement) in ANSI/ASHRAE/IES Standard 90.1, Tables 5.5-4 through 5.5-8.
2. The *SHGC* shall not be modified where the *SHGC* requirement is designated as "NR" (no requirement) in ANSI/ASHRAE/IES Standard 90.1, Tables 5.5-0 through 5.5-8.
3. *Spaces* that meet the requirements of Section 801.4.1 (8.4.1), regardless of *space* area, are exempt from the *SHGC* criteria for *skylights*.

Informative Notes:

1. U-factors, C-factors, and F-factors for many common assemblies are provided in ANSI/ASHRAE/IES Standard 90.1, Normative Appendix A.
2. Section 501.3.5.3 (5.3.5.3) of this code includes additional provisions related to *roofs*.

701.4.2.2 (7.4.2.2) Mechanical equipment penetration requirements. Where the total area of penetrations from mechanical equipment listed in ANSI/ASHRAE/IES Standard 90.1, Table 6.8.1-4, exceeds 2% of the opaque above-grade *wall* area, the mechanical equipment penetration area shall be calculated as a separate assembly with a published U-factor value for that equipment or a default U-factor of 0.5 Btu/h • ft^2 • °F (3 W/m^2 • K) in accordance with ANSI/ASHRAE/IES Standard 90.1, Section 5.5.3(b). Where Exception 2 to ANSI/ASHRAE/IES Standard 90.1 Section 5.5.3 is used for compliance, the penetration shall be considered to be the same class of construction as an adjacent *wall*.

701.4.2.3 (7.4.2.3) [JO] Single-rafter roof insulation. *Single-rafter roofs* shall comply with the requirements in Normative Appendix A, Table A101.1 (A-1). These requirements supersede the requirements in ANSI/ASHRAE/IES Standard 90.1, Section A2.4.2.4. ANSI/ASHRAE/IES Standard 90.1, Section A2.4.2.4 and Table A2.4.2, shall not apply.

701.4.2.4 (7.4.2.4) [JO] High-speed doors. *High-speed doors* that are intended to operate on average at least 75 cycles per day shall not exceed a maximum U-factor of 1.20 Btu/h • ft^2 • °F (6.81 W/m^2 • K). Opening rate, closing rate, and average cycles per day shall be included in construction drawings. ANSI/ASHRAE/IES Standard 90.1, Sections 5.5.3.6 and 5.5.4.3, shall not apply for *high-speed doors* complying with all criteria in this section.

701.4.2.5 (7.4.2.5) Air curtains. Where air curtains are provided at *building entrances* or *building entrance* vestibules, for the distance from the air-curtain discharge nozzle to the floor, the air-curtain unit shall produce a minimum velocity of 6.6 ft/s (2.0 m/s) in accordance with ANSI/AMCA 220 and be installed in accordance with manufacturer's instructions. *Automatic* controls shall be provided that will operate the air curtain with the opening and closing of the door. Air curtains and their controls shall comply with Section 1001.3.2.1 (10.3.2.1).

701.4.2.6 (7.4.2.6) Vertical fenestration area. The total *vertical fenestration area* shall be less than 40% of the *gross wall area*. This requirement supersedes the requirement in ANSI/ASHRAE/IES Standard 90.1, Section 5.5.4.2.1.

701.4.2.7 (7.4.2.7) [JO] Permanent projections. For Climate Zones 1 and 2, the *vertical fenestration* on the west, south, and east shall be shaded by permanent projections that have an area-weighted average *projection factor* (*PF*) of not less than 0.50 for the first story above grade and 0.25 for other above-grade stories. The building is allowed to be rotated up to 45 degrees to the nearest cardinal orientation for purposes of calculations and showing compliance. Where different windows or glass doors have different *PF* values, each shall be evaluated separately, or an area-weighted *PF* value shall be calculated and used for all windows and glass doors. *Horizontal projections shall extend over the full width of the glazing.*

Exceptions: Permanent projections are not required for the following buildings and *fenestrations*:

1. Where *vertical fenestration* is located within 18 in. (450 mm) of the lot line.
2. Where equivalent shading of the *vertical fenestration* is provided by buildings, structures, geological formations, or permanent exterior projections that are not horizontal, as determined by sun-angle studies at the peak solar altitude on the summer solstice and three hours before and after the peak solar altitude on the summer solstice.
3. *Vertical fenestration* with automatically controlled shading devices capable of modulating in multiple steps the amount of solar gain and light transmitted into the *space* in response to daylight levels or solar intensity that comply with all of the following:
    a. Exterior shading devices shall be capable of providing at least 90% coverage of the *fenestration* in the closed position.
    b. Interior shading devices shall be capable of providing at least 90% coverage of the *fenestration* in the closed position and have a minimum solar reflectance of 0.50 for the surface facing the *fenestration*.
    c. A manual override located in the same *enclosed space* as the *vertical fenestration* shall override operation of *automatic* controls no longer than four hours.
    d. *Functional and performance testing* (*FPT*) and commissioning shall be conducted as required by Chapter 10 to verify that *automatic* controls for shading devices respond to changes in illumination or radiation intensity.
4. *Vertical fenestration* with automatically controlled *dynamic glazing* capable of modulating in multiple steps the amount of solar gain and light transmitted into the *space* in response to daylight levels or solar intensity that comply with all of the following:
    a. *Dynamic glazing* shall have a lower labeled *SHGC* equal to or less than 0.12, lowest labeled visible transmittance (VT) no greater than 0.05, and highest labeled VT no less than 0.40.

b. A manual override located in the same *enclosed space* as the *vertical fenestration* shall override operation of *automatic* controls no longer than 4 hours.

c. *FPT* and commissioning shall be conducted as required by Chapter 10 to verify that *automatic* controls for *dynamic glazing* respond to changes in illumination or radiation intensity.

5. Existing buildings undergoing alteration, repair, relocation, or a change of occupancy.

701.4.2.8 (7.4.2.8) SHGC of north-facing vertical fenestration. This section is intentionally left blank.

701.4.2.9 (7.4.2.9) Building envelope trade-off option. The *building envelope* trade-off option in ANSI/ASHRAE/IES Standard 90.1, Section 5.6, shall not apply unless the procedure incorporates the modifications and additions to ANSI/ASHRAE/IES Standard 90.1 noted in Section 701.4.2 (7.4.2).

701.4.2.10 (7.4.2.10) Orientation. The *vertical fenestration* shall comply with either (a) or (b):

a. $A_W \le (A_N + A_S)/4$ and $A_E \le (A_N + A_S)/4$

b. $A_W \times SHGC_W \le (A_N \times SHGC_C + A_S \times SHGC_C)/6$ and $A_E \times SHGC_E \le (A_N \times SHGC_C + A_S \times SHGC_C)/6$

where:

$SHGC_x$ = The *SHGC* for orientation *x* that complies with Section 701.4.2.8 (7.4.2.8).
$SHGC_C$ = The *SHGC* criteria for each climate zone from Section 701.4.2.1 (7.4.2.1).
A_x = *Fenestration area* for orientation *x.*
N = North (oriented less than 45 degrees of true north).
S = South (oriented less than 45 degrees of true south).
E = East (oriented less than or equal to 45 degrees of true east).
W = West (oriented less than or equal to 45 degrees of true west).

Exceptions:

1. *Vertical fenestration* that complies with ANSI/ASHRAE/IES Standard 90.1, Section 5.5.4.4.1, Exception 3.
2. Buildings with shade on 75% of the west- and east-oriented *vertical fenestration areas* from permanent projections, existing buildings, existing permanent infrastructure, or topography at 9 a.m. and 3 p.m. on the summer solstice (June 21 in the northern hemisphere).
3. Alterations and additions with no increase in *vertical fenestration area*.
4. Buildings where the west- and east-oriented *vertical fenestration areas* do not exceed 20% of the *gross wall area* for each of those façades, and the *SHGC* on those façades is not greater than 90% of the criteria in Section 701.4.2.1 (7.4.2.1).

701.4.3 (7.4.3) Heating, ventilating, and air conditioning. The heating, ventilating, and air conditioning shall comply with ANSI/ASHRAE/IES Standard 90.1, Section 6, with the following modifications and additions.

701.4.3.1 (7.4.3.1) Minimum equipment efficiencies for the alternate renewables approach. All *building projects* complying with the Alternate Renewables Approach in Section 701.4.1.1 (7.4.1.1) and Table 701.4.1.1 (7.4.1.1) shall comply with the applicable equipment efficiency requirements in Normative Appendix B and the applicable requirements in Section 701.4.7.3.2 (7.4.7.3.2) or the best international (or equivalent national) practices approved by *AHJ*. Where equipment efficiency is not defined/listed in Normative Appendix B or in Section 701.4.7.3.2 (7.4.7.3.2) or 701.4.7.6 (7.4.7.6), the equipment shall meet the minimum efficiency requirements defined/listed in ANSI/ASHRAE/IES Standard 90.1. Specifically, this applies to the following products in ANSI/ASHRAE/IES Standard 90.1:

a. Table 6.8.1-3, “Water-Chilling Packages—Minimum Efficiency Requirements.”
b. Table 6.8.1-10, “Floor-Mounted Air Conditioners and Condensing Units Serving Computer Rooms—Minimum Efficiency Requirements.”
c. Table 6.8.1-11, “Commercial Refrigerators, Commercial Freezers, and Refrigeration—Minimum Efficiency Requirements.”
d. Table 6.8.1-12, “Vapor-Compression-Based Indoor Pool Dehumidifiers—Minimum Efficiency Requirements.”
e. Table 6.8.1-13, “Electrically Operated DX-DOAS Units, Single-Package and Remote Condenser, without Energy Recovery—Minimum Efficiency Requirements.”
f. Table 6.8.1-14, “Electrically Operated DX-DOAS Units, Single-Package and Remote Condenser, with Energy Recovery—Minimum Efficiency Requirements.”
g. Table 10.8-1, “Minimum Nominal Full-Load Efficiency for NEMA Design A, NEMA Design B, and IEC Design N Motors (Excluding Fire Pump Electric Motors) at 60 Hz” (NEMA MG 1).
h. Table 10.8-2, “Minimum Nominal Full-Load Efficiency for NEMA Design C and IEC Design H Motors at 60 Hz” (NEMA MG 1).
i. Table 10.8-3, “Minimum Average Full-Load Efficiency for Polyphase Small Electric Motors.”

j. Table 10.8-4, “Minimum Average Full-Load Efficiency for Capacitor-Start Capacitor-Run and Capacitor-Start Induction-Run Small Electric Motors.”

k. Table 10.8-5, “Minimum Nominal Full-Load Efficiency for Fire Pump Electric Motors.”

701.4.3.1.1 (7.4.3.1.1) Water-cooled centrifugal chiller packages efficiency adjustment.

a. **For water-cooled centrifugal units rated per AHRI Standard 550/590 (I-P).** Equipment not designed for operation at AHRI Standard 550/590 test conditions of 44.00°F leaving and 54.00°F entering chilled-fluid temperatures, and with 85.00°F entering and 94.30°F leaving condenser-fluid temperatures, shall have maximum full-load (FL) kW/ton and part-load rating requirements adjusted using the following equations:

$FL_{adj} = FL/K_{adj}$

$PLV_{adj} = IPLV/K_{adj}$

$K_{adj} = A \times B$

where:

FL = Full-load kW/ton value from ANSI/ASHRAE/IES Standard 90.1, Table 6.8.1-3.

FL_{adj} = Maximum full-load kW/ton rating, adjusted for nonstandard conditions.

IPLV = IPLV value from ANSI/ASHRAE/IES Standard 90.1, Table 6.8.1-3.

PLV_{adj} = Maximum *NPLV* rating, adjusted for nonstandard conditions.

A = $0.000000145920 \times (LIFT)^4 - 0.0000346496 \times (LIFT)^3 + 0.00314196 \times (LIFT)^2 - 0.147199 \times (LIFT) + 3.93073$.

B = $0.0015 \times LvgEvap + 0.934$.

LIFT = LvgCond – LvgEvap.

LvgCond = Full-load condenser leaving fluid temperature, °F.

LvgEvap = Full-load evaporator leaving temperature, °F.

The FL_{adj} and PLV_{adj} values are only applicable for centrifugal chillers meeting all of the following full-load design ranges:

- 36.00°F ≤ LvgEvap ≤ 60.00°F.
- LvgCond ≤ 115.00°F.
- 20.00°F ≤ LIFT ≤ 80.00°F.

Centrifugal chillers designed to operate outside of these ranges are not covered by this code.

b. **For water-cooled centrifugal units rated per AHRI Standard 551/591 (SI)**. Equipment not designed for operation at AHRI Standard 551/591 test conditions of 7.00°C leaving and 12.00°C entering chilled-fluid temperatures, and with 30.00°C entering and 35.00°C leaving condenser-fluid temperatures, shall have maximum full-load (FL) COP and part-load rating requirements adjusted using the following equations:

$FL_{adj} = FL \times K_{adj}$

$PLV_{adj} = IPLV \times K_{adj}$

$K_{adj} = A \times B$

where:

FL = Full-load COP value from ANSI/ASHRAE/IES Standard 90.1, Table 6.8.1-3.

FL_{adj} = Minimum full-load COP rating, adjusted for nonstandard conditions.

IPLV = IPLV value from ANSI/ ASHRAE/IES Standard 90.1, Table 6.8.1-3.

PLV_{adj} = Minimum *NPLV* rating, adjusted for nonstandard conditions.

A = $0.00000153181 \times (LIFT)^4 - 0.000202076 \times (LIFT)^3 + 0.0101800 \times (LIFT)^2 - 0.264958 \times LIFT + 3.93073$.

B = $0.0027 \times LvgEvap + 0.982$.

LIFT = LvgCond – LvgEvap.

LvgCond = Full-load condenser leaving fluid temperature, °C.

LvgEvap = Full-load evaporator leaving temperature, °C.

The FL_{adj} and PLV_{adj} values are only applicable for centrifugal chillers meeting all of the following full-load design ranges:

- 2.20°C ≤ LvgEvap ≤ 15.60°C.
- LvgCond ≤ 46.00°C.

- 11.00°C ≤ LIFT ≤ 44.00°C.

Centrifugal chillers designed to operate outside of these ranges are not covered by this code.

701.4.3.2 (7.4.3.2) [JO] Ventilation controls for densely occupied spaces. The requirements in this section supersede those in ANSI/ASHRAE/IES Standard 90.1, Section 6.4.3.8. *Demand control ventilation* (*DCV*) shall be provided for *densely occupied spaces* served by systems with one or more of the following:

a. An air-side economizer.
b. *Automatic* modulating control of the *outdoor air* dampers.
c. A design outdoor airflow greater than 1000 cfm (500 L/s).

Exceptions:

1. Systems with exhaust air energy recovery complying with Section 701.4.3.7 (7.4.3.7).
2. Systems with a design outdoor airflow less than 750 cfm (375 L/s).
3. *Spaces* where more than 75% of the *space* design outdoor airflow is used as *makeup air* or *transfer air* to provide *makeup air* for other *spaces*.
4. *Spaces* with one of the following occupancy categories as listed in ANSI/ASHRAE Standard 62.1: cells in correctional facilities; daycare sickrooms; science laboratories; barbershops; beauty and nail salons; and bowling alleys (seating).

The *DCV* system shall be designed to comply with ASHRAE Standard 62.1, Section 6.2.6.1. Occupancy assumptions shall be shown in the design documents for spaces provided with *DCV*. All CO_2 sensors used as part of a *DCV* system or any other system that dynamically controls *outdoor air* shall meet the following requirements:

a. *Spaces* with CO_2 sensors or air-sampling probes leading to a central CO_2 monitoring station shall be provided with at least one sensor or probe for each 10,000 ft^2 (1000 m^2) of floor *space*. Sensors or probes shall be installed between 3 and 6 ft (1 and 2 m) above the floor.
b. *Outdoor air* CO_2 concentrations shall be determined by one of the following:
    1. *Outdoor air* CO_2 concentrations shall be dynamically measured using one or multiple CO_2 sensors. The CO_2 sensor locations shall be identified on the *construction documents*.
    2. When documented statistical data on the local ambient CO_2 concentrations are available, a fixed value typical of the location where the building is located shall be allowed in lieu of an outdoor sensor.
c. Occupant CO_2 generation rate assumptions shall be shown in the design documents.

701.4.3.3 (7.4.3.3) Duct leakage tests. Leakage tests shall comply with the requirements in ANSI/ASHRAE/IES Standard 90.1, Section 6.4.4.2.2, with the following modification. Ductwork that is designed to operate at static pressures in excess of 2 in. of water (500 Pa), and all ductwork located outdoors, shall be leak-tested according to industry-accepted test procedures.

701.4.3.4 (7.4.3.4) [JO] Economizers. Systems shall include economizers meeting the requirements in ANSI/ASHRAE/IES Standard 90.1, Section 6.5.1, except as modified by the following:

a. The minimum size requirements for economizers for comfort cooling and for computer rooms are defined in Table 701.4.3.4 (7.4.3.4) and supersede the requirements in ANSI/ASHRAE/IES Standard 90.1, Tables 6.5.1-1 and 6.5.1-2.
b. Rooftop units with a capacity of less than 54,000 Btu/h (16 kW) shall have two stages of capacity control, with the first stage controlling the economizer and the second stage controlling *mechanical cooling*. Units with a capacity equal to or greater than 54,000 Btu/h (16 kW) shall comply with the staging requirements defined in ANSI/ASHRAE/IES Standard 90.1, Section 6.5.3.1.
c. For systems that control to a fixed leaving air temperature (i.e., *variable-air-volume* [*VAV*] systems), the system shall be capable of resetting the supply air temperature up at least 5°F (3°C) during economizer operation.

All the exceptions in ANSI/ASHRAE/IES Standard 90.1, Section 6.5.1, shall apply except as modified by the following:

a. Where the alternate renewables approach defined in Section 701.4.1.1 (7.4.1.1) and Table 701.4.1.1 (7.4.1.1) is used, ANSI/ASHRAE/IES Standard 90.1, Section 6.5.1, Exception 10, shall be permitted to eliminate the economizer requirement, provided the requirements in ANSI/ASHRAE/IES Standard 90.1, Table 6.5.1-2, are applied to the efficiency requirements required by Section 701.4.1.1 (7.4.1.1) and Table 701.4.1.1 (7.4.1.1). If the standard renewable approach is chosen, as defined in Section 701.4.1.1 (7.4.1.1) and Table 701.4.1.1 (7.4.1.1), then the requirements in ANSI/ASHRAE/IES Standard 90.1, Table 6.5.1-2, shall be applied to the efficiency requirements in ANSI/ASHRAE/IES Standard 90.1, Tables 6.8.1-1 through 6.8.1-11.
b. For water-cooled units with a capacity less than 54,000 Btu/h (16 kW) that are used in systems where heating and cooling loads are transferred within the building (i.e., water-source heat-pump systems), the requirement for an air or water economizer can be eliminated if the condenser-water temperature controls are capable of being set to

maintain full-load heat rejection capacity down to a 55°F (12°C) condenser-water supply temperature, and the HVAC equipment is capable of operating with a 55°F (12°C) condenser-water supply temperature.

701.4.3.5 (7.4.3.5) [JO] Zone controls. The exceptions to ANSI/ASHRAE/IES Standard 90.1, Section 6.5.2.1, shall be modified as follows:

a. Exception 1 shall not be used.

b. Exception 2(a)(2) shall be replaced by the following text: "the design outdoor airflow rate for the zone."

TABLE 701.4.3.4 (TABLE 7.4.3.4)
MINIMUM SYSTEM SIZE FOR WHICH AN ECONOMIZER IS REQUIRED

CLIMATE ZONES	COOLING CAPACITY FOR WHICH AN ECONOMIZER IS REQUIRED[1]
Zone 1	No economizer requirement
Zone 2	□□33,000 Btu/h (9.7 kW) [a]

701.4.3.6 (7.4.3.6) Fan system power and efficiency.

701.4.3.6.1 (7.4.3.6.1) Fan system power limitation. Systems shall have fan power limitations 10% below limitations specified in ANSI/ASHRAE/IES Standard 90.1, Table 6.5.3.1-1. This requirement supersedes the requirement in ANSI/ASHRAE/IES Standard 90.1, Section 6.5.3.1 and Table 6.5.3.1-1. All exceptions in ANSI/ASHRAE/IES Standard 90.1, Section 6.5.3.1, shall apply.

701.4.3.6.2 (7.4.3.6.2) Fan efficiency. The fan efficiency requirements defined in ANSI/ASHRAE/IES Standard 90.1, Section 6.5.3.1.3, shall be used, except that the *fan energy index* (*FEI*) at the design point of operation shall be 1.10 or greater. All exceptions in ANSI/ASHRAE/IES Standard 90.1, Section 6.5.3.1.3, shall apply.

701.4.3.6.3 (7.4.3.6.3) Low-power ventilation systems. Ventilation systems shall meet the fan efficacy requirements of Table 701.4.3.6.3 (7.4.3.6.3).

Exceptions:

1. Fans in fan coils and terminal units that operate only when providing heating to the *space* served.
2. Fans in *space* conditioning equipment certified under ASHRAE/IES Standard 90.1, Section 6.4.1.
3. Intermittently operating dryer exhaust duct power ventilators, domestic range hoods, or domestic range booster fans.
4. Ventilation systems with fan motor nameplate power ≥ $^{1}/_{12}$ hp (62.1 W).
5. Ventilation fans with fan nameplate electrical input power ≥ 180 W.

701.4.3.7 (7.4.3.7) [JO] Exhaust air energy recovery. The exhaust air energy recovery requirements defined in ANSI/ASHRAE/IES Standard 90.1, Section 6.5.6.1.2, including the requirements in Tables 6.5.6.1.2-1 and 6.5.6.1.2-2, shall be used except that the *enthalpy recovery ratio* shall not be less than 60%, superseding the 50% effectiveness requirement in ANSI/ASHRAE/IES Standard 90.1, Section 6.5.6.1.

701.4.3.8 (7.4.3.8) [JO] Kitchen exhaust systems. The requirements in ANSI/ASHRAE/IES Standard 90.1, Section 6.5.7.2 shall apply, except as follows: Sections 701.4.3.8.1 (7.4.3.8.1) and 701.4.3.8.2 (7.4.3.8.2) supersede the requirements in ANSI/ASHRAE/IES Standard 90.1, Sections 6.5.7.2.2 and 6.5.7.2.3.

701.4.3.8.1 (7.4.3.8.1) For kitchen/dining facilities with total kitchen hood exhaust airflow rate greater than 2000 cfm (950 L/s), the maximum exhaust flow rate for each hood shall be determined in accordance with Table 701.4.3.8.1 (7.4.3.8.1). For single hoods, or hood sections installed over appliances with different duty ratings, the maximum allowable exhaust flow rate for the hood or hood section shall be determined in accordance with Table 701.4.3.8.1 (7.4.3.8.1) for the highest appliance duty rating under the hood or hood section. Refer to ANSI/ASHRAE Standard 154 for definitions of hood type, appliance duty, and net exhaust flow rate.

Exception: When at least 75% of all the replacement air is *transfer air* that would otherwise be exhausted.

[1]Where economizers are required, the total capacity of all systems without economizers shall not exceed 480,000 Btu/h (140 kW) per building or 20% of the building's air economizer capacity, whichever is greater.

TABLE 701.4.3.6.3 (TABLE 7.4.3.6.3)
MINIMUM VENTILATION FAN EFFICACY REQUIREMENTS

FAN TYPE	MINIMUM EFFICACY NAMEPLATE RATING	TEST METHOD AND RATING CONDITIONS
Fan system with exhaust air energy recovery	1.2 cfm/W (0.6 L/s/W)	CAN/CSA 439-18 • Efficacy for a fan system providing exhaust air energy recovery is that associated with the average of the system's supply and exhaust flow rate
Bathroom, utility room ≥ 90 cfm (40 L/s)	6.0 cfm/W (2.8 L/s/W)	ENERGY STAR Specification for Residential Ventilating Fans • Eligibility Criteria Version 4.1

TABLE 701.4.3.8.1 (TABLE 7.4.3.8.1)
MAXIMUM NET EXHAUST FLOW RATE PER LENGTH OF HOOD

TYPE OF HOOD	LIGHT-DUTY EQUIPMENT		MEDIUM-DUTY EQUIPMENT		HEAVY-DUTY EQUIPMENT		EXTRA-HEAVY-DUTY EQUIPMENT	
	cfm per linear foot	L/s per linear meter	cfm per linear foot	L/s per linear meter	cfm per linear foot	L/s per linear meter	cfm per linear foot	L/s per linear meter
Wall-mounted canopy	140	217	210	325	280	433	385	596
Single island [a]	280	433	350	541	420	650	490	758
Double island (per side)	175	271	210	325	280	433	385	596
Eyebrow	175	271	175	271	NA [b]	NA [b]	NA [b]	NA [b]
Backshelf/Passover	210	325	210	325	280	433	NA [b]	NA [b]

a. The total exhaust flow rate for all single-island hoods in a kitchen/dining facility shall be no more than 5000 cfm (2360 L/s).
b. NA = Not Allowed.

701.4.3.8.2 (7.4.3.8.2) Kitchen/dining facilities with total kitchen hood exhaust airflow rate greater than 2000 cfm (950 L/s) shall comply with at least one of the following:

a. At least 50% of all replacement air must be *transfer air* that would otherwise be exhausted.
b. At least 75% of kitchen hood exhaust air shall be controlled by demand ventilation system, which shall:
    1. Be capable of reducing exhaust and replacement air system airflow rates by no more than the larger of:
        i. 50% of total design exhaust and replacement air system airflow rate; or
        ii. The outdoor airflow and exhaust rates required to meet the ventilation and exhaust requirements of ASHRAE Standard 62.1, Sections 6.2 and 6.5, for the zone.
    2. Include controls to modulate airflow in response to appliance operation and to maintain full capture and containment of smoke, effluent, and combustion products during cooking and idle;
    3. Include controls that result in full flow when the demand ventilation systems fail to modulate airflow in response to appliance operation; and
    4. Allow occupants to temporarily override the systems to full flow.
c. *Listed* energy recovery devices with a *sensible energy recovery ratio* of not less than 40% shall be applied on at least 50% of the total exhaust airflow. A 40% *sensible energy recovery ratio* shall mean a change in the dry-bulb temperature of the *outdoor air* supply equal to 40% of the difference between the *outdoor air* and entering exhaust air dry-bulb temperatures at *design conditions*.
d. In Climate Zones 1 and 2, when *makeup air* is uncooled or cooled without the use of *mechanical cooling*, the capacity of any nonmechanical *cooling* systems (***Informative Note:*** e.g., natural cooling or evaporative cooling) shall be demonstrated to be no less than the system capacity of a *mechanical cooling* system necessary to meet the same loads under design conditions.

701.4.3.9 (7.4.3.9) Automatic control of HVAC and lights in hotel/motel guest rooms. Where hotels and motels have over 50 guest rooms, *automatic controls* for the lighting, switched outlets, television, and HVAC equipment serving each guest room shall be configured according to the following requirements. Captive keycard systems shall not be used to comply with this section.

701.4.3.9.1 (7.4.3.9.1) Lighting and switched outlet control. Within 20 minutes of all occupants leaving the guest room, power for lighting and switched outlets shall be automatically turned off.

701.4.3.9.2 (7.4.3.9.2) Television control. Within 20 minutes of all occupants leaving the guest room, televisions shall be automatically turned off or placed in sleep or standby mode.

701.4.3.9.3 (7.4.3.9.3) HVAC set-point control. HVAC system controls shall be in accordance with ANSI/ASHRAE/IES Standard 90.1, Section 6.4.3.3.5.1.

701.4.3.9.4 (7.4.3.9.4) Ventilation control. Within 20 minutes of all occupants leaving the guest room, ventilation and exhaust fans shall be automatically turned off, or *isolation devices* serving each guest room shall automatically shut off the supply of *outdoor air* to the room and shut off exhaust air from the guest room. In conjunction with the *automatic* ventilation shutoff, an *automatic* preoccupancy purge cycle shall provide *outdoor air* ventilation as specified in Section 801.3.1.9 (8.3.1.9).

701.4.4 (7.4.4) Service water heating. The *service water heating* shall comply with ANSI/ASHRAE/IES Standard 90.1, Section 7, with the following modifications and additions.

701.4.4.1 (7.4.4.1) Equipment efficiency for the alternate renewables approach. All *building projects* complying with the Alternate Renewables Approach in Section 701.4.1.1 (7.4.1.1) and Table 701.4.1.1 (7.4.1.1) shall comply with the applicable equipment efficiency requirements in Normative Appendix B, Table B101.8 (B-8), and with the applicable requirements in Section 701.4.7.3.2 (7.4.7.3.2). These requirements supersede the requirements in ANSI/ASHRAE/IES Standard 90.1, Table 7.8.

701.4.4.2 (7.4.4.2) Buildings with high-capacity service water heating systems. This section supersedes ANSI/ASHRAE/IES Standard 90.1, Section 7.5.3. New buildings with *service water heating* systems with a total installed water heating input capacity of 1,000,000 Btu/h (300 kW) or greater shall meet the following:

a. Fuel-burning water heating equipment shall have a minimum rated efficiency of 0.92 E_t or 0.92 UEF.

b. Electric water heating equipment shall have a minimum rated efficiency of 2.4 UEF or 2.0 COP.

Multiple units of water heating equipment of the same type, fuel-burning or electric, shall be allowed to meet this requirement based on an input-capacity-weighted average of rated efficiency.

Exceptions:

1. Buildings provided with any combination of *on-site renewable energy systems* or waste heat recovery systems capable of providing not less than 25% of the total water heating load, not including *on- site renewable energy system* capacity used for compliance with any other section of this code.
2. Water heaters installed in individual *dwelling units*.

701.4.4.3 (7.4.4.3) [JO] Insulation for spa pools. Pools heated to more than 90°F (32°C) shall have side and bottom surfaces insulated on the exterior with a minimum insulation value of R-12 (R-2.1).

701.4.5 (7.4.5) Power. The power shall comply with ANSI/ASHRAE/IES Standard 90.1, Section 8.

701.4.6 (7.4.6) Lighting. The lighting shall comply with ANSI/ASHRAE/IES Standard 90.1, Section 9, with the following modifications and additions.

701.4.6.1 (7.4.6.1) Lighting power allowance.

701.4.6.1.1 (7.4.6.1.1) Interior lighting power densities (LPDs). The interior *lighting power allowance* shall be determined using ANSI/ASHRAE/IES Standard 90.1, either Section 9.5 or 9.6, with the following modifications:

a. For those areas where the Building Area Method is used, the LPD from ANSI/ASHRAE/IES Standard 90.1, Table 9.5.1, shall be replaced with the corresponding LPD in Table 701.4.6.1A (7.4.6.1A).

b. For those areas where the Space-by-Space Method is used, the LPD from ANSI/ASHRAE/IES Standard 90.1, Table 9.6.1, shall be replaced with the corresponding LPD in Table 701.4.6.1B (7.4.6.1B).

c. Room geometry adjustment when using the Space-by-Space Method: ANSI/ASHRAE/ IES Standard 90.1, Section 9.6.4, shall be replaced with the following. For corridor/transition *spaces* less than 8 ft (2.4 m) wide, or individual *spaces* where room cavity ratio (RCR) calculated for the empty room is documented to be greater than the RCR threshold for that *space* type shown in Table 7.4.6.1B, the allowed LPD shall be 1.2 times the LPD in Table 701.4.6.1B (7.4.6.1B). RCR shall be calculated as described in ANSI/ASHRAE/IES Standard 90.1, Section 9.6.4.

d. Additional lighting power when using the Space-by-Space Method: For those areas where the Space-by-Space Method is used, the additional increase in the interior lighting power allowed by ANSI/ASHRAE/IES Standard 90.1, Section 9.6.2, for specific lighting functions shall be replaced by the requirements and allowances of this section. Additional power shall be allowed only if the specified lighting is installed and automatically controlled separately from the *general lighting* and is designed and installed to be turned off during nonbusiness hours. This additional power shall be used only for the specified luminaires and shall not be used for any other purpose. An increase in the interior *lighting power allowance* is permitted in the following cases:

1. For *spaces* in which lighting is specified to be installed in addition to the *general lighting* for the purpose of decorative appearance or for highlighting art or exhibits, provided that the additional lighting power shall not exceed 0.5W/ft^2 (5.4 W/m^2) of such *spaces*.
2. For lighting equipment installed in sales areas and specifically designed and directed to highlight merchandise, calculate the additional lighting power as follows:

   Additional interior *lighting power allowance* =

   750 W + [Retail Area 1 × 0.40 W/ft^2 (4.3 W/m^2)]

   + [Retail Area 2 × 0.40 W/ft^2 (4.3 W/m^2)]

   + [Retail Area 3 × 1.00 W/ft^2 (10.8 W/m^2)]

+ [Retail Area 4 × 1.50 W/ft^2 (16.1 W/m^2)]

TABLE 701.4.6.1A (TABLE 7.4.6.1A)
LIGHTING POWER DENSITIES USING THE BUILDING AREA METHOD

BUILDING AREA TYPE[a]	LPD, W/ft^2	LPD, W/m^2
Automotive facility	0.64	6.9
Convention center	0.51	5.5
Courthouse	0.74	8.0
Dining: Bar lounge/leisure	0.69	7.4
Dining: Cafeteria/fast food	0.66	7.1
Dining: Family	0.61	6.6
Dormitory	0.52	5.6
Exercise center	0.61	6.6
Fire station	0.50	5.4
Gymnasium	0.67	7.2
Health care clinic	0.68	7.3
Hospital	0.86	9.3
Hotel/Motel	0.70	7.5
Library	0.72	7.8
Manufacturing facility	0.60	6.5
Motion picture theater	0.62	6.7
Multifamily	0.49	5.3
Museum	0.68	7.3
Office	0.69	7.4
Parking garage	0.12	1.3
Penitentiary	0.67	7.2
Performing arts theater	0.85	9.1
Police station	0.68	7.3
Post office	0.62	6.7
Religious facility	0.70	7.5
Retail	0.91	9.8
School/university	0.67	7.2
Sports arena	0.76	8.2

Town hall	0.72	7.8
Transportation	0.51	5.5
Warehouse	0.41	4.4
Workshop	0.83	8.9

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

where:

Retail Area 1 = The floor area for all products not listed in Retail Areas 2, 3, or 4.

Retail Area 2 = The floor area used for the sale of vehicles, sporting goods, and small *electronics*.

Retail Area 3 = The floor area used for the sale of furniture, clothing, cosmetics, and artwork.

Retail Area 4 = The floor area used for the sale of jewelry, crystal, and china.

Exception: Other merchandise categories included in Retail Areas 2 through 4 where the documented need for additional lighting power based on visual inspection, contrast, or other critical display has been *approved*.

e. Any of the control factors from ANSI/ASHRAE/IES Standard 90.1, Table 9.6.3, shall be permitted to be applied, provided that the corresponding control method is not required by ANSI/ASHRAE/ICC/ USGBC/IES Standard 189.1.

f. An additional *lighting power allowance* shall be credited for *institutional tuning* of dimmable lighting systems that meet all of the following requirements:

1. *Institutional tuning* controls shall be accessible only to authorized personnel.
2. *Construction documents* shall state that maximum light output or power of controlled lighting shall be reduced by at least 15% from full output.
3. The maximum light output or power of the controlled lighting shall be measured without *institutional tuning* and with *institutional tuning* to verify reduction of light output or power by at least 15% when tuned. In daylighted areas these measurements shall be conducted at night.

For controlled lighting in daylighted areas, the additional *lighting power allowance* shall be 0.05 times the controlled lighting power. In nondaylighted areas, the additional *lighting power allowance* shall be 0.10 times the controlled lighting power.

TABLE 701.4.6.1B (TABLE 7.4.6.1B)
LIGHTING POWER DENSITY (LPD) ALLOWANCES AND ROOM CAVITY RATIO (RCR) THRESHOLDS USING THE SPACE-BY-SPACE METHOD

Informative Note: This table is divided into two sections. The first section covers *space* types that can be commonly found in multiple-building types. The second part covers *space* types that are typically found in a single-building type.

COMMON SPACE TYPES [a]	LPD, W/ft²	LPD, W/m²	RCR THRESHOLD
Atrium			
< 20 ft (6.1 m) in height	0.39	4.2	NA
≥ 20 ft (6.1m) and ≤ 40 ft (12.2 m) in height	0.48	5.2	NA
> 40 ft (12.2 m) in height	0.60	6.5	NA
Audience Seating Area			
Auditorium	0.44	4.7	6
Convention center	0.23	2.5	4
Gymnasium	0.23	2.5	6
Motion picture theater	0.30	3.2	4
Penitentiary	0.44	4.7	4

COMMON SPACE TYPES [a]	LPD, W/ft²	LPD, W/m²	RCR THRESHOLD
Performing arts theater	0.75	8.1	8
Religious building	0.65	7.0	4
Sports arena	0.30	3.2	4
All other audience seating areas	0.23	2.5	4
Banking Activity Area	0.55	6.0	6
Breakroom (See Lounge/Breakroom)			
Classroom/Lecture Hall/Training Room			
Penitentiary	0.81	8.7	4
All other *classrooms*/lecture halls/training rooms	0.65	6.9	4
Conference/Meeting/Multipurpose Room	0.88	9.5	6
Confinement Cells	0.52	5.6	6
Copy/Print Room	0.31	3.3	6
Corridor [b]			
Facility for the visually impaired (and not used primarily by the staff) [c]	0.71	7.6	width < 8 ft (2.4 m)
Hospital	0.65	6.9	width < 8 ft (2.4 m)
Manufacturing facility	0.28	3.0	width < 8 ft (2.4 m)
All other corridors	0.37	4.0	width < 8 ft (2.4 m)
Courtroom	0.98	10.5	6
Computer Room	0.85	9.2	4
Dining Area			
Penitentiary	0.42	4.5	6
Facility for the visually impaired (and not used primarily by staff) [c]	1.27	13.7	4
Bar/lounge or leisure dining	0.62	6.7	4
Cafeteria or fast food dining	0.36	3.9	4
Family dining	0.54	5.8	4
All other dining areas	0.39	4.2	4
Electrical/Mechanical Room [g]	0.39	4.2	6
Emergency Vehicle Garage	0.47	5.1	4
Food Preparation Area	0.92	9.9	6
Guest Room	0.41	4.4	6
Laboratory			
In or as a *classroom*	1.04	11.2	6
All other laboratories	1.24	13.3	6

Laundry/Washing Area	0.43	4.6	4
Loading Dock, Interior	0.51	5.5	6
COMMON SPACE TYPES [a]	**LPD, W/ft²**	**LPD, W/m²**	**RCR THRESHOLD**
Lobby			
Facility for the visually impaired (and not used primarily by the staff) [c]	1.30	14.0	4
Elevator	0.52	5.6	6
Hotel	0.46	5.0	4
Motion picture theater	0.30	3.2	4
Performing arts theater	0.82	8.8	6
All other lobbies	0.76	8.2	4
Locker Room	0.45	4.8	6
Lounge/Breakroom			
Health care facility	0.38	4.1	6
All other lounges/breakrooms	0.44	4.7	4
Office			
Enclosed and ≤ 250 ft^2 (23 m^2)	0.67	7.2	8
Enclosed and > 250 ft^2 (23 m^2)	0.60	6.5	8
Open plan	0.55	6.0	4
Parking Area, Interior	0.11	1.2	4
Pharmacy Area	1.23	13.2	6
Restroom			
Facility for the visually impaired (and not used primarily by the staff) [c]	0.81	8.7	8
All other restrooms	0.57	6.2	8
Sales Area [d]	0.95	10.3	6
Seating Area, General	0.23	2.5	4
Stairway	The *space* containing the stairway shall determine the LPD requirements for the stairway.		
Stairwell	0.45	4.8	10
Storage Room			
< 50 ft^2 (4.6m^2)	0.51	5.5	6
≥ 50 ft^2 (4.6m^2) and ≤ 1000 ft^2 (93 m^2)	0.35	3.7	6
All other storage rooms	0.35	3.7	6
Vehicular Maintenance Area	0.53	5.7	4
Workshop	1.09	11.7	6
BUILDING TYPE SPECIFIC SPACE TYPES [a]	**LPD, W/ft²**	**LPD, W/m²**	**RCR THRESHOLD**

Facility for the Visually Impaired [c]			
Chapel (used primarily by residents)	0.70	7.5	4
Recreation room/common living room (and not used primarily by staff)	1.53	15.3	6
Automotive (See "Vehicular Maintenance Area")			
Convention Center—Exhibit Space	0.55	6.0	4
Dormitory—Living Quarters	0.46	4.95	8
BUILDING TYPE SPECIFIC SPACE TYPES [a]	**LPD, W/ft²**	**LPD, W/m²**	**RCR THRESHOLD**
Fire Station—Sleeping Quarters	0.19	2.05	6
Gymnasium/Fitness Center			
Exercise area	0.50	5.4	4
Playing area	0.75	8.1	4
Health Care Facility			
Exam/treatment room	1.16	12.5	8
Imaging room	0.85	9.2	6
Medical supply room	0.54	5.8	6
Nursery	0.94	10.1	6
Nurse's station	0.75	8.1	6
Operating room	1.87	20.1	6
Patient room	0.45	4.8	6
Physical therapy room	0.85	9.1	6
Recovery room	0.89	9.6	6
Library			
Reading area	0.77	8.3	4
Stacks	1.08	11.6	4
Manufacturing Facility			
Detailed manufacturing area	0.80	8.6	4
Equipment room	0.61	6.6	6
Extra high bay area (> 50 ft [15.2 m] floor-to-ceiling height)	0.73	7.9	4
High bay area (25 ft [7.6 m] to 50 ft [15.2 m] floor-to-ceiling height)	0.58	6.2	4
Low bay area (< 25 ft [7.6 m] floor-to-ceiling height)	0.61	6.6	4
Museum			
General exhibition area	0.31	3.3	6
Restoration room	0.77	8.3	6
Performing Arts Theater—Dressing Room	0.35	3.8	6

Post Office—Sorting Area	0.66	7.1	4
Religious Buildings			
Fellowship hall	0.42	4.5	4
Worship/pulpit/choir area	0.77	8.3	4
Retail Facilities			
Dressing/fitting room	0.49	5.3	8
Mall concourse	0.53	5.7	4
Sports Arena—Playing Area [h]			
Class I facility	2.26	24.3	4
Class II facility	1.45	15.6	4
BUILDING TYPE SPECIFIC SPACE TYPES [a]	**LPD, W/ft²**	**LPD, W/m²**	**RCR THRESHOLD**
Class III facility	1.08	11.6	4
Class IV facility	0.72	7.8	4
Transportation Facility			
Baggage/carousel area	0.35	3.8	4
Airport concourse	0.22	2.4	4
Terminal ticket counter	0.48	5.2	4
Warehouse—Storage Area			
Medium-to-bulky, palletized items	0.27	2.9	4
Smaller, hand-carried items [e]	0.60	6.5	6

a. In cases where both a common *space* type and a building area specific *space* type are listed, the building area specific *space* type shall apply.
b. In corridors, the extra LPD allowance is permitted when the width of the corridor is less than 8 ft (2.4 m) and is not based on the RCR, see Section 701.4.6.1.1(c) [7.4.6.1.1(c)].
c. A "Facility for the visually impaired" is a facility that can be documented as being designed to comply with the light levels in ANSI/IES RP-28 and is licensed or will be licensed by local/state authorities for either senior long-term care, adult daycare, senior support, and/or people with special visual needs.
d. For accent lighting, see Section 701.4.6.1.1(d) [7.4.6.1.1(d)].
e. Sometimes referred to as a "picking area."
f. Not used to keep footnote numbering consistent with ANSI/ASHRAE/IES Standard 90.1.
g. Electrical/mechanical rooms. An additional 0.50 W/ft^2 (5.4 W/m^2) shall be allowed, provided that the additional lighting is controlled separately from the base allowance of 0.39 W/ft^2 (4.2 W/m^2). The additional 0.50 W/ft^2 (5.4 W/m^2) allowance shall not be used for any other purpose.
h. Class of play as defined by IES RP-6.

701.4.6.1.2 (7.4.6.1.2) Exterior LPDs. The exterior *lighting power allowance* shall be determined using ANSI/ASHRAE/IES Standard 90.1, Section 9.4.3, with the following modification. The LPDs from ANSI/ASHRAE/IES Standard 90.1, Table 9.4.2-2, shall be multiplied by the appropriate LPD factor from Table 701.4.6.1.2 (7.4.6.1.2).

701.4.6.2 (7.4.6.2) Dwelling units. This section supersedes ANSI/ASHRAE/IES Standard 90.1, Section 9.4.3. Not less than 90% of the *permanently installed* lighting serving *dwelling units* shall be provided by *lamps* with an *efficacy* of not less than 75 lm/W or *luminaires* with an efficacy of not less than 55 lm/W.

Exception: Lighting attached to, or integral to, appliances.

701.4.6.3 (7.4.6.3) Interior lighting controls. The interior lighting control requirements in this section are in addition to the control requirements in ANSI/ASHRAE/IES Standard 90.1, Section 9.4.1.1.

701.4.6.3.1 (7.4.6.3.1) [JO] Occupancy sensor controls in commercial and industrial storage stacks. The lighting in commercial and industrial storage stack areas shall be controlled by an occupancy sensor with multilevel switching or dimming system that reduces lighting power a minimum of 50% within 20 minutes of all occupants leaving the stack area.

Exception: Storage stack areas illuminated by high-intensity discharge (HID) lighting with an LPD of 0.8 W/ft^2 (8.6 W/m^2) or less.

701.4.6.3.2 (7.4.6.3.2) [JO] Automatic controls for egress and security lighting. Lighting in any area within a building that is required to be continuously illuminated for reasons of building security or emergency egress shall not exceed 0.1 W/ft^2 (1 W/m^2). Additional egress and security lighting shall be allowed, provided it is controlled by an *automatic* control device that turns off the additional lighting.

701.4.6.3.3 (7.4.6.3.3) Occupancy sensing control in large office spaces. *General lighting* in office *spaces* greater than 250 ft^2 (23 m^2) shall be controlled by occupancy sensing controls that comply with all of the following:

a. The occupancy sensing controls shall be configured so that *general lighting* shall be controlled separately in control zones with floor areas not greater than 600 ft^2 (56 m^2).

b. Within 20 minutes of the control zone being unoccupied, the occupancy sensing controls shall turn off or uniformly reduce lighting power to no more than 20% of full power.

TABLE 701.4.6.1.2 (TABLE 7.4.6.1.2)
LIGHTING POWER ALLOWANCE FACTORS

	LIGHTING ZONE				
	LZ0	LZ1	LZ2	LZ3	LZ4
For tradable areas, uncovered parking areas: parking areas and drives with measured *SRI* < 29 or without *SRI* measurement	Not allowed	1	0.75	0.83	0.63
For tradable areas, uncovered parking areas: parking areas and drives with new concrete without added color pigment or with measured *SRI* ≥ 29	Not allowed	1	1	1	1
For tradable areas, other	1.00	0.90	0.90	0.95	0.95
For nontradable areas	1.00	0.95	0.95	0.95	0.95

c. Within 20 minutes of the entire office *space* being unoccupied, the occupancy sensing controls shall automatically turn off *general lighting* in all control zones in the *space*.

d. *General lighting* in each control zone shall be allowed to automatically turn on to full power upon occupancy within the control zone. When occupancy is detected in any control zone in the *space*, the *general lighting* in other control zones that are unoccupied shall operate at no more than 20% of full power.

701.4.6.4 (7.4.6.4) Exterior lighting controls. This section supersedes ANSI/ASHRAE/IES Standard 90.1, Section 9.4.1.4, for all exterior sign lighting and lighting serving uncovered parking areas and open areas in outdoor sales lots.

701.4.6.4.1 (7.4.6.4.1) Controls for exterior sign lighting. All exterior sign lighting, including internally illuminated signs and lighting on externally illuminated signs, shall comply with the requirements of Section 701.4.6.4.1.1 (7.4.6.4.1.1) or 701.4.6.4.1.2 (7.4.6.4.1.2).

Exceptions:

1. Sign lighting that is specifically required by a health or life safety statute, ordinance, or regulation.
2. Signs in tunnels.

701.4.6.4.1.1 (7.4.6.4.1.1) All sign lighting that operates more than one hour per day during *daylight hours* shall include controls to automatically reduce the input power to a maximum of 35% of full power for a period from one hour after sunset to one hour before sunrise.

Exception: Sign lighting using neon lamps with controls to automatically reduce the input power to a maximum of 70% of full power for a period from one hour after sunset to one hour before sunrise.

701.4.6.4.1.2 (7.4.6.4.1.2) All other sign lighting shall include the following:

a. Controls to automatically reduce the input power to a maximum of 50% of full power for a period from midnight or within one hour of the end of business operations, whichever is later, until 6:00 am or business opening, whichever is earlier.

b. Controls to automatically turn off during *daylight hours.*

701.4.6.4.2 (7.4.6.4.2) Parking and outdoor sales lighting. Outdoor luminaires serving uncovered parking areas and open areas in outdoor sales lots shall be controlled by all of the following:

a. Luminaires shall be controlled by a device that automatically turns off the luminaire during *daylight hours*.

b. Luminaires shall be controlled by a timeclock or other control that automatically turns off the luminaire according to a timed schedule.

c. For luminaires having a rated input wattage of more than 50 W and where the bottom of the luminaire is mounted 24 ft (7.3 m) or less above the ground, the luminaires shall be controlled by one or more devices that automatically reduce lighting power of each luminaire by a minimum of 50% when there is no activity detected in the controlled zone for a period no longer than 15 minutes. No more than 1500 input watts of lighting power shall be controlled together.

Exceptions:

1. Lighting serving street frontage for vehicle sales lots.
2. Lighting for covered vehicle entrances or exits from buildings or parking structures where required for safety, security, or eye adaptation.

701.4.6.5 (7.4.6.5) Dwelling unit lighting controls. *Permanently installed* luminaires in laundry rooms, utility rooms, closets, and storage rooms in *dwelling units* shall be controlled with *automatic shut-off controls*.

For all other spaces and exterior applications that are controlled from within a *dwelling unit*, where three or more *permanently installed* luminaires are controlled together, the control shall be either a *dimmer* or an *automatic shut-off control*.

Dwelling units with greater than 5000 ft^2 (460 m^2) of conditioned floor area shall have a lighting *control* system that has the capability to turn off all *permanently installed* interior lighting from a control located at an exit door or have a lighting *control* system that has the capability to turn off all *permanently installed* interior lighting from remote locations.

Exceptions:

1. Spaces using less than 10 W of total lighting power.
2. Lighting designed for safety or security.
3. *Permanently installed* night lighting that does not exceed 2 W per luminaire.

701.4.7 (7.4.7) Other equipment. The other equipment shall comply with ANSI/ASHRAE/IES Standard 90.1, Section 10, with the following modifications and additions.

701.4.7.1 (7.4.7.1) Equipment efficiency for the alternate renewables approach. All *building projects* complying with the Alternate Renewables Approach in Section 701.4.1.1 (7.4.1.1) and Table 701.4.1.1 (7.4.1.1) shall comply with the applicable equipment efficiency requirements in Normative Appendix B, the applicable requirements in Section 701.4.7.3.2 (7.4.7.3.2), and the pump efficiency requirements in Section 701.4.7.6 (7.4.7.6).

701.4.7.2 (7.4.7.2) [JO] Supermarket heat recovery. Supermarkets with a floor area of 25,000 ft^2 (2500 m^2) or greater shall recover waste heat from the condenser heat rejection on *permanently installed* refrigeration equipment meeting one of the following criteria:

a. Twenty-five percent (25%) of the refrigeration system full-load total heat rejection.

b. Eighty percent (80%) of the *space* heat, *service water heating*, and dehumidification reheat.

If a recovery system is used that is installed in the refrigeration system, the system shall not increase the saturated condensing temperature at design conditions by more than 5°F (3°C) and shall not impair other head pressure control/energy reduction strategies.

701.4.7.3 (7.4.7.3) Energy performance equipment. All *building projects* and all *building projects* complying with the Alternate Renewables Approach in Section 701.4.1.1 (7.4.1.1) and Table 701.4.1.1 (7.4.1.1) shall also comply with the best international (or equivalent national) practices approved by *AHJ*.

701.4.7.3.1 (7.4.7.3.1) Requirements for equipment not covered by appliance efficiency regulations (all building projects). Minimum energy performance requirement for the following equipment shall comply with the best international (or equivalent national) practices approved by *AHJ.*

a. Appliances:
    1. Room air cleaners: Requirements for Room Air Cleaners.
    2. Water coolers: Requirements for Water Coolers.
b. Heating and Cooling:
    1. Programmable thermostats: Requirements for Programmable Thermostats.
    2. Ventilating fans: Requirements for *Residential* Ventilating Fans.
c. Electronics:
    1. Cordless phones
    2. Audio and video: Requirements for Audio and Video.
    3. Televisions: Requirements for Televisions.

4. Set-top boxes: Requirements for Set-Top Boxes.

d. Office Equipment:

1. Computers: Requirements for Computers.
2. Copiers: Requirements for Imaging Equipment.
3. Fax machines: Requirements for Imaging Equipment.
4. Laptops: Requirements for Computers.
5. Mailing machines: Requirements for Imaging Equipment.
6. Monitors: Requirements for Displays.
7. Multifunction devices (printer/fax/ scanner): Requirements for Imaging Equipment.
8. Printers: Requirements for Imaging Equipment.
9. Scanners: Requirements for Imaging Equipment.
10. Computer servers: Requirements for Computer Servers.

e. Lighting:

1. Integral LED lamps not subject to Section 701.4.6.2 (7.4.6.2): Requirements for Integral LED Lamps.

f. Commercial Food Service:

1. Commercial fryers: Requirements for Commercial Fryers.
2. Commercial hot food holding cabinets: Requirements for Hot Food Holding Cabinets.
3. Commercial steam cookers: Requirements for Commercial Steam Cookers [see also water efficiency requirements in Section 601.3.2.5 (6.3.2.5)].
4. Commercial dishwashers: Requirements for Commercial Dishwashers.
5. Commercial griddles: Requirements for Commercial Griddles.
6. Commercial ovens: Requirements for Commercial Ovens [see also water efficiency requirements in Section 601.3.2.5 (6.3.2.5)].

Exception: Products with minimum efficiencies addressed in any other Federal Policy Act superseding these standards when complying with Section 701.4.1.1 (7.4.1.1).

701.4.7.3.2 (7.4.7.3.2) Requirements for equipment covered by appliance efficiency regulations (alternate renewables approach). For all building projects complying with the Alternate Renewables Approach in Section 701.4.1.1 (7.4.1.1) and Table 701.4.1.1 (7.4.1.1), the following equipment shall comply with the best international (or equivalent national) practices approved by *AHJ.* For those products listed below that are also contained in Normative Appendix B, the installed equipment shall comply by meeting or exceeding both the requirements in this section and in Normative Appendix B.

a. Appliances:

1. Clothes washers: Requirements for Clothes Washers [see also the water efficiency requirements in Section 601.3.2.2 (6.3.2.2)].
2. Dehumidifiers: Requirements for Dehumidifiers.
3. Dishwashers: Requirements Product Specifications for Residential Dishwashers [see also the water efficiency requirements in Section 601.3.2.2 (6.3.2.2)].
4. Refrigerators and freezers: Requirements for Refrigerators and Freezers.
5. Room air conditioners: Requirements and Criteria for Room Air Conditioners.

b. Heating and Cooling:

1. *Residential* air-source heat pumps: Requirements for ASHPs and Central Air Conditioners [see also the energy efficiency requirements in Section 701.4.1 (7.4.1)].
2. *Residential* boilers: Requirements for Boilers [see also the energy efficiency requirements in Section 701.4.1 (7.4.1)].
3. *Residential* central air conditioners: Requirements for ASHPs and Central Air Conditioners [see also the energy efficiency requirements in Section 701.4.1 (7.4.1)].
4. *Residential* ceiling fans: Requirements for Residential Ceiling Fans.
5. Dehumidifiers: Requirements for Dehumidifiers.
6. *Residential* warm air furnaces: Requirements for Furnaces.
7. *Residential* geothermal heat pumps: Requirements for Geothermal Heat Pumps.

c. Water Heaters: Requirements for Residential Water Heaters.

d. Lighting:
    1. Lamps: Requirements for Lamps (Light Bulbs).
    2. Luminaires: Requirements for Luminaires.
    3. *Residential* light fixtures: Requirements for Residential Light Fixtures.

e. Commercial Food Service:
    1. Commercial refrigerators and freezers Requirements for Commercial Refrigerators and Freezers.
    2. Commercial ice machines: Requirements for Commercial Ice Machines.

f. Other Products:
    1. Battery charging systems: Requirements for Products with Battery Charger Systems (BCSs).
    2. External power adapters: Requirements for Single-Voltage AC-DC and AC-AC Power Supplies.
    3. Vending machines: Requirements for Refrigerated Beverage Vending Machines.

701.4.7.4 (7.4.7.4) [JO] Programmable thermostats. *Residential* programmable thermostats shall meet the requirements of NEMA Standards Publication DC 3, Annex A, "Energy-Efficiency Requirements for Programmable Thermostats," or the requirements of the ENERGY STAR program for connected thermostats.

701.4.7.5 (7.4.7.5) [JO] Refrigerated display cases. All open refrigerated display cases shall be covered by using field-installed strips, curtains, or doors.

701.4.7.6 (7.4.7.6) Elevator power conversion System. In new buildings, traction elevators with a rise of 75 ft (23 m) or more shall be provided with a power conversion system that includes all of the following:

a. A drive motor with a minimum Class IE2 efficiency rating, as defined by IEC EN 60034-30.
b. A regenerative drive that recovers potential energy released during motion, converts it to electrical energy, and supplies it to the building electrical system.

701.4.7.7 (7.4.7.7) Pump efficiency. All pumps in buildings complying with the Alternate Renewables Approach in Section 701.4.1.1 (7.4.1.1) and Table 701.4.1.1 (7.4.1.1) that are subject to the requirements of ASHRAE/IES Standard 90.1, Section 10.4.7, shall have a Pump Energy Index no greater than 0.97.

701.4.8 (7.4.8) Energy cost budget. The Energy Cost Budget option in ANSI/ASHRAE/IES Standard 90.1, Section 11, shall not be used.

701.5 (7.5) Performance option. This section is intentionally left blank.

701.5.1 (7.5.1) Annual energy cost. This section is intentionally left blank.

701.5.1.1 (7.5.1.1) Compliance with ANSI/ ASHRAE/IES Standard 90.1 without renewables. This section is intentionally left blank.

701.5.2 (7.5.2) Annual carbon dioxide equivalent (CO_2e). This section is intentionally left blank.

701.5.3 (7.5.3) Zero energy performance index. This section is intentionally left blank.

701.5.4 (7.5.4) [JO] Energy simulation aided design. This section is intentionally left blank.

CHAPTER 8

INDOOR ENVIRONMENTAL QUALITY (IEQ)

801.1 Scope. Many external factors which affect indoor air quality are not controllable most of the time in the local context. Therefore, only limited provisions are made for these in this chapter.

801.3 (8.3) Mandatory provisions

801.3.1 For improving the quality of the indoor environment, the provisions are as follows.

a. The indoor space should be naturally ventilated. Natural ventilation can be achieved by (1) cross ventilation, which occurs when dwellings have openings in different orientations so that breeze can flow through the room or building to flush out hot or stale air, and (2) passive ventilation, which relies on the effect of rising hot air, and requires high and low openings so that warm air is flushed from higher openings and cooler air is drawn in through lower openings. Provision for ventilation are

   i. Place the windows in walls facing wind direction prevalent in the summer season.

   ii. Install windows towards open spaces on the rear and front sides of buildings.

   iii. Provide patios or small open-to-sky spaces in the building plans.

   iv. Install ventilation duct and exhaust fan over the stove to improve internal area thermal comfort in climate zone 1. The threshold of exhaust systems whose total exhaust exceeds 5000 cubic feet per minute, or cfm, (i.e., 2400 litres/second) is 2000 cfm (950 L/s).

   v. A 10-foot- (3-m-) long wall-mounted canopy hood serving medium-duty appliances must exhaust no more than 2,100 cfm (990 L/s) (IgCC 2018).

   vi. These naturally ventilated spaces must have minimum air openings and space configuration requirements in accordance with ASHRAE Standard 62.2-2010.

   vii. ASHRAE/ANSI/ ASHE Standard 170-2013 for ventilation of health care facilities, shall be followed for ensuring Indoor Air Quality perspectives.

   viii. ANSI/ASHRAE Standard 62.1-2016 for ventilation for acceptable indoor air quality, shall be followed for ensuring Indoor Air Quality perspectives.

b. There should be not be any smoking zone within the building nor within 25 ft from entries and operatable windows or openings.

c. Kitchen/s must have an exhaust system installed, with its vent outside to ensure removal of smoke from the building.

d. The occupants of the building should have access to the controls of any kind of air conditioning, lighting or heating system in order to ensure their thermal comfort.

e. Use of paints and coatings having a high content of Volatile Organic Chemicals (VOCs), such as formaldehyde, and other gases including carbon dioxide, carbon monoxide, ozone, nitrogen dioxide and radon, should be prohibited to ensure healthy indoor air.

f. Composite wood and agrifiber products must contain no added urea-formaldehyde resins.

g. Humidity Control shall be ensured through Indoor moisture control (primarily to reduce the likelihood of microbial growth on indoor surfaces) superseding the general reference to Standard 62.1.

h. Acoustical Control compliance shall be ensured through either testing or design.

i. Products of combustion from any equipment or system that is permanently installed indoors, with certain limited exceptions, be vented to the outside

j. ANSI/ASHRAE Standard 55-2017, along-with due amendments made in ASHRAE Standard 55-2020 shall be referred to ensure designs providing acceptable thermal environmental conditions for human occupancy.

CHAPTER 9

MATERIALS AND RESOURCES

901.1 (9.1) Scope. This section specifies requirements related to the environmental and human health impacts of materials, including resource conservation, reduced life-cycle impacts of building materials, impacts on the atmosphere, product transparency, and waste management.

901.2 (9.2) Compliance. The building materials shall comply with Section 901.3 (9.3), "Mandatory Provisions," and either:

a. Section 901.4 (9.4), "Prescriptive Option," or

b. Section 901.5 (9.5), "Performance Option."

901.3 (9.3) Mandatory provisions.

901.3.1 (9.3.1) Construction and demolition waste management.

901.3.1.1 (9.3.1.1) Diversion. A minimum of 25% of nonhazardous construction, demolition, or deconstruction waste material shall be diverted from disposal in landfills and incinerators through reuse, recycling, repurposing, and/or composting. Excavated soil and land-clearing debris shall not be included in the calculation. *Alternative daily cover* and waste-to-energy incineration shall not be included as diverted material. All diversion calculations shall be based on weight throughout the construction process.

901.3.1.2 (9.3.1.2) [JO] Total waste. For new construction only, the total amount of construction waste generated prior to the issuance of the final certificate of occupancy on the project shall not exceed **20 lbs per ft^2** (100 kg per m^2) of new building floor area. This shall apply to all waste, whether diverted, landfilled, incinerated, or otherwise disposed of. Excavated soil, land-clearing debris, and demolition debris shall not be included in the calculation. The amount of waste shall be tracked throughout the construction process in accordance with the construction waste management plan required in Section 901.3.1.3 (9.3.1.3).

Exception: Projects where the waste diversion in accordance with Section 901.3.1.1 (9.3.1.1) is 50% or greater.

901.3.1.3 (9.3.1.3) Construction and demolition waste management plan. Prior to the start of any construction, demolition, or deconstruction, a construction and demolition waste management plan shall be prepared and made available to the *owner* and AHJ. The plan shall do the following:

a. Identify the construction and demolition waste materials expected to be diverted.

b. Identify materials or building elements to be deconstructed.

c. Indicate whether construction and demolition waste materials are to be source-separated or comingled.

d. Identify service providers and designate destination facilities for construction and demolition waste materials generated at the job *site*.

e. Identify the average diversion rate for facilities that accept or process comingled construction and demolition materials. Separate average percentages shall be included for those materials collected by construction and demolition materials processing facilities that end up as *alternative daily cover* and incineration.

f. Specify a method for tracking.

g. Specify a reporting mechanism for disposition of waste using items (a) through (f).

901.3.2 (9.3.2) Extracting, harvesting, and/or manufacturing. This section applies to all materials, products, and/or assemblies installed prior to the issuance of the final certificate of occupancy.

Materials shall be harvested and/or extracted, and products and/or assemblies shall be manufactured, according to the laws and regulations of the country of origin.

Wood products in the project, other than recovered or reused wood, shall not contain wood from endangered wood species unless the trade of such wood conforms with the requirements of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

901.3.3 (9.3.3) Refrigerants. [Reserved for future use.]

901.3.4 (9.3.4) Areas for storage and collection of recyclables and discarded goods. Areas for recyclables and discarded goods shall be provided as described in this section. These areas shall be coordinated with the anticipated collection services to maximize the effectiveness of the dedicated areas. Instructions regarding the identification and handling of recyclables and discarded goods in these areas shall be posted in or adjacent to each dedicated area.

901.3.4.1 (9.3.4.1) Recyclables. There shall be areas that serve the entire building and are dedicated to the collection and storage of nonhazardous materials for recycling, including paper, corrugated cardboard, glass, plastics, and metals.

901.3.4.2 (9.3.4.2) Reusable goods. For *building projects* with *residential spaces*, there shall be an area that serves the entire building and is designed for the collection and storage of discarded but clean items in good condition. Charitable organizations or others to arrange for periodic pickups shall be identified and posted.

901.3.4.3 (9.3.4.3) Fluorescent and high-intensity discharge (hid) lamps and ballasts. An area shall be provided that serves the entire building, is designed for the collection and storage of fluorescent and HID lamps and ballasts, and facilitates proper disposal and/or recycling according to jurisdictional hazardous waste requirements.

901.3.4.4 (9.3.4.4) Electronics and batteries. Separate containers or areas shall be provided that serve the entire building; are designed for the collection and storage of *electronics*, alkaline batteries, and rechargeable batteries; and facilitate disposal and/or recycling according to jurisdictional requirements.

901.3.5 (9.3.5) Mercury content levels of lamps. Electric lamps used in the *building project* shall not contain mercury in an amount exceeding, per lamp, the maximum mercury content levels of Table 901.3.5 (9.3.5).

Exceptions:

1. Eight-foot models of straight fluorescent T8 lamps.
2. High-output and very-high-output, straight fluorescent lamps greater than 1.25 in. (32 mm) in diameter.
3. Mogul bi-pin-based lamps.
4. Preheat straight fluorescent lamps of any size.
5. U-bend and circline fluorescent lamps.
6. HID lamps.
7. Induction lamps.
8. Special-purpose lamps: appliance, black light, germicidal, bug, colored, grow, straight fluorescent reflector, reprographic, shatter resistant, cold temperature, and three-way lamps.

901.4 (9.4) Prescriptive option.

901.4.1 (9.4.1) Reduced impact materials. The *building project* shall comply with any two of the following: Sections 901.4.1.1, 901.4.1.2, 901.4.1.3, or 901.4.1.4 (9.4.1.1, 9.4.1.2, 9.4.1.3, or 9.4.1.4). Calculations shall only include materials *permanently installed* in the project. A value of 45% of the total construction cost shall be permitted to be used in lieu of the actual total cost of materials.

901.4.1.1 (9.4.1.1) Recycled content and salvaged material content. The sum of the *recycled content* and the *salvaged material* content shall constitute a minimum of 10%, based on cost, of the total materials in the *building project*.

901.4.1.1.1 (9.4.1.1.1) Recycled content. The *recycled content* of a material shall be the *postconsumer recycled content* plus one-half of the *preconsumer recycled content*, determined by weight (mass). The recycled fraction of the material in a product or an assembly shall then be multiplied by the cost of the product or assembly to determine its contribution to the 10% requirement.

The annual average industry values, by country of production, for the *recycled content* of steel products manufactured in basic oxygen furnaces and electric arc furnaces shall be permitted to be used as the *recycled content* of the steel. For the purpose of calculating the *recycled content* contribution of concrete, the constituent materials in concrete (***Informative Note:*** e.g., the cementitious materials, aggregates, and water) shall be permitted to be treated as separate components and calculated separately.

901.4.1.1.2 (9.4.1.1.2) Salvaged material content. The *salvaged material* content shall be determined based on the actual cost of the *salvaged material* or the cost of a comparable alternative component material.

901.4.1.2 (9.4.1.2) Regional materials. A minimum of 10% of building materials or products used, based on cost, shall be regionally extracted/harvested/recovered or manufactured within a radius of 250 mi (400 km) of the project *site.* If only a fraction of a product or material is extracted/harvested/recovered or manufactured locally, then only that percentage (by weight) shall contribute to the regional value.

Exception: For building materials or products shipped in part by rail or water, the total distance to

TABLE 901.3.5 (TABLE 9.3.5)
MAXIMUM MERCURY CONTENT FOR ELECTRIC LAMPS

LAMP	MAXIMUM MERCURY CONTENT
Screw-base compact fluorescent lamps < 25 W	4 mg
Screw-base compact fluorescent lamps ≥ 25 W and < 40 W	5 mg
Pin-base compact fluorescent lamps, all wattages	5 mg
Straight fluorescent T5 normal lifetime lamps [a]	3 mg
Straight fluorescent T8 normal lifetime lamps [a]	4 mg
Straight fluorescent T5 and T8 long lifetime lamps [b]	5 mg
T12 eight-foot straight fluorescent lamps	15 mg

a. Electric lamps with a rated lifetime less than 25,000 h when tested on an electronic fluorescent ballast, including T8 instant-start ballasts and T5 programmed-start ballasts, and turned off and on every three hours.
b. Electric lamps with a rated lifetime equal to or greater than 25,000 hours when tested on an electronic fluorescent ballast, including T8 instant-start ballasts and T5 programmed-start ballasts, and turned off and on every three hours.

the project shall be determined by weighted average, whereby that portion of the distance shipped by rail or water shall be multiplied by 0.25 and added to that portion not shipped by rail or water, provided that the total does not exceed 250 mi (400 km).

901.4.1.3 (9.4.1.3) Biobased products. A minimum of 2% of building materials used, based on cost, shall be *biobased product*s. *Biobased products* shall:

a. Comply with the minimum biobased contents of the USDA's Bio Preferred Program;
b. Contain the "USDA Certified *Biobased Product*" label; or
c. Be composed of solid wood, engineered wood, bamboo, wool, cotton, cork, agricultural fibers, or other biobased materials with at least 50% biobased content.

901.4.1.3.1 (9.4.1.3.1) Wood building components. Wood building components, including but not limited to structural framing, sheathing, flooring, subflooring, wood window sash and frames, doors, and architectural millwork, used to comply with this requirement shall contain not less than 50% certified wood content tracked through a chain of custody process, either by physical separation or percentage-based approaches, or wood that qualifies as a *salvaged material*. Certified wood content documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the WTO Technical Barriers to Trade. Wood building components from a *vendor* shall be permitted to comply when the annual average amount of certified wood products purchased by the *vendor*, for which they have chain of custody *verification* not older than two years, is 50% or greater of their total annual wood products purchased.

901.4.1.4 (9.4.1.4) Multiple-attribute product declaration or certification. A minimum of ten different products installed in the *building project* at the time of issuance of certificate of occupancy shall comply with one of the following subsections. Declarations, reports, and assessments shall be submitted to *AHJ* and shall contain documentation of the critical peer review by an independent third party, results from the review, the reviewer's name, company name, contact information, and date of the review or certification.

901.4.1.4.1 (9.4.1.4.1) Industry-wide declaration. A Type III industry-wide environmental product declaration (EPD) shall be submitted for each product. Where the program operator explicitly recognizes the EPD as fully representative of the product group on a national level, it is considered industry-wide. In the case where an industry-wide EPD represents only a subset of an industry group, as opposed to being industry-wide, the manufacturer shall be explicitly recognized as a participant by the EPD program operator. All EPD shall be consistent with ISO Standards 14025 and 21930, with at least a cradle-to-gate scope. Each product complying with this section shall be counted as one product for compliance with Section 901.4.1.4 (9.4.1.4).

901.4.1.4.2 (9.4.1.4.2) Product-specific declaration. A product-specific Type III EPD shall be submitted for each product. The product-specific declaration shall be manufacturer-specific for a product family. Type III EPDs shall be certified as complying with the goal and scope for the cradle-to-gate requirements in accordance with ISO Standards 14025 and 21930. Each product complying with this section shall be counted as two products for compliance with Section 901.4.1.4 (9.4.1.4).

901.4.1.4.3 (9.4.1.4.3) Third-party multiattribute certification. A material-specific assessment shall be submitted for each product in accordance with one of the following standards, where applicable. The assessment shall be certified as meeting the minimum performance level specified in each standard. Each product complying with this section shall be counted as two products for compliance with Section 901.4.1.4 (9.4.1.4).

a. ANSI/BIFMA e3
b. NSF/ANSI 140
c. NSF/ANSI 332
d. NSF/ANSI 336
e. NSF/ANSI 342
f. NSF/ANSI 347
g. NSC 373
h. ANSI A138.1
i. UL 100
j. UL 102

901.4.1.4.4 (9.4.1.4.4) Product life cycle. A report by a third-party that has critically reviewed the *life-cycle assessment* (*LCA*) of a product, based on ISO Standards 14040 and 14044, shall be submitted. The report shall demonstrate

compliance with the goal and scope for the cradle-to-gate requirements. Each product complying with this section shall be counted as two products for compliance with Section 901.4.1.4 (9.4.1.4).

901.5 (9.5) Performance option.

901.5.1 (9.5.1) Life-cycle assessment (LCA). An *LCA* shall be performed in accordance with ASTM E2921 and ISO Standard 14044, as modified by this section, for a minimum of two building alternatives, both of which shall conform to the *owner's project requirements* (*OPR*). For the purposes of Section 9.5, values for global warming potential relative to CO_2 shall be based on a 100 year time horizon when used for calculations, results, and comparisons.

901.5.1.1 (9.5.1.1) LCA performance metric. The *LCA* shall demonstrate that the final building design achieves one of the following minimum improvements over the reference building design assessed in the *LCA*:

a. **Ten percent (10%)** improvement in a minimum of each of two impact categories, one of which must be global warming.

b. **Five percent (5%)** improvement in a minimum of each of three impact categories, one of which must be global warming.

The following impact categories shall be used to determine compliance with this section and shall be included in the report described in Section 901.5.1.3 (9.5.1.3): land use, resource use, global warming, ozone layer depletion, human health effects, ecotoxicity, smog, acidification, and eutrophication.

901.5.1.2 (9.5.1.2) Procedure. The *LCA* shall be performed in accordance with the service lives, life-cycle stages, study boundaries, and comparison methodologies of ASTM E2921 with the following modifications:

a. Each building alternative shall comply with Chapters 6, 7 and 8 (Sections 6, 7, and 8) of this code.

b. The service life of the buildings shall not be less than that determined using Table 1001.10 (10.10), except that the service life of long-life buildings shall be no less than 75 years.

c. Operating energy consumption shall be included or excluded at the discretion of the project team.

d. The *LCA* tool (or tools) or software shall include a published third-party impact indicator method.

e. The estimate of structural system material quantities shall be verified by a *registered design professional* or other *approved source*.

901.5.1.3 (9.5.1.3) Reporting. A report that includes a description of the building alternatives and their physical differences shall be prepared and shall comply with the reporting requirements stated in ASTM E2921. The name and address of the *registered design professional* or other *approved source* verifying structural system material quantities shall be included. A critical review shall be performed by an external expert independent of those performing the *LCA*.

The report shall be submitted to the *AHJ* and include documentation of critical peer review by a third party, results from the review, and the reviewer's name and contact information.

CHAPTER 10

CONSTRUCTION AND PLANS FOR OPERATION

1001.1 (10.1) Scope. This section specifies requirements covering: the construction process, system start-up and commissioning, tests of completed systems and corrective actions, plans for high performance operation and maintenance of the building and site, energy and water performance verification, service life plans, and transportation management.

1001.2 (10.2) Compliance. All of the provisions of Chapter 10 (Section 10) are mandatory provisions.

1001.3 (10.3) Functional and performance testing and commissioning. *Building projects* with not greater than 10,000 ft^2 (1000 m^2) of gross floor area shall comply with Section 10.3.1. *Building projects* with greater than 10,000 ft^2 (1000 m^2) of gross floor area, shall comply with Section 1001.3.2 (10.3.2).

1001.3.1 (10.3.1) Building systems functional and performance testing (FPT). *Functional and performance testing* shall be performed on all building systems specifically referenced in this section using *generally accepted engineering standards* where such standards are *approved*.

An *FPT* process and system performance requirements shall be incorporated into *construction documents* and construction schedule of the *building project* to verify system performance.

1001.3.1.1 (10.3.1.1) FPT requirements. An *FPT* process shall be performed for the following:

a. Heating, ventilating, air conditioning, and refrigeration systems (mechanical and passive) and associated controls that exceed total system capacities of 180,000 Btu/h (53,000 W) for cooling, 300,000 Btu/h (88,000 W) for heating, or 10,000 cfm (5000 L/s) for ventilation.

b. Lighting systems over 5 kW in total capacity, including *automatic* and daylighting controls, manual daylighting controls, occupancy-sensing devices, time switching, and *automatic shut-off controls*.

c. Domestic water-heating systems rated at over 50,000 Btu/h (15,000 W).

d. Water pumping and mixing systems over 5 hp (4 kW).

e. Irrigation systems that use more than 1000 gal (4000 L) per day.

1001.3.1.2 (10.3.1.2) Activities prior to building permit for facilities using the FPT process. The following activities shall be completed before a permit is issued for any system requiring *FPT*:

a. Designate *FPT providers*. For systems that are required to comply with Section 1001.3.1 (10.3.1), *FPT providers* shall be *owner's* qualified employees, independent *commissioning (Cx) providers*, or qualified designers experienced with *FPT* on the designated systems. *FPT providers* shall be independent of the building system design and construction function and shall possesses the necessary experience and testing equipment.

b. *FPT providers* shall review the *construction documents* to verify that the relevant sensor locations, devices, and control sequences are properly specified; performance and testing criteria are included; and equipment to be tested is accessible for testing and maintenance.

1001.3.1.3 (10.3.1.3) Activities prior to building occupancy for facilities using the FPT process. Before issuance of a certificate of occupancy, the *FPT providers* shall complete the following activities:

a. Installation and startup of the specified systems shall be verified.

b. *FPT* of systems shall be verified.

Exception: Systems for which operation is seasonally dependent, and which cannot be fully commissioned in accordance with the *commissioning (Cx) plan* at the time of occupancy, shall be commissioned at the earliest operation time, postoccupancy, as determined by the *FPT providers*.

c. The preparation of operation and maintenance (O&M) documentation and warranty information shall be verified. O&M documentation, including the information needed to understand, operate, and maintain the building systems, shall be provided to the building *owner* and facility manager.

1001.3.1.4 (10.3.1.4) Documentation. The completed project design and *FPT* documentation shall be provided to the *owner* and shall be retained with the project records.

1001.3.2 (10.3.2) Building project commissioning (Cx) Process. The *Cx process* shall be performed in accordance with this section using ANSI/ASHRAE/IES Standard 202 or other *generally accepted engineering standards* where such standards are *approved*. The *Cx provider* shall verify that a *Cx process* has been incorporated into the design phases of the project and that commissioning shall be incorporated into the *construction documents.* The *Cx process* documents that the building and its commissioned components, assemblies, and systems comply with the *owner's project requirements* (*OPR*). The project requirements, including *OPR*, *BoD*, design and construction record documentation, training plans and records, O&M plans and procedures, and Cx reports shall be assembled in a systems manual that provides information for building operation and maintenance staff.

1001.3.2.1 (10.3.2.1) Systems to be commissioned. The *Cx process* shall be included in the design and construction of the *building project*. The following systems and associated controls, where included in the *building project*, shall be commissioned:

a. Heating, ventilating, air-conditioning, and refrigeration systems (mechanical and/or passive) and associated controls.

b. Air-curtain systems.

c. Lighting systems: *automatic* and manual daylighting controls, occupancy sensing devices, *automatic shut-off controls*, time switching, and other lighting control devices, and dimming systems claiming a *lighting power allowance* for *institutional tuning* according to Section 701.4.6.1.1(f) [7.4.6.1.1(f)].

d. Domestic hot-water systems and controls.

e. Water pumping and mixing systems over 5 hp (4kW) and purification systems.

f. Irrigation system performance that uses more than 1000 gal (4000 L) per day.

g. Renewable energy systems and energy storage systems.

h. Energy and building management and demand-control systems.

1001.3.2.2 (10.3.2.2) Cx activities prior to building permit. The following activities shall be completed prior to issuance of a building permit:

a. A copy of the *Cx plan* in accordance with ANSI/ASHRAE/IES Standard 202 shall be submitted for review with the building permit application.

b. An *approved Cx provider* shall be designated by the *owner* to manage *Cx process* activities prior to completion of *construction documents*. The *Cx provider* shall have the necessary training, experience, and equipment and be independent from the design team and the contractor responsible for the work being commissioned. The *Cx provider* shall disclose possible conflicts of interest so that objectivity can be confirmed. The Cx team shall include an *FPT provider* who may also be the *Cx provider*.

c. Construction phase Cx requirements shall be incorporated into project specifications and other *construction documents* developed by the design team.

1001.3.2.3 (10.3.2.3) Cx activities prior to building occupancy. The following activities shall be completed prior to issuance of a certificate of occupancy:

a. For the systems being commissioned, verify that commissioning has been completed, installation has been verified, *FPT* has been performed, and that reporting includes documentation of test results.

   Exception: Systems for which operation is seasonally dependent and which cannot be fully commissioned in accordance with the *Cx plan* at the time of occupancy shall be commissioned at the earliest operation time, postoccupancy, as determined by the *Cx provider*.

b. The *owner* shall be provided with a preliminary Cx report per compliance with Section 10.3.2.3. A copy of the Cx preliminary report shall be submitted to the *AHJ* upon request.

c. The *Cx provider* shall verify that the *owner* has been provided with a systems manual that includes the information needed to understand and operate the commissioned systems as designed, including warranty information for the commissioned systems. The systems manual with design and operational information shall be available for building operator and maintenance training.

1001.3.2.4 (10.3.2.4) Postoccupancy Cx activities. The *Cx plan* shall contain postoccupancy Cx requirements in accordance with ANSI/ASHRAE/IES Standard 202. The *Cx provider* shall provide the *owner* with a complete systems manual, all record documents, and a complete final Cx report in accordance with Standard 202.

1001.3.2.5 (10.3.2.5) Project Cx documents.

1001.3.2.5.1 (10.3.2.5.1) Cx plan. A *Cx plan* shall be developed by a *Cx provider* in accordance with ANSI/ASHRAE/IES Standard 202 for all systems to be commissioned and/or tested.

1001.3.2.5.2 (10.3.2.5.2) Design review report. The *Cx provider* shall provide to the *owner* and design teams a Cx design review report that complies with ANSI/ASHRAE/IES Standard 202 and details compliance with the *OPR*. This Cx design review shall not be considered a design peer review or a code or regulatory review.

1001.3.2.5.3 (10.3.2.5.3) Preliminary Cx report. The *Cx provider* shall provide a preliminary Cx report that includes the following information:

a. Performance of commissioned equipment, systems, and assemblies.

b. Issue and resolution logs, including itemization of deficiencies found during testing and commissioning that have not been corrected at the time of report preparation.

c. Deferred tests that cannot be performed at the time of report preparation.

d. Documentation of the training of operating personnel and building occupants on commissioned systems and a plan for the completion of any deferred trainings that were unable to be fully commissioned at the time of report preparation.

e. A plan for the completion of commissioning, including climatic and other conditions required for performance of the deferred tests.

1001.3.2.5.4 (10.3.2.5.4) Final Cx report. The *Cx provider* shall provide to the *owner*, prior to project completion, a final Cx report that complies with ANSI/ASHRAE/IES Standard 202.

1001.3.2.5.5 (10.3.2.5.5) Documentation. *Owner* shall retain the systems manual and final Cx report.

1001.4 (10.4) Construction operations and start-up requirements.

1001.4.1 (10.4.1) Erosion and sedimentation control (ESC). Develop and implement an ESC plan for all construction activities. The ESC plan shall conform to the erosion and sedimentation control requirements of the most current version of the USEPA NPDES General Permit for Stormwater Discharges from Construction Activities, or local erosion and sedimentation control standards and codes, whichever is more stringent, and regardless of size of project.

1001.4.2 (10.4.2) IAQ Construction management. Develop and implement an IAQ construction management plan to include the following:

a. Air conveyance materials shall be stored and covered so that they remain clean. All filters and controls shall be in place and operational when HVAC systems are operated during building flush-out or baseline IAQ monitoring. Except for system startup, testing, balancing, and commissioning, permanent HVAC systems shall not be used during construction.

b. Materials stored on-site, or materials installed that are absorptive, shall be protected from moisture damage.

c. Building construction materials that show visual evidence of biological growth due to the presence of moisture shall not be installed on the *building project*.

1001.4.3 (10.4.3) Construction activity pollution prevention: idling of construction vehicles. Construction-related vehicles shall not idle on the construction *site* for more than five minutes in any 60-minute period, except where necessary to perform their construction-related function. Signage shall be posted at vehicle entrances to the *building project* providing notice of this requirement.

1001.4.4 (10.4.4) [JO] Construction activity pollution prevention: protection of occupied areas. The *construction documents* shall identify operable windows, doors, and air intake openings that serve occupied *spaces*, including those not associated with the *building project*, that are in the area of construction activity or within 35 ft (11 m) of the limits of construction activity. Such windows, doors, and air intake openings that are under control of the *owner* shall be closed, or other measures shall be taken to limit *contaminant* entry.

Management of the affected buildings not under the control of the *building project owner* shall be notified in writing of planned construction activity and possible entry of *contaminants* into their buildings.

1001.4.5 (10.4.5) Construction and demolition waste management.

1001.4.5.1 (10.4.5.1) Collection. Specific areas on the construction *site* shall be designated for the collection of recyclable and reusable materials. Alternatively, off-site storage and sorting of materials shall be permitted. Diversion efforts shall be tracked throughout the construction process.

1001.4.5.2 (10.4.5.2) Documentation. Where requested by the *AHJ*, prior to issuance of the final certificate of occupancy, a final construction waste management report documenting compliance with Section 901.3.1 (9.3.1) shall be submitted to the *AHJ*.

1001.5 (10.5) Acoustical field measurement. Where required by Chapter 8 (Section 8), the *FPT* specified in Sections 1001.5.1 through 1001.5.3 (10.5.1 through 10.5.3) shall be completed.

1001.5.1 (10.5.1) Interior background sound levels. The interior sound level shall be measured in accordance with ANSI S12.72 using a sound level meter in slow-response setting as defined in ANSI/ASA S1.4. The testing shall include not less than 10% of the rooms of each type specified in Table 801.3.3.2 (8.3.3.2) that has a prescribed maximum *hourly average sound pressure level* L_{eq} dBA of 40 or less. The measured performance of the *spaces* shall not exceed the values specified in Table 801.3.3.2 (8.3.3.2) by greater than 5 dBA or 5 dBC.

1001.5.2 (10.5.2) Interior sound transmission. The testing of interior sound transmission shall be in accordance with ASTM E336 with respect to noise isolation class (NIC) and ASTM E1007 with respect to impact sound rating (ISR). Tested NIC values shall not be more than five less than the composite sound transmission class (cSTC) values, and the ISR values shall not be less than the impact insulation class (IIC) values in Table 801.3.3.3 (8.3.3.3). Testing shall be performed on not less than 10% of the partitions between rooms of each type in Table 801.3.3.3 (8.3.3.3) that has a prescribed cSTC or IIC of 50 or higher.

1001.5.3 (10.5.3) Property line sound. Testing shall be performed at the locations and times of day or night that are estimated to most likely result in failure and shall be performed with all equipment operating under normal 100% load operation. If daytime test results comply with the nighttime requirements, nighttime testing is not required. The testing

shall be in accordance with ANSI/ASA S1.13. The testing results shall comply with the property line noise levels in Table 801.3.3.5.2 (8.3.3.5.2). Where *approved*, noise that is not created on the source property need not be included in the reported test results.

1001.6 (10.6) Building envelope airtightness. *Building envelope* airtightness shall comply with ANSI/ASHRAE/IES Standard 90.1, with the following modifications and additions. Air leakage *verification* shall be determined in accordance with ANSI/ASHRAE/IES Standard 90.1, Section 5.9.1:

a. When implementing the testing option in ANSI/ASHRAE/IES Standard 90.1, Section 5.4.3.1.1, whole-building pressurization testing shall meet the following requirements:
    1. It shall be conducted in accordance with ASTM E779, ASTM E1827, CAN/CGSB-149.10, CAN/CGSB-149.15, ISO 9972, or equivalent standard by an independent third party.
    2. The measured air leakage rate of the *building envelope* shall not exceed 0.25 cfm/ft^2 (1.25 L/s • m^2) under a pressure differential of 0.3 in. of water (75 Pa), with this air leakage rate normalized by the sum of the above- and below-grade *building envelope* areas of the *conditioned* and *semiheated space.*
    3. Section 501.4.3.1.1 (5.4.3.1.1), Exception 1, is not allowed.
    4. Section 501.4.3.1.1 (5.4.3.1.1), Exception 2, is allowed where the measured air leakage rate exceeds 0.25 cfm/ft^2 (1.25 L/s × m^2) but does not exceed 0.40 cfm/ft^2 (2.0 L/s × m^2).
b. When implementing the *verification* program option in ANSI/ASHRAE/IES Standard 90.1, Section 5.9.1, the air barrier design review shall be performed by an independent third party.

1001.7 (10.7) [JO] Postconstruction building flush-out and air monitoring. After construction ends, prior to occupancy and with all interior finishes installed, a postconstruction, preoccupancy building flush-out as described under Section 1001.7.1 (10.7.1), or postconstruction, preoccupancy baseline IAQ monitoring as described under Section 1001.7.2 (10.7.2), shall be performed.

1001.7.1 (10.7.1) Postconstruction, preoccupancy flush-out. A total air volume of *outdoor air* in total air changes as defined by Equation 10-1 shall be supplied while maintaining an internal temperature of a minimum of 60°F (15°C) and relative humidity no higher than 60%. For buildings located in nonattainment areas, filtration and/or air cleaning as described in Section 801.3.1.3 (8.3.1.3) shall be supplied when the Air Quality Index forecast exceeds 100 (category orange, red, purple, or maroon). One of the following options shall be followed:

a. **Continuous postconstruction, preoccupancy flush-out.** The flush-out shall be continuous and supplied at an outdoor airflow rate no less than that determined in Section 801.3.1.1 (8.3.1.1).
b. **Continuous postconstruction, preoccupancy/postoccupancy flush-out.** If occupancy is desired prior to completion of the flush-out, the *space* is allowed to be occupied following delivery to the *space* of half of the total air changes calculated from Equation 10-1. The *space* shall be ventilated at a minimum rate of 0.30 cfm per ft^2 (1.5 L/s per m^2) of *outdoor air*, or the outdoor airflow rate determined in Section 801.3.1.1 (8.3.1.1), whichever is greater. These conditions shall be maintained until the total air changes calculated according to Equation 10-1 have been delivered to the *space*. The flush-out shall be continuous.

$$\text{TAC} = V_{ot} \times \frac{1}{A} \times \frac{1}{H} \times 60 \text{ min/h} \times 24 \text{ h/day} \times 14 \text{ days (I-P)}$$

$$\text{TAC} = V_{ot} \times \frac{1 \text{ m}^3}{1000L} \times \frac{1}{A} \times \frac{1}{H} \times 3600 \text{ s/h} \times 24 \text{ h/day} \times 14 \text{ days (SI)}$$

(Equation 10-1)

where:

TAC = Total air changes.

V_{ot} = System design *outdoor air* intake flow, cfm (L/s) (according to ANSI/ASHRAE Standard 62.1).

A = Floor area, ft^2 (m^2).

H = Ceiling height, ft (m).

1001.7.2 (10.7.2) Postconstruction, preoccupancy baseline IAQ monitoring. Baseline IAQ testing shall be conducted after construction ends and prior to occupancy. The ventilation system shall be operated continuously, within ±10% of the outdoor airflow rate provided by the ventilation system at design occupancy, for a minimum of 24 hours prior to IAQ monitoring. Testing shall be performed using protocols consistent with the USEPA Compendium of Methods for the Determination of Toxic Organic Pollutants in Ambient Air, TO-1, TO-11, TO-17, and ASTM Standard Method D5197.

The testing shall demonstrate that the *contaminant* maximum concentrations listed in Table 1001.7.2 (10.7.2) are not exceeded in the return airstreams of the HVAC systems that serve the *space* intended for occupancy. If the return airstream of the HVAC system serving the *space* intended for occupancy cannot be separated from other *spaces*, then for each portion of the building served by a separate ventilation system the testing shall demonstrate that the *contaminant* maximum concentrations at *breathing zone* listed in Table 1001.7.2 (10.7.2) are not exceeded in the larger of:

a. No fewer than one location per 25,000 ft^2 (2500 m^2) or

b. In each contiguous floor area.

For each sampling point where the maximum concentration limits are exceeded, conduct additional flush-out with *outdoor air*, and retest the specific parameters exceeded to demonstrate that the requirements are achieved. Repeat procedure until all requirements have been met. When retesting noncomplying building areas, take samples from the same locations as in the first test.

TABLE 1001.7.2 (TABLE 10.7.2)
MAXIMUM CONCENTRATION OF
AIR POLLUTANTS RELEVANT TO IAQ

CONTAMINANT	MAXIMUM CONCENTRATION, µg/m³ (UNLESS OTHERWISE NOTED)
Nonvolatile Organic Compounds	
Carbon monoxide (CO)	9 ppm and no greater than 2 ppm above outdoor levels
Ozone	0.075 ppm (8-h)
Particulates (PM2.5)	35 (24 h)
Particulates (PM10)	150 (24 h)
Volatile Organic Compounds	
Acetaldehyde	140
Acrylonitrile	5
Benzene	60
1,3-butadiene	20
t-butyl methyl ether (methyl-t-butyl ether)	8000
Carbon disulfide	800
Caprolactam [a]	100
Carbon tetrachloride	40
Chlorobenzene	1000
Chloroform	300
1,4-dichlorobenzene	800
Dichloromethane (methylene chloride)	400
1,4-Dioxane	3000
Ethylbenzene	2000
Ethylene glycol	400
Formaldehyde	33
2-Ethylhexanoic acid [a]	25
n-Hexane	7000
1-methyl-2-pyrrolidinone [a]	160
Naphthalene	9
Nonanal [a]	13
Octanal [a]	7.2
Phenol	200
4-phenylcyclohexene (4-PCH) [a]	2.5

2-propanol (isopropanol)	7000
Styrene	900
Tetrachloroethene (tetrachloroethylene, perchloroethylene)	35
Toluene	300
1,1,1-trichloroethane (methyl chloroform)	1000
Trichloroethene (trichloroethylene)	600
Xylene isomers	700
Total volatile organic compounds (TVOC)	__[b]

a. This test is only required if carpets and fabrics with styrene butadiene rubber (SBR) latex backing material are installed as part of the base building systems.

b. TVOC reporting shall be in accordance with CDPH/EHLB/Standard Method and shall be in conjunction with the individual VOCs listed.

1001.8 (10.8) Soil-gas control. The building shall be tested, postconstruction, for radon in accordance with ANSI/AARST MALB. The indoor radon concentration shall be below 2.7 pCi/L (100 Bq/m^3). Where radon testing indicates that the indoor radon concentration is 2.7 pCi/L (100 Bq/m^3) or greater, radon mitigation shall be conducted in accordance with ANSI/AARST RMS-LB, and the building shall be retested to verify that the radon concentration is below 2.7 pCi/L (100 Bq/m^3).

1001.9 (10.9) Plans for high-performance building operation. This section specifies the items to be included in plans for operation of a *building project*. A plan for operation starting immediately prior to occupancy shall be developed that meets the requirements specified in Sections 1001.9.1 through 1001.9.8 (10.9.1 through 10.9.8). The plan shall be turned over to the *owner.*

1001.9.1 (10.9.1) Site sustainability. A *site* sustainability portion of the plan for operation shall be developed and shall contain the following provisions:

a. Where trees and vegetation are used to comply with the shade requirements of Section 501.3.5 (5.3.5), the plan for operation shall include the maintenance procedures needed to maintain healthy vegetation growth. The plan shall also outline the procedures for replacing any vegetation used to comply with the provisions in Chapter 5 (Section 5).

b. For *roof* surface materials selected to comply with the requirements of Section 501.3.5.3 (5.3.5.3), the plan for operation shall include the maintenance procedures for keeping the *roof* surfaces cleaned in accordance with manufacturer's recommendations.

c. For vegetated terrace and roofing systems selected to comply with Section 501.3.5.5 (5.3.5.5), the plan for operation shall include the maintenance procedures needed to maintain healthy vegetation growth and *roof* membrane system. The plan shall also outline the procedures for replacing any vegetation used to comply with the provisions in Chapter 5 (Section 5).

1001.9.2 (10.9.2) Water use efficiency. The plan for operation shall specify water use *verification* activities for *building projects* to track and assess building water consumption. The plan shall describe the procedures needed to comply with the requirements outlined below.

1001.9.2.1 (10.9.2.1) Initial M&V. Use the water measurement devices and collection/storage infrastructure specified in Section 601.3.5 (6.3.5) to collect and store water use data for each device, starting no later than after building *FPT* has been completed and certificate of occupancy has been issued.

1001.9.2.2 (10.9.2.2) Track and assess water use. The plan shall specify the procedures for tracking and assessing the *building project* water use and the frequency for benchmark comparisons. The initial assessment shall be completed after 12 months but no later than 18 months after a certificate of occupancy has been issued. Ongoing assessments shall be completed at least every three years. The plan shall include the following:

a. **Water use reports.** Develop a plan for collecting *building project* water use data for water sources and subsystems measured in Section 601.3.5 (6.3.5).

b. **Benchmark water performance.** Develop a plan to enter building operating characteristics and water use data into the ENERGY STAR Portfolio Manager. For building parameter inputs into Portfolio Manager (***Informative Note:*** e.g., number of occupants, hours of operation, etc.), use actual average values.

c. **Assess water use performance.** Develop a plan to assess *building project* water use efficiency.

1001.9.2.3 (10.9.2.3) Documentation of water use. All documents associated with the M&V of the building's water use shall be retained by the *owner* for a minimum of three years.

1001.9.3 (10.9.3) Energy efficiency. The plan for operation shall specify energy performance *verification* activities for *building projects* to track and assess building energy performance. The plan shall describe the procedures needed to comply with the requirements outlined in the following subsections.

1001.9.3.1 (10.9.3.1) Initial M&V. Use the energy measurement devices and collection/storage infrastructure specified in Section 701.3.3 (7.3.3) to collect and store energy data for each device, starting no later than after FPT has been completed and certificate of occupancy has been issued.

1001.9.3.2 (10.9.3.2) Track and assess energy consumption. The plan for operation shall specify the procedures for tracking and assessing the *building project* energy performance and the frequency for benchmark comparisons. The initial assessment shall be completed after 12 months but no later than 18 months after a certificate of occupancy has been issued. Ongoing assessments shall be completed at least every three years. The plan shall include the following:

a. **Energy use reports.** Develop a plan for collecting *building project* energy data for energy sources and system energy loads measured in Section 701.3.3 (7.3.3). The reports shall include the following, as a minimum:
    1. Hourly load profile for each day.
    2. Monthly average daily load profile.
    3. Monthly and annual energy use.
    4. Monthly and annual peak demand.

b. **Track energy performance.** Develop a plan to enter building operating characteristics and energy consumption data into the ENERGY STAR Portfolio Manager for those building types addressed by this program to track building performance. For building parameter inputs into Portfolio Manager (***Informative Note:*** e.g., number of occupants, hours of operation, number of PCs, etc.), use actual average values.

c. **Assess energy performance.** Develop a plan to assess *building project* energy performance.

1001.9.3.3 (10.9.3.3) Documentation of energy efficiency. All documents associated with the M&V of the building's energy efficiency shall be retained by the *owner*.

1001.9.4 (10.9.4) IAQ. The plan for operation shall include the requirements of ASHRAE Standard 62.1, Section 8, and shall describe additional procedures for implementing a regular indoor environmental quality M&V program after building occupancy.

1001.9.4.1 (10.9.4.1) Outdoor airflow measurement. The plan for operation shall document procedures for implementing a regular outdoor airflow monitoring program after building occupancy and shall meet the following requirements:

a. For each mechanical ventilation system where direct outdoor airflow measurement is required according to Section 801.3.1.2 (8.3.1.2), a procedure shall be in place to respond when there is notification that the *minimum outdoor airflow* is in an *outdoor air fault condition*. For systems that use a damper indicator instead of a direct measurement, per the exception to Section 801.3.1.2 (8.3.1.2), a procedure shall be in place to respond when there is notification that the indicator identifies that the damper is out of position.

b. For each mechanical ventilation system where direct *minimum outdoor airflow* measurement is required according to Section 801.3.1.2 (8.3.1.2), the *minimum outdoor airflow* shall be recorded every three months in either electronic or written form.

c. For systems that use a damper indicator per the exception to Section 801.3.1.2 (8.3.1.2), the *minimum outdoor airflow* shall be measured and recorded in either electronic or written form every two years for air-handling systems with a design supply airflow rate of more than 2000 cfm (1000 L/s). The *minimum outdoor airflow* shall be measured using methods as described in ANSI/ASHRAE Standard 111 and with an accuracy of ±10% or better.

1001.9.4.2 (10.9.4.2) Outdoor airflow scheduling. Ventilation systems shall be operated such that *spaces* are ventilated when these *spaces* are expected to be occupied.

1001.9.4.3 (10.9.4.3) Outdoor airflow documentation. The following documentation shall be maintained concerning outdoor airflow M&V:

a. A list of each air system requiring direct outdoor airflow measurement.

b. Monitoring procedures and monitoring frequencies for each monitored sensing device, including a description of the specific response measures to be taken if needed.

c. Ventilation systems shall be operated such that *spaces* are ventilated when these *spaces* are expected to be occupied.

d. Operation and calibration check procedures and the records associated with operation checks and recalibration.

1001.9.4.4 (10.9.4.4) IAQ maintenance and monitoring. The plan for operation shall document procedures for maintaining and monitoring IAQ after building occupancy and shall contain the following:

a. For buildings located in nonattainments areas for PM2.5, as defined by USEPA, air filtration and/or air cleaning equipment, as defined in Section 801.3.1.3(a) [8.3.1.3(a)], shall be operated continuously during occupied hours or when the USEPA Air Quality Index exceeds 100 or equivalent designation by the local authorities for PM2.5.

   Exception: *Spaces* without mechanical ventilation.

b. For buildings located in nonattainments areas for ozone, as defined by the USEPA, air cleaning equipment, as defined in Section 801.3.1.3(b) [8.3.1.3(b)], shall be operated continuously during occupied hours during the local summer and fall seasons or when the USEPA Air Quality Index exceeds 100 or equivalent designations by the local authorities for ozone.

   Exception: *Spaces* without mechanical ventilation.

c. Biennial monitoring of IAQ by one of the following methods:
   1. Performing IAQ testing as described in Section 1001.7.1.2 (10.7.1.2).
   2. Monitoring occupant perceptions of IAQ by any method, including but not limited to occupant questionnaires.
   3. Each building shall have an occupant complaint/response program for IEQ.

d. For buildings where radon mitigation is required under Section 1001.8 (10.8), operation, maintenance, and monitoring procedures shall include all of the following:
   1. Quarterly inspection to verify operation of fans and other mechanical components.
   2. Biennial radon testing in accordance with AARST MALB to verify that radon concentrations remain below 2.7 pCi/L (100 Bq/m^3). Where radon testing indicates that the indoor radon concentration is 2.7 pCi/L (100 Bq/m^3) or greater, mitigation shall be conducted in accordance with AARST RMS-LB, and the building shall be retested to verify that the radon concentration is below 2.7 pCi/L (100 Bq/m^3).

      Where the required effectiveness of mitigation systems is consistently demonstrated for a period of not less than eight years, and such systems are inspected quarterly to verify fan operation, radon testing shall be repeated at intervals of not less than every five years.

   3. Biennial inspection and repair as needed for mitigation system performance indicators, fans, and visible mitigation system components, including piping, fasteners, supports, labels, and soil-gas barrier closures at exposed membranes, sumps, and other openings between soil and interior *space*.
   4. Documentation and retention of inspection and repair records and testing reports.

1001.9.4.5 (10.9.4.5) Outdoor air ozone air cleaners. Ozone air cleaning devices required under Section 801.3.1.3 (8.3.1.3) shall be operated whenever outdoor ozone concentrations are forecast to exceed applicable regulatory limits.

1001.9.5 (10.9.5) Building green cleaning plan. A green cleaning plan shall be developed for the *building project* in compliance with Green Seal Standard GS-42.

Exception: *Dwelling units* of a *building project.*

1001.9.6 (10.9.6) Moisture measurement. The plan for operation shall document procedures for implementing a regular humidity sensor monitoring program after building occupancy. Such procedures shall include provisions for the following:

a. For systems complying with Section 801.3.1.4 (8.3.1.4), using relative humidity sensors to determine *HVAC zone* relative humidity directly, or using dew-point and zone temperature sensors to determine *HVAC zone* relative humidity indirectly, the relative humidity determined shall be checked annually and compared to the relative humidity established using methods described in ASHRAE Standard 111.

b. Sensors shall be cleaned or repaired and recalibrated as necessary to ensure that sensor measurements are within 10% of actual relative humidity measurements.

1001.9.7 (10.9.7) Indoor environmental quality survey. The plan for operation shall include an indoor environmental quality occupant survey complying with all of the following:

a. The survey shall be implemented within a period of 6 to 18 months after issuance of the certificate of occupancy. The survey shall be repeated not less often than once every three years.

b. The survey questions shall include satisfaction questions and diagnostic questions for IAQ, lighting, acoustics, and thermal comfort. The survey questions shall use a seven-point satisfaction scale and comply with ANSI/ASHRAE Standard 55, Section 7.3.1.1.

c. A plan for reporting the survey results shall be produced that includes the following:
   1. The survey report shall state where the response rate was less than the response rates specified in ASHRAE Standard 55, Section 7.3.1.

2. The survey report shall indicate the percentage of satisfaction for each question in accordance with ASHRAE Standard 55, Section 7.4.1(a).
3. The percentage satisfaction results shall be compared to a nationally recognized survey benchmarking database where the building occupancy category is represented in the databases of nationally recognized organizations.

1001.9.8 (10.9.8) Renewable energy certificate tracking. For multitenant buildings where *RECs* are transferred to tenants, the plan for operation shall include procedures for tracking the quantity and vintage of *RECs* that are required to be retained and retired in compliance with Sections 701.3.2 (7.3.2) and 701.4.1.1 (7.4.1.1) of this code. The plan shall include provisions to transfer the *RECs* to building tenants, or to retire *RECs* on their behalf in proportion to the *gross conditioned* and *semiheated floor area* leased or rented. The plan shall include provisions to use a *REC* tracking system that meets the requirements of Section V.B of the Green-e Framework for Renewable Energy Certification. The plan shall describe how the building *owner* will procure alternative qualifying renewable energy in the case that the renewable energy producer ceases operation.

1001.9.9 (10.9.9) Renewable energy allocation to multiple buildings. Where renewable energy is allocated to multiple buildings in compliance with Section 701.4.1.3(g) [7.4.1.3(g)], the plan shall indicate how renewable energy produced from on-site or off-site systems that is not allocated before issuance of the certificate of occupancy will be allocated to new or existing buildings included in the *building project*. The plan shall indicate who will be responsible for retaining the documentation for allocations and where it will be stored so that it can be made available for inspection by the *AHJ* upon request.

Where multiple buildings in a *building project* share a common utility interconnection and are served by the same *on-site renewable energy system*, the building *owner* shall allocate for not less than 15 years the annual *REC* generation of the on-site renewable energy system to the *buildings* served by the system. The annual generation vintage date of delivered *RECs* shall be allocated to the same 12 month reporting year, up to six months prior, or up to three months after the calendar year in which the electricity is used in the building. The annual allocation of *RECs* shall be documented as part of the plan. The plan shall indicate who will be responsible for retaining the documentation and where it will be stored so that it can be made available for inspection by the *AHJ* upon request.

1001.9.10 (10.9.10) Maintenance plan. A *maintenance plan* shall be developed for mechanical, electrical, plumbing, and fire protection systems. The plan shall include the following:

a. The plan shall be in accordance with ASHRAE/ACCA Standard 180 for HVAC systems in buildings that meet the definition of commercial buildings in Standard 180.
b. The plan shall address all elements of ASHRAE/ACCA Standard 180, Section 4, and shall develop required inspection and maintenance tasks similar to ASHRAE/ACCA Standard 180, Section 5, for electrical and plumbing systems in buildings that meet the definition of commercial buildings in ASHRAE/ACCA Standard 180.
c. *Outdoor air* delivery monitors required by Section 801.3.1.2 (8.3.1.2) shall be visually inspected at least once each quarter and cleaned or repaired, as necessary, and calibrated at the manufacturer's recommended interval or not less than once per year, whichever is more frequent.
d. For systems with a damper indicator and with less than 2000 cfm (1000 L/s) of supply air, the system components that control the *minimum outdoor airflow* shall be visually inspected every two years. Records of this inspection shall be maintained on-site either in electronic or written form.
e. Documentation of the plan and of completed maintenance procedures shall be maintained on the building *site* at all times in:
    1. Electronic format for storage on the building energy management system (EMS), building management system (BMS), computerized maintenance management system (CMMS), or other computer storage means, or
    2. Maintenance manuals specifically developed and maintained for documenting completed maintenance activities.

1001.10 (10.10) [JO] Service life plan. A service life plan that is consistent with the *OPR* shall be developed to estimate to what extent structural, *building envelope* (not mechanical and electrical), and *hardscape* materials will need to be repaired or replaced during the service life of the building. The design service life of the building shall be no less than that determined using Table 1001.10 (10.10). The estimated service life shall be documented for building assemblies, products, and materials that will need to be inspected, repaired, and/or replaced during the service life of the building. *Site* improvements and *hardscape* shall also be included. Documentation in the service life plan shall include the *building project* design service life and basis for determination, and the following for each assembly or component:

a. Building assembly description.
b. Materials or products.
c. Design or estimated service life in years.
d. Maintenance frequency.
e. Maintenance access for components with an estimated service life less than the service life of the building.

Provide a service life plan at the completion of design development. The *owner* shall retain a copy of the service life plan for use during the life of building.

TABLE 1001.10 (TABLE 10.10)
MINIMUM DESIGN SERVICE LIFE FOR BUILDINGS

CATEGORY	MINIMUM SERVICE LIFE	BUILDING TYPES
Temporary	Up to 10 years	Nonpermanent construction buildings (sales offices, bunkhouses); temporary exhibition buildings
Medium life	25 years	Industrial buildings; stand-alone parking structures
Long life	50 years	All buildings not temporary or medium life, including the parking structures below buildings designed for long life category

1001.11 (10.11) Transportation management plan. A transportation management plan shall be developed compliant with the following requirements. The *owner* shall retain a copy of the transportation management plan.

1001.11.1 (10.11.1) All building projects. The plan shall include the following:

a. Preferred parking for carpools and vanpools with parking facilities.

b. A plan for bicycle transportation.

1001.11.2 (10.11.2) [JO] Owner-occupied building projects or portions of building projects. For *owner*-occupied buildings, or for the employees in the *owner*-occupied portions of a building, the building *owner* shall offer at least one of the following primary benefits to the *owner*'s employees:

a. Incentivize employees to commute using mass transit, vanpool, carpool, or nonmotorized forms of transportation.

b. Initiate a telework or flexible work schedule program that reduces by at least 5% the number of commuting trips by the *owner*'s employees.

c. Initiate a ridesharing or carpool matching program, either in-house or through an outside organization.

Exception: Multifamily *residential building project.*

In addition, the *owner* shall provide all of the following to the *owner*'s employees:

a. Access to an *emergency ride home* for employees, either provided in-house or by an outside organization.

b. A central point of contact in charge of commuter benefits.

c. Maintenance of commuter benefits in a centralized location.

d. Active promotion of commuter benefits to employees.

1001.11.3 (10.11.3) [JO] Building tenant. The building *owner*:

a. Shall provide a copy of the plan to tenants within the building.

b. Shall not include parking fees in lease rates, or shall identify the value of parking in the lease.

INORMATIVE APPENDIX A

NORMATIVE REFERENCES

Section numbers indicate where the reference occurs in this document.

AARST

American Association of Radon Scientists and Technologists
527 N. Justice Street
Hendersonville, NC 28739

ANSI/AARST RMS-LB-2018

Radon Mitigation Standards for Schools and Large Buildings
1001.3.9 (10.3.9), 1001.9.4.4 (10.9.4.4)

ANSI/AARST MALB-2014

Protocols for Measuring Radon and Radon Decay Products in School and Large Buildings
1001.3.9 (10.3.9), 1001.9.4.4 (10.9.4.4)

AHAM

Association of Home Appliance Manufacturers
1111 19th Street NW, Suite 402
Washington, DC, 20036

ANSI/AHAM RAC-1—2015

Room Air Conditioners
Appendix B

AHRI

Air-Conditioning, Heating, and Refrigeration Institute
2111 Wilson Blvd, Suite 500
Arlington, VA 22201

ANSI/AHRI 210/240—2017

Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment
Appendix B

ANSI/AHRI 310/380—2017

Standard for Packaged Terminal Air-Conditioners and Heat Pumps (CSA-C744-17)
Appendix B

AHRI 340/360—2019

Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment
Appendix B

ANSI/AHRI 365—2009

Performance Rating of Commercial and Industrial Unitary Air-Conditioning Condensing Units
Appendix B

ANSI/AHRI 460—2005

Performance Rating of Remote Mechanical-Draft Air-Cooled Refrigerant Condensers
Appendix B

ANSI/AHRI 1230—2014 (with Addendum 1)

Performance Rating of Variable Refrigerant Flow (VRF) Multi-Split Air-Conditioning and Heat Pump Equipment
Appendix B

AMCA

Air Movement and Control Association International, Inc.
30 West University Drive
Arlington Heights, IL 60004-1893

AMCA 208—18

Calculation of the Fan Energy Index
701.4.3.6.2 (7.4.3.6.2)

ANSI/AMCA 220—19

Laboratory Methods of Testing Air Curtain Units for Aerodynamic Performance Rating
701.4.2.5 (7.4.2.5)

ANSI

American National Standards Institute
25 West 43rd Street
New York, NY 20036

ANSI C78.377—2017

American National Standard for Electric Lamps—Specifications for the Chromaticity of Solid State Lighting (SSL) Products
801.3.5.3 (8.3.5.3)

ANSI Z21.10.3—2017

Gas Water Heaters, Volume III, Storage Water Heaters with Input Ratings above 75,000 Btu/h, Circulating and Instantaneous
Appendix B

ANSI Z21.11.2—2016

Gas-fired Room Heaters, Volume II, Unvented Room Heaters
801.3.1.5 (8.3.1.5)

ANSI Z21.47—2016

Gas-Fired Central Furnaces
Appendix B

ANSI Z83.4—2017/CSA 3.7—2017

Non-recirculating Direct Gas-fired Industrial Air Heaters
801.3.1.5 (8.3.1.5)

ANSI Z83.8—2016

Gas Unit Heaters, Gas Packaged Heaters, Gas Utility Heaters, and Gas-Fired Duct Furnaces
Appendix B

ANSI Z83.19—2009/CSA 2.35—2009

Gas-fired High-intensity Infrared Heaters
801.3.1.5 (8.3.1.5)

APA

The Engineered Wood Association
7011 S. 19th Street
Tacoma, WA 98466-5333

ANSI A190.1—2017

Standard for Wood Products-Structural Glued Laminated Timber
801.4.2.4 (8.4.2.4)

ANSI/APA PRG 320—2019

Standard for Performance-Rated Cross-Laminated Timber
801.4.2.4 (8.4.2.4)

ASA

Acoustical Society of America
1305 Walt Whitman Road
Suite 300
Melville, NY 11747-4300

ANSI/ASA S1.13—2005 (R2010)

Measurement of Sound Pressure Levels in Air

1001.5 (10.5)

ANSI/ASA S1.4—2014

Sound Level Meters
1001.5 (10.5)

ANSI/ASA S12.60—2009/Part 2 (R2014)

Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 2: Relocatable Classroom Factors
801.3.3 (8.3.3), 801.3.3.4 (8.3.3.4)

ANSI/ASA S12.60—2010/Part 1 (R2015)

Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 1: Permanent Schools
801.3.3 (8.3.3)

ANSI/ASA 12.72—2015

Measuring the Ambient Noise Level in a Room
1001.5 (10.5)

ASABE

American Society of Agricultural and Biological Engineers
2950 Niles Road
Saint Joseph, MI 49085

ASABE/ICC 802—2020

Landscape Irrigation Sprinkler and Emitter Standard
601.3.1.2.1 (6.3.1.2.1)

ASHE

American Society for Healthcare Engineering of the American Hospital Association
155 N. Wacker Drive, Suite 400
Chicago, IL 60606

2018 FGI Guidelines: Hospitals and Outpatient Facilities

Guidelines for Design and Construction of Hospitals
801.3.3 (8.3.3)

2018 FGI Guidelines: Hospitals and Outpatient Facilities

Guidelines for Design and Construction of Outpatient Facilities
801.3.3 (8.3.3)

2018 FGI Guidelines: Residential Health, Care and Support Facilities

Guidelines for Design and Construction of Residential Health, Care, and Support Facilities
801.3.3 (8.3.3)

ASHRAE

ASHRAE
180 Technology Parkway NW
Peachtree Corners, GA 30092

ANSI/ASHRAE Standard 52.2—2017

Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
801.3.1.3 (8.3.1.3)

ANSI/ASHRAE Standard 55—2017 (with Addenda a and b)

Thermal Environmental Conditions for Human Occupancy
801.3.2 (8.3.2), 1001.9.7 (10.9.7)

ANSI/ASHRAE Standard 62.1—2019

Ventilation for Acceptable Indoor Air Quality
301.2 (3.2), 701.4.3.2 (7.4.3.2), 701.4.3.8 (7.4.3.8), 801.3 (8.3), 1001.4.2 (10.4.2), 1001.3.2.4 (10.3.2.4)

ANSI/ASHRAE Standard 62.2—2019

Ventilation and Acceptable Indoor Air Quality in Residential Buildings
801.3.1 (8.3.1), 801.3.1.1 (8.3.1.1), 801.3.1.5 (8.3.1.5)

ANSI/ASHRAE/IES Standard 90.1—2019

Energy Standard for Buildings Except Low-Rise Residential Buildings
301.1 (3.1), 301.2 (3.2), 501.3.6 (5.3.6), 701.3.1 (7.3.1), 701.4.1 (7.4.1), 701.4.2 (7.4.2), 701.4.3 (7.4.3), 701.4.4 (7.4.4), 701.4.5 (7.4.5), 701.4.6 (7.4.6), 701.4.7 (7.4.7), 701.4.8 (7.4.8), 801.3.1.10 (8.3.1.10), 1001.6 (10.6), Appendix A, Appendix B, Appendix C

ANSI/ASHRAE Standard 111—2008 (RA 2017)

Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems
801.3.1.2.2 (8.3.1.2.2), 1001.9.4 (10.9.4), 1001.9.6 (10.9.6)

ANSI/ASHRAE Standard 146—2011

Method of Testing and Rating Pool Heaters
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ANSI/ASHRAE Standard 154—2016

Ventilation for Commercial Cooking Operations
701.4.3.8.1 (7.4.3.8.1)

ANSI/ASHRAE Standard 160—2016

Criteria for Moisture-Control Design Analysis in Buildings
801.3.6 (8.3.6)

ANSI/ASHRAE Standard 169—2013

Climatic Data for Building Design Standards
701.3.1.1 (7.3.1.1)

ANSI/ASHRAE/ASHE Standard 170—2017

Ventilation of Health Care Facilities
801.3.1 (8.3.1)

ANSI/ASHRAE/ACCA Standard 180—2018

Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems
301.2 (3.2), 1001.9.10 (10.9.10)

ANSI/ASHRAE/ASHE Standard 189.3—2017

Design, Construction, and Operation of Sustainable High-Performance Health Care Facilities
401.1 (4.1)

ANSI/ASHRAE/IES Standard 202—2018

Commissioning Process for Buildings and Systems
1001.3.2 (10.3.2), 1001.3.2.5 (10.3.2.5)

ANSI/ASHRAE Standard 209—2018

Energy Simulation Aided Design for Buildings Except Low-Rise Residential Buildings
701.5.4 (7.5.4)

ASME

American Society of Mechanical Engineers
Three Park Avenue
New York, NY 10016-5990

ASME A112.18.1—2020/CSA B125.1—20

Plumbing Supply Fittings
601.3.2.1 (6.3.2.1)

ASME A112.19.2—2020/CSA B45.1—20

Ceramic Plumbing Fixtures
601.3.2.1 (6.3.2.1)

ASME A112.19.14—2013 (R2018)

Six-Liter Water Closets Equipped with a Dual Flushing Device

601.3.2.1 (6.3.2.1)

ASME A112.19.19—2021

Vitreous China Nonwater Urinals
601.3.2.1 (6.3.2.1)

ASTM

ASTM International
100 Barr Harbor Dr.
West Conshohocken, PA 19428-2959

C33/C33M—18

Standard Specification for Concrete Aggregates
801.3.4.1.2 (8.3.4.1.2)

C518-15

Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
Appendix A

C919—19

Standard Practice for Use of Sealants in Acoustical Applications.
801.3.3.1.1 (8.3.3.1.1), 801.3.3.2.3.3 (8.3.3.2.3.3), 801.3.3.3.2 (8.3.3.3.2)

C920—18

Standard Specification for Elastomeric Joint Sealants
801.3.4.1.1 (8.3.4.1.1)

C1371—15

Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers
501.3.5.4 (5.3.5.4)

C1549—16

Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer
501.3.5.4 (5.3.5.4)

D1003—13

Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics
301.2 (3.2), 801.4 (8.4), 801.4.1.1.3 (8.4.1.1.3), 801.4.1.3 (8.4.1.3)

D1785—15e1

Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
801.3.4.1.3 (8.3.4.1.3)

D2559—12a (2018)

Standard Specification for Adhesives for Bonded Structural Wood Products for Use Under Exterior Exposure Conditions
801.4.2.4 (8.4.2.4)

D5197—16

Standard Test Method for Determination of Formaldehyde and Other Carbonyl Compounds in Air (Active Sampler Methodology)
801.4.2 (8.4.2), 1001.7 (10.7)

D5456—18

Standard Specification for Evaluation of Structural Composite Lumber Products
801.4.2.4 (8.4.2.4)

D5055—16

Standard Specification for Establishing and Monitoring Structural Capacities of Prefabricated Wood I-Joists
801.4.2.4 (8.4.2.4)

E90—09 (2016)

Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
801.3.3.1.1 (8.3.3.1.1)

E336—17a

Standard Test Method for Measurement of Airborne Sound Attenuation Between Rooms in Buildings
801.3.3.1.1 (8.3.3.1.1), 1001.5.2 (10.5.2)

E408—13 (2019)

Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques
501.3.5.4 (5.3.5.4)

E492—09 (2016) e1

Standard Test Method for Laboratory Measurement of Impact Sound Transmission through Floor-Ceiling Assemblies Using the Tapping Machine
801.3.3.1.1 (8.3.3.1.1)

ASTM—continued

E779—10 (2018)

Standard Test Method for Determining Air Leakage Rate by Fan Pressurization
1001.6 (10.6)

E972—96 (2013)

Standard Test Method for Solar Photometric Transmittance of Sheet Materials Using Sunlight
301.2 (3.2)

E1007—16

Test Method for Field Measurement of Tapping Machine Impact Sound Transmission through Floor-Ceiling Assemblies and Associated Support Structures
801.3.3.1.1 (8.3.3.1.1)

E1643—18a

Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs
801.3.4.1.1 (8.3.4.1.1)

E1745—17

Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs
801.3.4.1.1 (8.3.4.1.1)

E1827—11 (2017)

Standard Test Methods for Determining Airtightness of Building Using an Orifice Blower Door
1001.6 (10.6)

E1903—11

Standard Practice for Environmental Site Assessments: Phase II Environmental Site Assessment Process
301.2 (3.2)

E1918—16

Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-sloped Surfaces in the Field
501.3.5.4 (5.3.5.4)

E1980—11

Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-sloped Opaque Surfaces
501.3.5.4 (5.3.5.4)

E2399/E2399M—19

Standard Test Method for Maximum Media Density for Dead Load Analysis of Vegetative (Green) Roof Systems
501.3.5.5 (5.3.5.5)

E2843—17

Standard Specification for Demonstrating that a Building is in Walkable Proximity to Neighborhood Assets
501.3.1.1 (5.3.1.1)

E2844—15e1

Standard Specification for Demonstrating That a Building's Location Provides Access to Public Transit
501.3.1.1 (5.3.1.1)

E2921—16

Standard Practice for Minimum Criteria for Comparing Whole Building Life Cycle Assessments for Use with Building Codes and Rating Systems
901.5.1 (9.5.1)

BIFMA

Business and Institutional Furniture Manufacturer's Association
678 Front Avenue NW, Suite 150
Grand Rapids, MI 49504-5368

ANSI/BIFMA e3—2019

Furniture Sustainability Standard
801.4.2.5 (8.4.2.5), 901.4.1.4.3 (9.4.1.4.3)

ANSI/BIFMA M7.1—2011 (R2016)

Standard Test Method for Determining VOC Emissions from Office Furniture Systems, Components and Seating
801.4.2.5 (8.4.2.5), 801.5.2 (8.5.2)

ANSI/BIFMA X7.1—2011 (R2016)

Standard for Formaldehyde and TVOC Emissions of Low-Emitting Office Furniture Seating
801.4.2.5 (8.4.2.5)

BSI

BSI Customer Service
389 Chiswick High Road
London, W4 4AL, UK

BS EN 636:2012+A1:2015

Plywood—Specifications
801.4.2.4 (8.4.2.4)

CARB

California Air Resources Board
1001 "I" Street
P.O. Box 2815
Sacramento, CA 95812

CARB SCM for Architectural Coatings 2019

California Air Resources Board (ARB) Suggested Control Measure for Architectural Coatings
801.4.2.2 (8.4.2.2)

California Code of Regulations, Title 17, Sections 93120-93120.12

Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products
801.4.2.4 (8.4.2.4)

CDPH

California Department of Public Health
Indoor Air Quality Section
850 Marina Bay Parkway
Richmond, CA 94804

CDPH/EHLB/Standard Method V1.2 (2017)

Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers—Version 1.2
801.4.2 (8.4.2), 801.5.2 (8.5.2), Table 1001.7.2 (Table 10.7.2), Appendix D

CEC

California Energy Commission
1516 Ninth Street
Sacramento, CA 95814

2019 Title 24 Part 6, JA 10

Reference Appendices for the 2019 Building Energy Efficiency Standards. Joint Appendix JA10, Test Method for Measuring Flicker of Lighting Systems and Reporting Requirements
801.3.5.4 (8.3.5.4)

CEN

European Committee for Standardization
Avenue Marnix 17—B-1000
Brussels, Belgium

EN14500:2008

Blinds and shutters—Thermal and visual comfort—Test and calculation methods
801.3.8 (8.3.8)

CGSB

Canadian General Standards Board
Place du Portage III, 6B1
11 Laurier Street
Gatineau, Quebec K1A 1G6, Canada

CAN/CGSB 149.2019

Determination of the Airtightness of Building Envelopes by the Fan Depressurization Method
1001.6 (10.6)

CAN/CGSB 149.15-96

Determination of the Overall Envelope Airtightness of Buildings by the Fan Pressurization Method Using the Building's Air Handling Systems
1001.6 (10.6)

CITES

Convention on International Trade in Endangered Species of Wild Fauna and Flora
International Environment House
11 Chemin des Anémones
CH-1219 Châtelaine, Geneva, Switzerland

CITES-1973, amended 1979 and 1983

Convention on International Trade in Endangered Species of Wild Fauna and Flora
901.3.2 (9.3.2)

CPA

Composite Panel Association
19465 Deerfield Avenue, Suite 306
Leesburg, VA 20176

ANSI A208.1—2016

Particleboard
801.4.2.4 (8.4.2.4)

ANSI A208.2—2016

Medium Density Fiberboard (MDF) for Interior Applications
801.4.2.4 (8.4.2.4)

CRRC

Cooling Roof Rating Council
449 15th Street, Suite 400
Oakland, CA 94612

ANSI/CRRC S100—2020

Standard Test Methods for Determining Radiative Properties of Materials
501.3.5.4 (5.3.5.4)

CSA

Canadian Standards Association
178 Rexdale Blvd.
Toronto, ON, M9W 1R3, Canada

CAN/CSA 439—18

Standard Laboratory Methods of Test for Rating the Performance of Heat/Energy-Recovery Ventilators
701.4.3.6.3 (7.4.3.6.3)

CSA O121—17

Douglas Fir Plywood
801.4.2.4 (8.4.2.4)

CSA O151—17

Canadian Softwood Plywood
801.4.2.4 (8.4.2.4)

CSA O153—13 (R2017)

Poplar Plywood
801.4.2.4 (8.4.2.4)

CSA O325—16

Construction Sheathing
801.4.2.4 (8.4.2.4)

CTI

Cooling Technology Institute
PO Box 681807
Houston, TX 77268

CTI ATC-105 (19)

Acceptance Test Code for Water Cooling Towers
Appendix B

CTI ATC-105S (11)

Acceptance Test Code for Closed-Circuit Cooling Towers
Appendix B

CTI ATC-106 (11)

Acceptance Test Code for Mechanical Draft Evaporative Vapor Condensers
Appendix B

CTI STD-201RS (19)

Standard for the Certification of Water Cooling Tower Thermal Performance
Appendix B

DHA

Decorative Hardwoods Association
42777 Trade West Dr.
Sterling, VA 20166

ANSI/HPVA HP-1—2016

American National Standard for Hardwood and Decorative Plywood
801.4.2.4 (8.4.2.4)

Green-e

Green-e
c/o Center for Resource Solutions
1012 Torney Ave., Second Floor
San Francisco, CA 94129

Version 1.0, July 7, 2017

Green-e Framework for Renewable Energy Certification
1001.9.8 (10.9.8)

Version 2.8, April 1, 2016

Green-e Energy National Standard for Renewable Electricity Products
701.4.1.1 (7.4.1.1)

GS

Green Seal
1001 Connecticut Avenue, NW, Suite 827
Washington, DC 20036-5525

GS-36, 2.1, July 12, 2013

Standard for Adhesives for Commercial Use
801.4.2.1.2 (8.4.2.1.2)

GS-42, July 7, 2015

Standard for Commercial and Institutional Cleaning Services
1001.9.5 (10.9.5)

IA

Irrigation Association
8280 Willow Oaks Corporate Drive, Suite 400
Fairfax, VA 22031

Smart Water Application Technologies (SWAT) Climatologically Based Controllers, 8th Testing Protocol—September 2008

Smart Water Application Technologies (SWAT), Turf and Landscape Irrigation System Smart Controllers, Climatologically Based Controllers
301.2 (3.2), 601.3.1.2.2 (6.3.1.2.2)

IAPMO

International Association of Plumbing and Mechanical Officials
5001 East Philadelphia Street
Ontario, CA 91761

Z124.9—2004

Plastic Urinal Fixtures
601.3.2.1 (6.3.2.1)

ICC

International Code Council
500 New Jersey Ave NW # 300
Washington, DC 20001

2021 IBC

International Building Code®
101.3, 102.4, 102.6, 107.1

2021 IEBC

International Existing Building Code®
102.4, 102.6

2021 IECC

International Energy Conservation Code®
101.5.2, 102.4

2021 IFC

International Fire Code®
102.4, 102.6, 501.3.5.5 (5.3.5.5)

2021 IFGC

International Fuel Gas Code®

102.4

2021 IMC

International Mechanical Code®
102.4

2021 IPC

International Plumbing Code®
102.4, 601.3.5.3 (6.3.5.3)

2021 IPMC

International Property Maintenance Code®
102.4, 102.6

ICC—continued

2021 IRC

International Residential Code®
102.4

2021 ICC PC

International Code Council Performance Code for Buildings and Facilities®
102.4

IEC

International Electrotechnical Commission
IEC Regional Centre for North America (IEC-ReCNA)
446 Main Street, 16th Floor
Worcester, MA 01608

IEC EN 60034-30

Rotating Electrical Machines—Part 30-1: Efficiency Classes of Line Operated AC Motors (IE code)
701.4.7.6 (7.4.7.6)

IES

Illuminating Engineering Society
120 Wall Street, Floor 17
New York, NY 10005-4001

IDA/IES Model Lighting Ordinance

Model Lighting Ordinance (MLO)
501.3.6 (5.3.6)

LM-83—12

Approved Method: IES Spatial Daylight Autonomy (sDA) and Annual Sunlight Exposure (ASE)
301.2 (3.2), 801.5.1 (8.5.1)

TM-15—2011 including addendum "a"

Luminaire Classification System for Outdoor Luminaires
501.3.6.2 (5.3.6.2)

TM-30—2018

IES Method for Evaluating Light Source Color Rendition
801.3.5.3 (8.3.5.3)

ISO

International Organization for Standardization
ISO Central Secretariat
Chemin de Blandonnet 8
CP 401 - 1214 Vernier, Geneva, Switzerland

ISO-9972:2015

Thermal Performance of Buildings—Determination of Air Permeability of Buildings—Fan Pressurization Method

1001.6 (10.6)

ISO-13256-1:2017

Water-Source Heat Pumps—Testing and Rating for Performance—Part 1: Water-to-Air and Brine-to-Air Heat Pumps
Appendix B

ISO-13256-2:2017

Water-Source Heat Pumps—Testing and Rating for Performance—Part 2: Water-to-Water and Brine-to-Water Heat Pumps
Appendix B

ISO 14025:2006

Environmental Labels and Declarations—Type III Environmental Declarations—Principles and Procedures
901.4.1.4 (9.4.1.4)

ISO 14040:2006

Environmental Management—Life Cycle Assessment—Principles and Framework
901.4.1.4 (9.4.1.4)

ISO 14044:2006

Environmental Management—Life Cycle Assessment— Requirements and Guidelines
901.5.1 (9.5.1), 901.5.1.2 (9.5.1.2)

ISO-16890:2016

Air Filters for General Ventilation
801.3.1.3 (8.3.1.3)

ISO 21930:2017

Sustainability in Building and Civil Engineering Works—Core Rules for Environmental Product Declarations of Construction Products and Services
901.4.1.4 (9.4.1.4)

ISO/IEC-17025:2007

General Requirements for the Competence of Testing and Calibration Laboratories
801.4.2 (8.4.2)

ISO—continued

ISO/IEC 17065:2012

Conformity Assessment—Requirements for Bodies Certifying Products, Processes, and Services
801.4.2 (8.4.2)

ISO/IEC Guide 59:2019

ISO and IEC Recommended Practices for Standardization by National Bodies
901.4.1.3.1 (9.4.1.3.1)

LIHI

Low Impact Hydropower Institute
329 Massachusetts Avenue, Suite 6
Lexington, MA 02420

Version 2.03, December 20, 2018

Low Impact Hydropower Certification Handbook
701.4.3.1 (7.4.3.1)

NEMA

National Electrical Manufacturers Association
1300 North 17th Street, Suite 900
Rosslyn, VA 22209

ANSI/NEMA MG 1—2016 (with 2018 supplements)

Motors and Generators
701.4.3.1 (7.4.3.1)

NEMA 77—2017

Standard for Temporal Light Artifacts: Test Methods and Guidance for Acceptance Criteria
801.3.5.4 (8.3.5.4)

NEMA DC 3, Annex A—2013

Energy-Efficiency Requirements for Programmable Thermostats
701.4.7.4 (7.4.7.4)

NEMA SSL7A—2015

Phase-Cut Dimming for Solid State Lighting—Basic Compatibility
801.3.5.1 (8.3.5.1)

NFPA

National Fire Protection Association
1 Battery March Park
Quincy, MA 02169-7471

NFPA 70—2020

National Electrical Code
501.3.6.3 (5.3.6.3)

NFRC

National Fenestration Rating Council
6305 Ivy Lane, Suite 140
Greenbelt, MD 20770-6323

ANSI/NFRC 200—2020

Procedure for Determining Fenestration Product Solar Heat Gain Coefficients and Visible Transmittance at Normal Incidence
301.2 (3.2)

NIST

National Institute of Standards and Technology
100 Bureau Drive
Gaithersburg, MD 20899

PS 1—19

Voluntary Product Standard—Structural Plywood
801.4.2.4 (8.4.2.4)

PS 2—18

Voluntary Product Standard—Performance Standard for Wood-Based Structural-Use Panels
801.4.2.4 (8.4.2.4)

PS 20—15

American Softwood Lumber Standard
801.4.2.4 (8.4.2.4)

NSC

Natural Stone Council
P.O. Box 539
Hollis, NH 03049

NSC 373—2013

Sustainable Production of Natural Dimension Stone
901.4.1.4 (9.4.1.4)

NSF

NSF International
789 Dixboro Road
Ann Arbor, MI 48105

NSF/ANSI 44—2018

Residential Cation Exchange Water Softeners
601.3.5 (6.3.5)

NSF/ANSI 58—2017

Reverse Osmosis Drinking Water Treatment Systems
601.3.6 (6.3.6)

NSF/ANSI 140—2019

Sustainability Assessment for Carpet
901.4.1.4.3 (9.4.1.4.3)

NSF/ANSI 332—2015

Sustainability Assessment for Resilient Floor Coverings
901.4.1.4.3 (9.4.1.4.3)

NSF/ANSI 336—2018

Sustainability Assessment for Commercial Furnishings Fabric
901.4.1.4.3 (9.4.1.4.3)

NSF/ANSI 342—2019

Sustainability Assessment for Wallcovering Products
901.4.1.4.3 (9.4.1.4.3)

NSF/ANSI 347—2018

Sustainability Assessment for Single Ply Roofing Membranes
901.4.1.4.3 (9.4.1.4.3)

NSF/ANSI 350—2018

On-Site Residential and Commercial Water Reuse Systems
601.3.7 (6.3.7)

NZS

Standards New Zealand
Ministry of Business, Innovation & Employment
15 Stout Street, Wellington 6011

AS/NZS 2269.0:2012

Australian/NewZealand Standard: Plywood—Structural
801.4.2.4 (8.4.2.4)

SCAQMD

South Coast Air Quality Management District
California Air Resources Board
1001 “I” Street; P.O. Box 2815
Sacramento, CA 95812

SCAQMD Rule 1113r, Amended February 5, 2016

Architectural Coatings
801.4.2.2 (8.4.2.2)

SCAQMD Rule 1168, Amended October 6, 2017

Adhesive and Sealant Applications
801.4.2.1 (8.4.2.1)

TCNA

Tile Council of North America
100 Clemson Research Boulevard
Anderson, SC 29625

ANSI A138.1—2011

Standard Specifications for Sustainable Ceramic Tiles, Glass Tiles, and Tile Installation Materials
901.4.1.4.3 (9.4.1.4.3)

UL

Underwriters Laboratories Inc.
333 Pfingsten Road
Northbrook, IL 60062

UL 100—2016

Standard for Sustainability for Gypsum Boards and Panels
901.4.1.4.3 (9.4.1.4.3)

UL 102—2012

Standard for Sustainability for Door Leafs
901.4.1.4.3 (9.4.1.4.3)

UL 727—2018

Standard for Oil-Fired Central Furnaces
Appendix B

UL 731—2018

Standard for Oil-Fired Unit Heaters
Appendix B

UL 2854 (First edition, January 25, 2018)

Standard for Sustainability for Renewable Low-Impact Electricity Products
701.4.1.3 (7.4.1.3)

UL 2998 (2019)

Environmental Claim Validation Procedure (ECVP) for Zero Ozone Emissions from Air Cleaners
801.3.1.3 (8.3.1.3)

US Congress

United States Congress
Washington, DC 20515

EPAct 2005 HR6 Public Law 109-58

The Energy Policy Act (EPAct) of 2005
701.4.7.3 (7.4.7.3)

EISA 2007 HR6 Public Law 110-140

The Energy Independence and Security Act of 2007
701.4.7 (7.4.7)

USDA

United States Department of Agriculture
BioPreferred Program
1400 Independence Avenue, SW
Washington, DC 20250

7 CFR Part 3201

Guidelines for Designating Biobased Products for Federal Procurement
901.4.1.3 (9.4.1.3)

7 CFR Part 3202

Voluntary Labeling Program for Biobased Products
901.4.1.3 (9.4.1.3)

USDOE

United States Department of Energy
Energy Information Administration
Washington, DC 20585

10 CFR Part 430, App N

Uniform Test Method for Measuring the Energy Consumption of Furnaces
Appendix B

USEPA

United States Environmental Protection Agency
Ariel Rios Building
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Code of Federal Regulations, Title 40 Part 50 (40 CFR 50), as amended July 1, 2004

National Primary and Secondary Ambient Air Quality Standards
801.3.1.3 (8.3.1.3)

Code of Federal Regulations, Title 40 Part 770 (40 CFR 770), published December 12, 2016

Formaldehyde Standards for Composite Wood Products
801.4.2.4 (8.4.2.4)

EPA 420-F-07-063, November 2007

Green Vehicle Guide: Consider a SmartWay Vehicle Program—Requirements for Certified Passenger Vehicles
501.3.7 (5.3.7)

EPA 625/R-96/0106, January 1999

Compendium of Methods for the Determination of Toxic Organic Pollutants in Ambient Air, Sections TO-1, TO-11, TO-17
1001.7 (10.7)

February 16, 2012

NPDES General Permit for Stormwater Discharges From Construction Activities
1001.4.1 (10.4.1)

USEPA Method TO-17 (1999)

Determination of Volatile Organic Compounds in Ambient Air Using Active Sampling Onto Sorbent Tubes
801.4.2 (8.4.2)

Version 1.0, August 14, 2009

WaterSense Specification for Flushing Urinals
601.3.2.1 (6.3.2.1)

USEPA—continued

Version 1.0, October 1, 2007

WaterSense High-Efficiency Lavatory Faucet Specification
601.3.2.1 (6.3.2.1)

Version 1.0, November 3, 2011

WaterSense Specification for Weather-Based Irrigation Controllers
601.3.1.2 (6.3.1.2)

Version 1.0, December 23, 2016

ENERGY STAR Program Requirements for Connected Thermostat Products
701.4.7.4 (7.4.7.4)

Version 1.1, July 26, 2018

Water Sense Specification for Showerheads
601.3.2.1 (6.3.2.1)

Version 1.2, August 1, 2003

ENERGY STAR Program Requirements for Commercial Steam Cookers
701.4.7 (7.4.7)

Version 1.2, January 1, 2011

ENERGY STAR Program Requirements for Commercial Griddles
701.4.7 (7.4.7)

Version 1.2, June 2, 2014

Water Sense Tank-Type Toilet Specification

601.3.2.1 (6.3.2.1)

Version 2.0, February 1, 2013

ENERGY STAR Program Requirements for Commercial Dishwashers
601.3.2.5 (6.3.2.5), 701.4.7 (7.4.7)

Version 2.0, February 2, 2014

ENERGY STAR Program Requirements for Water Coolers
701.4.7 (7.4.7)

Version 2.0, January 1, 2019

ENERGY STAR Program Requirements for Uninterruptible Power Supplies
701.4.7 (7.4.7)

Version 2.0, July 7, 2020

ENERGY STAR Program Requirements for Room Air Cleaners
701.4.7 (7.4.7)

Version 2.0, October 1, 2011

ENERGY STAR Program Requirements for Hot Food Holding Cabinets
701.4.7 (7.4.7)

Version 2.1 June 20, 2017

ENERGY STAR Program Requirements for Lamps (Light Bulbs)
701.4.7 (7.4.7)

Version 2.2, August 15, 2019

ENERGY STAR Program Requirements for Luminaires
701.4.7.3 (7.4.7.3)

Version 2.2, October 7, 2015

ENERGY STAR Program Requirements for Commercial Ovens
701.4.7 (7.4.7)

Version 3.0, January 2, 2018

ENERGY STAR Program Requirements for Commercial Ice Makers
601.3.2.5 (6.3.2.5), 701.4.7 (7.4.7)

Version 3.0, May 1, 2013

ENERGY STAR Program Requirements for Audio and Video
701.4.7 (7.4.7)

Version 3.0, October 1, 2014

ENERGY STAR Program Requirements for Boilers
701.4.7 (7.4.7)

Version 3.0, October 1, 2014

ENERGY STAR Program Requirements for Telephony
701.4.7 (7.4.7)

Version 3.0, October 1, 2016

ENERGY STAR Program Requirements for Commercial Fryers
701.4.7 (7.4.7)

Version 3.0, October 11, 2019

ENERGY STAR Program Requirements for Imaging Equipment
701.4.7 (7.4.7)

Version 3.2, April 16, 2015

ENERGY STAR Program Requirements for Geothermal Heat Pumps
701.4.7 (7.4.7)

Version 3.2, April 16, 2015

ENERGY STAR Program Requirements for Residential Water Heaters
701.4.7 (7.4.7)

Version 4.0, April 29, 2020

ENERGY STAR Program Requirements for Refrigerated Beverage Vending Machines
701.4.7 (7.4.7)

Version 4.0, June 15, 2018

ENERGY STAR Program Requirements for Residential Ceiling Fans
701.4.7 (7.4.7)

Version 4.0, March 27, 2017

ENERGY STAR Program Requirements for Commercial Refrigerators and Freezers
701.4.7 (7.4.7)

USEPA—continued

Version 4.1, February 1, 2013

ENERGY STAR Program Requirements for Furnaces
701.4.7 (7.4.7)

Version 4.1, February 21, 2018

ENERGY STAR Specifications for Residential Ventilating Fans Eligibility Criteria
701.4.3.6.3 (7.4.3.6.3)

Version 4.1, October 1, 2015

ENERGY STAR Program Requirements for Residential Ventilating Fans
701.4.7 (7.4.7)

Version 4.1, October 26, 2015

ENERGY STAR Program Requirements and Criteria for Room Air Conditioners
701.4.7 (7.4.7)

Version 5.0, October 31, 2019

ENERGY STAR Program Requirements for Dehumidifiers
701.4.7 (7.4.7)

Version 5.0, September 15, 2014

ENERGY STAR Program Requirements for Refrigerators and Freezers
701.4.7 (7.4.7)

Version 5.0, September, 15, 2015

ENERGY STAR Program Requirements for ASHPs and Central Air Conditioners
701.4.7 (7.4.7)

Version 5.1, January 1, 2018

ENERGY STAR Program Requirements for Set-Top Boxes
701.4.7 (7.4.7)

Version 6.0, January 1, 2016

ENERGY STAR Program Requirements Product Specification for Residential Dishwashers
601.3.2.2 (6.3.2.2), 701.4.7 (7.4.7)

Version 7.1, November 16, 2018

ENERGY STAR Program Requirements for Computers
701.4.7 (7.4.7)

Version 8.0, February 5, 2018

ENERGY STAR Program Requirements for Clothes Washers
601.3.2.2 (6.3.2.2), 701.4.7 (7.4.7)

Version 8.0, January 28, 2020

ENERGY STAR Program Requirements for Displays
701.4.7 (7.4.7)

Version 8.0, March 1, 2019

ENERGY STAR Program Requirements for Televisions
701.4.7 (7.4.7)

WTO

World Trade Organization
Centre William Rappard
Rue de Lausanne 154
CH-1211 Geneva 21, Switzerland

WTO TBT—1994

WTO Technical Barriers to Trade (TBT) Agreement Annex 3 Code of Good Practice for the Preparation, Adoption and Application of Standards

901.4.1.3.1 (9.4.1.3.1)

INORMATIVE APPENDIX B

PRESCRIPTIVE EQUIPMENT EFFICIENCY TABLES FOR THE ALTERNATE REDUCED RENEWABLES AND INCREASED EQUIPMENT EFFICIENCY APPROACH IN SECTION 701.4.1.1 (7.4.1.1)

This is a normative appendix and is part of this code.

Informative Note: *The first 11 tables appear in I-P units and are followed by 11 tables in SI units.*

TABLE B101.1 (TABLE B-1)
ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS—MINIMUM EFFICIENCY REQUIREMENTS (I-P)
(SUPERSEDES TABLE 6.8.1-1 IN ANSI/ASHRAE/IES STANDARD 90.1)

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITIONS	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
Air conditioners, air cooled	< 65,000 Btu/h (one phase)	All	Split systems	15.0 SEER 12.5 EER	AHRI 210/240
			Single packaged	15.0 SEER 12.0 EER	
	< 65,000 Btu/h (three phase)	All	Split systems	15.0 SEER 12.5 EER	
			Single packaged	15.0 SEER 12.0 EER	
Through-the-*wall*, air cooled	< 3 0,000 Btu/h	All	Split systems	12.0 SEER	
			Single packaged	12.0 SEER	
Small duct, high velocity, air cooled	< 65,000 Btu/h (one phase)	All	Split systems	12.0 SEER	
Small duct, high velocity, air cooled	< 65,000 Btu/h (three phase)	All	Split systems	12.0 SEER	
Air conditioners, air cooled	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	Split systems and single package	12.2 EER 14.0 IEER	AHRI 340/360
		All other	Split systems and single package	12.0 EER 13.8 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)	Split systems and single package	12.2 EER 13.2 IEER	
		All other	Split systems and single package	12.0 EER 13.0 IEER	
	≥ 240,000 Btu/h and < 760,000 Btu/h	Electric resistance (or none)	Split systems and single package	10.8 EER 12.3 IEER	
		All other	Split systems and single package	10.6 EER 12.1 IEER	
	≥ 760,000 Btu/h	Electric resistance (or none)	Split systems and single package	10.4 EER 11.6 IEER	
		All other	Split systems and single package	10.2 EER 11.4 IEER	
Air conditioners, water cooled	< 65,000 Btu/h	All	Split systems and single package	14.0 EER 15.3 IEER	AHRI 210/240

	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	Split systems and single package	14.0 EER 15.3 IEER	AHRI 340/360
		All other	Split systems and single package	13.8 EER 15.1 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)	Split systems and single package	14.0 EER 14.8 IEER	
		All other	Split systems and single package	13.8 EER 14.6 IEER	
	≥ 240,000 Btu/h and < 760,000 Btu/h	Electric resistance (or none)	Split systems and single package	14.0 EER 14.8 IEER	
		All other	Split systems and single package	13.8 EER 14.6 IEER	
	≥ 760,000 Btu/h	Electric resistance (or none)	Split systems and single package	14.0 EER 14.8 IEER	
		All other	Split systems and single package	13.8 EER 14.6 IEER	
Air conditioners, evaporatively cooled	< 65,000 Btu/h	All	Split systems and single package	14.0 EER 15.3 IEER	AHRI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	Split systems and single package	14.0 EER 15.3 IEER	AHRI 340/360
		All other	Split systems and single package	13.8 EER 15.1 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)	Split systems and single package	14.0 EER 14.8 IEER	
		All other	Split systems and single package	13.8 EER 14.6 IEER	
	≥ 240,000 Btu/h and < 760,000 Btu/h	Electric resistance (or none)	Split systems and single package	14.0 EER 14.8 IEER	
		All other	Split systems and single package	13.8 EER 14.6 IEER	
	≥ 760,000 Btu/h	Electric resistance (or none)	Split systems and single package	14.0 EER 14.8 IEER	
		All other	Split systems and single package	13.8 EER 14.6 IEER	
Condensing units, air cooled	≥ 135,000 Btu/h			Not applicable match with indoor coil	AHRI 365
Condensing, water or evaporatively cooled	≥ 135,000 Btu/h			Not applicable match with indoor coil	

a. Chapter 11 (Section 11) contains a details on the referenced test procedures, including year and version of the test procedure.

TABLE B101.2 (TABLE B-2)
ELECTRICALLY OPERATED UNITARY AND APPLIED HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS (I-P)
(SUPERSEDES TABLE 6.8.1-2 IN ANSI/ASHRAE/IES STANDARD 90.1)

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITIONS	MINIMUM EFFICIENCY	TEST PROCEDURE[a]

Air conditioners, air cooled (cooling mode)	< 65,000 Btu/h (one phase)	All	Split systems	15.0 SEER 12.5 EER	AHRI 210/240
			Single packaged	15.0 SEER 12.0 EER	
	< 65,000 Btu/h (three phase)	All	Split systems	15.0 SEER 12.5 EER	
			Single packaged	15.0 SEER 12.0 EER	
Through-the-*wall*, air cooled (cooling mode)	< 30,000 Btu/h	All	Split systems	12.0 SEER	
			Single packaged	12.0 SEER	
Small duct high velocity, air cooled (cooling mode)	< 65,000 Btu/h (one phase)	All	Split systems	12.0 SEER	
	< 65,000 Btu/h (three phase)	All	Split systems	12.0 SEER	
Air conditioners, air cooled (cooling mode)	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	Split systems and single package	11.3 EER 12.3 IEER	AHRI 340/360
		All other	Split systems and single package	11.1 EER 12.1 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)	Split systems and single package	10.9 EER 11.9 IEER	
		All other	Split systems and single package	10.7 EER 11.7 IEER	
	≥ 240,000 Btu/h	Electric resistance (or none)	Split systems and single package	10.3 EER 10.9 IEER	
		All other	Split systems and single package	10.1 EER 10.7 IEER	
Water-to-air water loop (cooling mode)	< 17,000 Btu/h	All	86°F entering water	14.0 EER	ISO-13256-1
	≥ 17,000 Btu/h and < 65,000 Btu/h	All	86°F entering water	14.0 EER	
	> 65,000 Btu/h and < 135,000 Btu/h	All	86°F entering water	14.0 EER	
Water-to-air ground water (cooling mode)	< 135,000 Btu/h	All	59°F entering water	18.0 EER	
Water-to-air ground loop (cooling mode)	< 135,000 Btu/h	All	77°F entering water	14.1 EER	
Water-to-water water loop (cooling mode)	< 135,000 Btu/h	All	86°F entering water	10.6 EER	ISO-13256-2
Water-to-water groundwater (cooling mode)	< 135,000 Btu/h	All	59°F entering water	16.3 EER	
Brine-to-water ground loop (cooing mode)	<135,000 Btu/h	All	77°F entering water	12.1 EER	
		All	Split systems	9.00 HSPF	AHRI 210/240

Air conditioners, air cooled (heating mode)	< 65,000 Btu/h (cooling capacity) (one phase)		Single packaged	8.50 HSPF	
	< 65,000 Btu/h (cooling capacity) (three phase)	All	Split systems	9.00 HSPF	
			Single packaged	8.50 HSPF	
Through-the-*wall*, air cooled (heating mode)	< 30,000 Btu/h (cooling capacity)	All	Split systems	7.40 HSPF	AHRI 210/240
			Single packaged	7.40 HSPF	
Small-duct high velocity, air cooled (heating mode)	< 65,000 Btu/h (cooling capacity) (one phase)	All	Split systems	7.20 HSPF	
	< 65,000 Btu/h (cooling capacity) (three phase)	All	Split systems	7.20 HSPF	
Air cooled (heating mode)	≥ 65,000 Btu/h and < 135,000 Btu/h (cooling capacity)		47°F db/43°F wb *outdoor air*	3.40 COP_H	AHRI 340/360
			17°F db/15°F wb *outdoor air*	2.40 COP_H	
	≥ 135,000 Btu/h (cooling capacity)		47°F db/43°F wb *outdoor air*	3.20 COP_H	
			17°F db/15°F wb *outdoor air*	2.10 COP_H	
Water-to-air water loop (heating mode)	< 135,000 Btu/h (cooling capacity)		68°F entering water	4.60 COP_H	ISO-13256-1
Water-to-air groundwater (heating mode)	< 135,000 Btu/h (cooling capacity)		50°F entering water	3.70 COP_H	
Brine-to-air ground loop (heating mode)	< 135,000 Btu/h (cooling capacity)		32°F entering fluid	3.20 COP_H	
Water-to-water water loop (heating mode)	< 135,000 Btu/h (cooling capacity)		68°F entering water	3.70 COP_H	ISO-13256-2
Water-to-water groundwater (heating mode)	< 135,000 Btu/h (cooling capacity)		50°F entering water	3.10 COP_H	
Brine-to-water ground loop (heating mode)	< 135,000 Btu/h (cooling capacity)		32°F entering fluid	2.50 COP_H	

a. Chapter 11 (Section 11) contains details on the referenced test procedures, including year and version of the test procedure.

TABLE B101.3 (TABLE B-3)
ELECTRICALLY OPERATED SINGLE-PACKAGED VERTICAL AIR CONDITIONERS AND SINGLE-PACKAGED VERTICAL HEAT PUMPS AIR-CONDITIONER HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS (I-P)
(SUPERSEDES TABLE 6.8.1-4 IN ANSI/ASHRAE/IES STANDARD 90.1)

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
PTAC (cooling mode) standard size	All capacities	95°F db *outdoor air*	14.4 – (0.300 × Cap/1000)[c] EER	AHRI 310/380
PTAC (cooling mode) nonstandard size[b]	All capacities	95°F db *outdoor air*	10.9 – (0.213 × Cap/1000)[c] EER	AHRI 310/380
PTHP (cooling mode) standard size	All capacities	95°F db *outdoor air*	14.4 – (0.300 × Cap/1000)[c] EER	ARI 310/380
PTHP (cooling mode) nonstandard size[b]	< 7000 Btu/h	95°F db *outdoor air*	10.8 – (0.213 × Cap/1000)[c] EER	ARI 310/380
PTHP (heating mode) new constructions	All capacities	47°F db/43°F wb *outdoor air*	3.7 – (0.052 × Cap/1000)[c] COP_H	ARI 310/380
PTHP (heating mode) nonstandard size[b]	All capacities	47°F db/43°F wb *outdoor air*	2.9 – (0.026 × Cap/1000)[c] COP_H	ARI 310/380

a. Chapter 11 (Section 11) contains a complete specification of the referenced test procedures, including year version of the test procedure.
b. Replacement units shall 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 and having a cross-sectional area less than 670 $in.^2$.
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 B101.4 (TABLE B-4)
SINGLE-PACKAGED VERTICAL AIR CONDITIONERS, SINGLE-PACKAGED VERTICAL HEAT PUMPS, ROOM AIR CONDITIONERS, AND ROOM AIR-CONDITIONER HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS (I-P)
(SUPERSEDES TABLE 6.8.1-4 IN ANSI/ASHRAE/IES STANDARD 90.1)

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY BASE	MINIMUM EFFICIENCY CONNECTED[b]	TEST PROCEDURE[a]
SPVAC (cooling mode)	< 65,000 Btu/h	95°F db/75°F wb *outdoor air*	14.0 SEER		AHRI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	95°F db/75°F wb *outdoor air*	11.2 EER 12.9 IEER		AHRI 340/360
	≥ 135,000 Btu/h and < 240,000 Btu/h	95°F db/75°F wb *outdoor air*	11.0 EER 12.4 IEER		
SPVHP (cooling mode)	< 65,000 Btu/h	95°F db/75°F wb *outdoor air*	14.0 SEER		AHRI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	95°F db/75°F wb *outdoor air*	11.0 EER 12.2 IEER		AHRI 340/360
	≥ 135,000 Btu/h and < 240,000 Btu/h	95°F db/75°F wb *outdoor air*	10.6 EER 11.6 IEER		
SPVHP (heating mode)	< 65,000 Btu/h	47°F db/43°F wb *outdoor air*	8.0 HSPF		AHRI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	47°F db/43°F wb *outdoor air*	3.3 COP_H		AHRI 340/360
	≥ 135,000 Btu/h and < 240,000 Btu/h	47°F db/43°F wb *outdoor air*	3.2 COP_H		

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY BASE	MINIMUM EFFICIENCY CONNECTED[b]	TEST PROCEDURE[a]
Room air conditioners, with louvered sides	< 6,000 Btu/h		12.1 *CEER*	11.5 *CEER*	ANSI/AHAM RAC-1
	≥ 6,000 Btu/h and < 8,000 Btu/h		12.1 *CEER*	11.5 *CEER*	
	≥ 8,000 Btu/h and < 14,000 Btu/h		12.0 *CEER*	11.5 *CEER*	
	≥ 14,000 Btu/h and < 20,000 Btu/h		11.8 *CEER*	11.2 *CEER*	
	≥ 20,000 Btu/h and < 28,000 Btu/h		10.3 *CEER*	9.8 *CEER*	
	≥ 28,000 Btu/h		9.9 *CEER*	9.4 *CEER*	
Room air conditioners, without louvered sides	< 6,000 Btu/h		11.0 *CEER*	10.5 *CEER*	
	≥ 6,000 Btu/h and < 8,000 Btu/h		11.0 *CEER*	10.5 *CEER*	
	≥ 8,000 Btu/h and < 11,000 Btu/h		10.6 *CEER*	10.1 *CEER*	
	≥ 11,000 Btu/h and < 14,000 Btu/h		10.5 *CEER*	10.0 *CEER*	
	≥ 14,000 Btu/h and < 20,000 Btu/h		10.2 *CEER*	9.7 *CEER*	
	≥ 20,000 Btu/h		10.3 *CEER*	9.8 *CEER*	
Room air conditioner heat pump, with louvered sides	< 20,000 Btu/h		10.8 *CEER*	10.3 *CEER*	
	≥ 20,000 Btu/h		10.2 *CEER*	9.7 *CEER*	
Room air conditioner heat pump, without louvered sides	< 14,000 Btu/h		10.2 *CEER*	9.7 *CEER*	
	≥ 14,000 Btu/h		9.6 *CEER*	9.1 *CEER*	
Room air conditioner, casement only	All capacities		10.5 *CEER*	10.0 *CEER*	
Room air conditioner, casement-slider	All capacities		11.4 *CEER*	10.8 *CEER*	

a. Chapter 11 (Section 11) contains details for the referenced test procedure, including the referenced year version of the test procedure.
b. Connected room air conditioners that are connected to utility programs are allowed a lower *CEER* value but must be in compliance with and certified per EnergyStar version 4.0 requirements for connected equipment.

TABLE B101.5 (TABLE B-5)
WARM-AIR FURNACES AND COMBINATION WARM-AIR FURNACES/AIR-CONDITIONING UNITS, WARM-AIR DUCT FURNACES, AND UNIT HEATERS—MINIMUM EFFICIENCY REQUIREMENTS (I-P)
(SUPERSEDES TABLE 6.8.1-5 IN ANSI/ASHRAE/IES STANDARD 90.1)

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
Warm-air furnace, gas fired (weatherized)	< 225,000 Btu/h	Maximum capacity [c]	81% AFUE [b]	DOE 10 CFR Part 430 or Section 2.39, Thermal Efficiency, ANSI Z21.47
	≥ 225,000 Btu/h		80% E_t [d]	Section 2.39, Thermal Efficiency, ANSI Z21.47
Warm-air furnace, gas fired (nonweatherized)	< 225,000 Btu/h	Maximum capacity [c]	90% AFUE or 92% E_t [b, d]	DOE 10 CFR Part 430 or Section 2.39, Thermal Efficiency, ANSI Z21.47
	≥ 225,000 Btu/h		92% E_t [d]	Section 2.39, Thermal Efficiency, ANSI Z21.47
Warm-air furnace, oil fired (weatherized)	< 225,000 Btu/h	Maximum capacity [c]	78% AFUE [b, d]	DOE 10 CFR Part 430 or Section 42, Combustion, UL 727
	> 225,000 Btu/h		81% E_t [d]	Section 42, Combustion, UL 727
Warm-air furnaces, oil fired (nonweatherized)	< 225,000 Btu/h	Maximum capacity [c]	85% AFUE or 87% E_t [b, d]	DOE 10 CFR Part 430 or Section 42, Combustion, UL 727
	≥ 225,000 Btu/h		87% E_t [d]	Section 42, Combustion, UL 727
Warm-air duct furnace, gas fired (weatherized)	All capacities	Maximum capacity [c]	80% E_c [e]	Section 2.10, Efficiency, ANSI Z83.8
Warm-air duct furnace, gas fired (nonweatherized)	All capacities	Maximum capacity [c]	90% E_c [e]	Section 2.10, Efficiency, ANSI Z83.8
Warm-air unit heater, gas fired (nonweatherized)	All capacities	Maximum capacity [c]	80% E_c [e, f]	Section 2.10, Efficiency, ANSI Z83.8
Warm-air unit heater, oil fired (weatherized)	All capacities	Maximum capacity [c]	90% E_c [e, f]	Section 40, Combustion, UL 731

a. Chapter 11 (Section 11) contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
b. Combination units not covered by the US Department of Energy Code of Federal Regulations 10 CFR 430 (three-phase power or cooling capacity greater than or equal to 65,000 Btu/h) may comply with either rating.
c. Compliance of multiple firing rate units shall be at the maximum firing rate.
d. 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 *flue damper* for those furnaces where combustion air is drawn from the *conditioned space*.
e. E_c = combustion *efficiency* (100% less flue losses). See test procedure for detailed discussion.
f. As of August 8, 2008, according to the Energy Policy Act of 2005, units must also include an interrupted or intermittent ignition device (IID) and have either power venting or an *automatic flue damper*.

TABLE B101.6 (TABLE B-6)
GAS- AND OIL-FIRED BOILERS—MINIMUM EFFICIENCY REQUIREMENTS (I-P)
(SUPERSEDES TABLE 6.8.1-6 IN ANSI/ASHRAE/IES STANDARD 90.1)

EQUIPMENT TYPE[a]	SUBCATEGORY OR RATING CONDITION	SIZE CATEGORY (INPUT)	MINIMUM EFFICIENCY[b, c]	TEST PROCEDURE[g]
Boilers, hot water	Gas fired	< 300,000 Btu/h[h, i]	89% AFUE[f, h]	10 CFR Part 430
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h[d]	89% E_t[f]	10 CFR Part 431
		> 2,500,000 Btu/h[a]	91% E_c[f]	
	Oil fired[e]	< 300,000 Btu/h	89% AFUE[f]	10 CFR Part 430
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h[d]	85% E_t[f]	10 CFR Part 431
		> 2,500,000 Btu/h[a]	86% E_c[f]	
Boilers, steam	Gas fired	< 300,000 Btu/h[i]	80% AFUE	10 CFR Part 430
	Gas fired all except natural draft	≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h[d]	79% E_t	10 CFR Part 431
		> 2,500,000 Btu/h[a]	79% E_t	
	Gas fired natural draft	≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h[d]	77% E_t	
		> 2,500,000 Btu/h[a]	77% E_t	
	Oil fired[e]	< 300,000 Btu/h	82% AFUE	10 CFR Part 430
		≥ 300,000 Btu/h and ≤ 2,5000,000 Btu/h[d]	81% E_t	10 CFR Part 431
		> 2,500,000 Btu/h[a]	81% E_t	

a. These requirements apply to boilers with rated input of 8,000,000 Btu/h or less that are not packaged boilers and to all packaged boilers. Minimum efficiency requirements for boilers cover all capacities of packaged boilers.
b. E_c = thermal efficiency (100% less flue losses). See reference document for detailed information.
c. E_t = thermal efficiency. See reference document for detailed information.
d. Maximum capacity—minimum and maximum ratings as provided for and allowed by the unit's controls.
e. Includes oil fired (residual).
f. Systems shall be designed with lower operating return hot-water temperatures (< 130°F) and use hot-water reset to take advantage of the much higher efficiencies of condensing boilers.
g. Chapter 11 (Section 11) contains details for the referenced test procedure, including the referenced year version of the test procedure.
h. A boiler not equipped with a tankless domestic water-heating coil shall be equipped with an *automatic* means for adjusting the temperature of the water such that an incremental change in inferred heat load produces a corresponding incremental change in the temperature of the water supplied.
i. Boilers shall not be equipped with a continuous pilot ignition system.

TABLE B101.7 (TABLE B-7)
PERFORMANCE REQUIREMENTS FOR HEAT REJECTION EQUIPMENT—MINIMUM EFFICIENCY REQUIREMENTS (I-P)
(SUPERSEDES TABLE 6.8.1-7 IN ANSI/ASHRAE/IES STANDARD 90.1)

EQUIPMENT TYPE	TOTAL SYSTEM HEAT REJECTION CAPACITY AT RATED CONDITIONS	SUBCATEGORY OR RATING CONDITION[g]	PERFORMANCE REQUIRED [a, b, c, d, e, f, i]	TEST PROCEDURE[h]
Propeller or axial fan open-circuit cooling towers	All	95°F entering water 85°F leaving water 75°F entering wb	≥42.1 gpm/hp	CTI ATC-105 and CTI STD-201RS
Centrifugal fan open-circuit cooling towers	All	95°F entering water 85°F leaving water 75°F entering wb	≥22.0 gpm/hp	CTI ATC-105 and CTI STD-201RS
Propeller or axial fan closed-circuit cooling towers	All	102°F entering water 90°F leaving water 75°F entering wb	≥16.1 gpm/hp	CTI ATC-105S and CTI STD-201RS
Centrifugal fan closed-circuit cooling towers	All	102°F entering water 90°F leaving water 75°F entering wb	≥8.0 gpm/hp	CTI ATC-105S and CTI STD-201RS
Propeller or axial fan evaporative condensers	All	Ammonia test fluid 140°F entering gas temperature 96.3°F condensing temperature 75°F entering wb	≥134,000 Btu/h × hp	CTI ATC-106
Centrifugal fan evaporative condensers	All	Ammonia test fluid 140°F entering gas temperature 96.3°F condensing temperature 75°F entering wb	≥110,000 Btu/h × hp	CTI ATC-106
Propeller or axial fan evaporative condensers	All	R-507A test fluid 165°F entering gas temperature 105°F condensing temperature 75°F entering wb	≥157,000 Btu/h × hp	CTI ATC-106
Centrifugal fan evaporative condensers	All	R-507A test fluid 165°F entering gas temperature 105°F condensing temperature 75°F entering wb	≥135,000 Btu/h × hp	CTI ATC-106
Air-cooled condensers	All	190°F entering gas temperature 125°F condensing temperature 15°F subcooling 95°F entering wb	≥176,000 Btu/h × hp	AHRI 460

a. For purposes of this table, *open-circuit cooling tower performance* is defined as the water flow rating of the tower at the thermal rating condition listed in Table B101.7 (B-7) divided by the fan motor nameplate power.
b. For purposes of this table, *closed-circuit cooling tower performance* is defined as the process water flow rating of the tower at the thermal rating condition listed in Table B101.7 (B-7) divided by the sum of the fan motor nameplate power and the integral spray pump motor nameplate power.
c. For purposes of this table, *evaporative condenser performance* is defined as the heat rejected at the specified rating condition in the table divided by the sum of the fan motor nameplate power and the integral spray pump nameplate power.
d. For purposes of this table, *air-cooled condenser performance* is defined as the heat rejected from the refrigerant divided by the fan motor nameplate power.
e. The efficiencies and test procedures for both *open-* and *closed-circuit cooling towers* are not applicable to hybrid cooling towers that contain a combination of separate wet and dry heat exchange sections. The certification requirements do not apply to field erected cooling towers.
f. All cooling towers, closed-circuit coolers, evaporative condensers, and air-cooled condensers shall comply with the minimum efficiency listed in the table for that specific type of equipment with the capacity effect of any project specific accessories and/or options included with the equipment.
g. Requirements for evaporative condensers are listed with ammonia (R-717) and R-507A as test fluids in the table. Evaporative condensers intended for use with halocarbon refrigerants other than R-507A must meet the minimum efficiency requirements listed for R-507A as the test fluid.
h. Informative Appendix G contains information on the referenced test procedures.
i. Not applicable for air-cooled condensers applied to condenserless chillers. The air-cooled condenser and condenserless chiller shall comply with the requirements for air-cooled chillers as defined in ANSI/ASHRAE/IES Standard 90.1, Table 6.8.1-3.

TABLE B101.8 (TABLE B-8)
PERFORMANCE REQUIREMENTS FOR SERVICE WATER HEATING EQUIPMENT (I-P)
(SUPERSEDES TABLE 7.8 IN ANSI/ASHRAE/IES STANDARD 90.1)

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	RATED STORAGE VOLUME AND INPUT RATING (IF APPLICABLE)	DRAW PATTERN	PERFORMANCE REQUIRED[a]	TEST PROCEDURE[b]
Electric table-top water heaters[c]	≤12 kW	≥ 20 gal and ≤ 120 gal	Very small	UEF ≥ 0.6323 – 0.0058V	DOE 10 CFR Part 430
			Low	UEF ≥ 0.9188 – 0.0031V	
			Medium	UEF ≥ 0.9577 – 0.0023V	
			High	UEF ≥ 0.9844 – 0.0016V	
Electric resistance storage water heaters		≥ 20 gal and ≤ 55 gal	Very small	UEF ≥ 0.8808 – 0.0008V	DOE 10 CFR Part 430
			Low	UEF ≥ 0.9254 – 0.0003V	
			Medium	UEF ≥ 0.9307 – 0.0002V	
			High	UEF ≥ 0.9349 – 0.0001V	
		> 55 gal		Must use heat-pump water heater	
Electric resistance grid-enabled water heaters		> 75 gal	Very small	UEF ≥ 1.0136 – 0.0028V	DOE 10 CFR Part 430
			Low	UEF ≥ 0.09984 – 0.0014V	
			Medium	UEF ≥ 0.9853 – 0.0010V	
			High	UEF ≥ 0.9720 – 0.0007V	
Heat-pump water heaters		□ 55 gal		EF ≥ 2.00, FHR ≥ 50 gal	DOE 10 CFR Part 430
		> 55 gal		EF ≥ 2.20, FHR ≥ 50 gal	
Gas-fired storage water heaters	□75,000 Btu/h	□ 55 gal		EF ≥ 0.67, FHR ≥ 67 gal	DOE 10 CFR Part 430
		> 55 gal		EF ≥ 0.77, FHR ≥ 67 gal	
	>75,000 Btu/h	□ 140 gal		E_t ≥ 0.94 or EF ≥ 0.93 and SL ≤ 0.84 × (Q/800 + 110$\sqrt{V}$), Btu/h	ANSI Z21.10.3
Gas instantaneous water heaters	>50,000 Btu/h and <200,000 Btu/h[d]	≥ 4000 (Btu/h)/gal and < 2 gal		EF ≥ 0.90 and GPM ≥ 2.5 over a 77°F rise	DOE 10 CFR Part 430
	≥75,000 Btu/h[c]	□ 140 gal and ≥ 4,000 (Btu/h)/gal		E_t ≥ 0.94 or EF ≥ 0.93 SL = 0.84 × (Q/800 + 110$\sqrt{V}$), Btu/h	ANSI Z21.10.3
Oil storage water heaters	≤105,000 Btu/h	□ 50 gal	Very small	EF = 0.2509 – 0.0012V	DOE 10 CFR Part 430
			Low	EF = 0.5330 – 0.0016V	
			Medium	EF = 0.6078 – 0.0016V	
			High	EF = 0.6815 – 0.0014V	
	>105,000 Btu/h	< 4,000 (Btu/h)/gal		E_t ≥ 80% and SL ≤ (Q/800 + 110$\sqrt{V}$), Btu/h	ANSI Z21.10.3
Oil instantaneous water heaters	□210,000 Btu/h	□ 50 gal		EF ≥ 0.59 – 0.0019V	DOE 10 CFR Part 430
	>210,000 Btu/h	≥ 4,000 (Btu/h)/gal and < 10 gal		E_t ≥ 80%	ANSI Z21.10.3
	>210,000 Btu/h	≥ 4,000 (Btu/h)/gal and ≥ 10 gal		E_t ≥ 78% and SL ≤ (Q/800 +110$\sqrt{V}$), Btu/h	
Solar water heater		Electric backup		SEF ≥ 1.8	ANSI Z21.10.3
		Gas backup		SEF ≥ 1.2	

Hot-water supply boilers, gas and oil	>300,000 Btu/h and □12,500,000 Btu/h	≥ 4,000 (Btu/h)/gal and < 10 gal		E_t ≥ 80%	ANSI Z21.10.3
Hot-water supply boilers, gas		≥ 4.000 (Btu/h)/gal and ≥ 10 gal		E_t ≥ 80% SL ≤ (Q/800 + 110$\sqrt{V}$), Btu/h	ANSI Z21.10.3
Hot-water supply boilers, oil		≥ 4,000 (Btu/h)/gal and ≥ 10 gal		E_t ≥ 78% SL ≤ (Q/800 + 110$\sqrt{V}$), Btu/h	
Pool heaters, gas	All sizes			E_t ≥ 82%	ASHRAE 146
Pool heaters, oil	All sizes			E_t ≥ 78%	ASHRAE 146
Heat-pump pool heaters	All sizes	50°F db 44.2°F wb outdoor air 80.0°F entering water		≥ 4.0 COP	AHRI 1180
Unfired storage tanks	All sizes			≥ R-12.5	None

a. Energy factor (EF) and thermal efficiency (Et) 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. Chapter 11 (Section 11) contains details on the referenced test procedures, including the year/version of the referenced test procedure.
c. Section G.1 is titled "Test Method for Measuring Thermal Efficiency," and Section G.2 is titled "Test Method for Measuring Standby Loss."
d. UEF is the Uniform Energy Factor and is a dimensionless number that is calculated per DOE 10 CFR Part 430 test procedures.

TABLE B101.9 (TABLE B-9)
COMMERCIAL CLOTHES WASHERS (I-P)

PRODUCT	MEF[a]	WF[b], gal/ft^3
All commercial clothes washers	1.72	4.0

a. MEF = modified energy factor, a combination of energy factor and remaining moisture content. MEF measures energy consumption of the total laundry cycle (washing and drying). It indicates how many cubic feet of laundry can be washed and dried with one kWh of electricity; the higher the number, the greater the efficiency.
b. *WF = water factor* (in gal/ft^3).

TABLE B101.10 (TABLE B-10)
ELECTRICALLY OPERATED VARIABLE-REFRIGERANT-FLOW (VRF) AIR CONDITIONERS—MINIMUM EFFICIENCY REQUIREMENTS (I-P)
(SUPERSEDES TABLE 6.8.1-9 IN ANSI/ASHRAE/IES STANDARD 90.1)

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
VRF air conditioners, air cooled	< 65,000 Btu/h	All	VRF multisplit system	15.0 SEER 12.5 EER	AHRI 1230
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	VRF multisplit system	11.7 EER 14.9 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system	11.7 EER 14.4 IEER	
	≥ 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system	10.5 EER 13.0 IEER	

a. Chapter 11 (Section 11) contains details for the referenced test procedure, including year version of the test procedure.

TABLE B101.11 (TABLE B-11)
ELECTRICALLY OPERATED VARIABLE-REFRIGERANT-FLOW AND APPLIED HEAT PUMP—MINIMUM EFFICIENCY REQUIREMENTS (I-P)
(SUPERSEDES TABLE 6.8.1-10 IN ANSI/ASHRAE/IES STANDARD 90.1)

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
VRF air cooled (cooling mode)	< 65,000 Btu/h	All	VRF multisplit system	15.0 SEER 12.5 EER	AHRI 1230
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	VRF multisplit system	11.3 EER 14.6 IEER	
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	VRF multisplit system with heat recovery	11.1 EER 14.4 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system	10.9 EER 13.9 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system with heat recovery	10.7 EER 13.7 IEER	
	≥ 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system	10.3 EER 12.7 IEER	
	≥ 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system with heat recovery	10.1 EER 12.5 IEER	
VRF water source (cooling mode)	< 65,000 Btu/h	All	VRF multisplit systems 86°F entering water	14.0 EER 16.0 IEER	AHRI 1230
	< 65,000 Btu/h	All	VRF multisplit systems with heat recovery 86°F entering water	13.8 EER 15.8 IEER	
	≥ 65,000 Btu/h and < 135,000 Btu/h	All	VRF multisplit system 86°F entering water	14.0 EER 16.0 IEER	
	≥ 65,000 Btu/h and < 135,000 Btu/h	All	VRF multisplit system with heat recovery 86°F entering water	13.8 EER 15.8 IEER	
	≥ 135,000 Btu/h	All	VRF multisplit system 86°F entering water	11.6 EER 14.0 IEER	
	≥ 135,000 Btu/h	All	VRF multisplit system with heat recovery 86°F entering water	11.2 EER 13.8 IEER	
VRF groundwater source (cooling mode)	< 135,000 Btu/h	All	VRF multisplit system 59°F entering water	16.2 EER	AHRI 1230
	< 135,000 Btu/h	All	VRF multisplit system with heat recovery 59°F entering water	16.0 EER	
	≥ 135,000 Btu/h	All	VRF multisplit system 59°F entering water	13.8 EER	
	≥ 135,000 Btu/h	All	VRF multisplit system with heat recovery 59°F entering water	13.6 EER	
VRF ground source (cooling mode)	< 135,000 Btu/h	All	VRF multisplit system 77°F entering water	13.4 EER	AHRI 1230
	< 135,000 Btu/h	All	VRF multisplit system with heat recovery 77°F entering water	13.2 EER	
	≥ 135,000 Btu/h	All	VRF multisplit system 77°F entering water	11.0 EER	
	≥ 135,000 Btu/h	All	VRF multisplit system with heat recovery 77°F entering water	10.8 EER	

VRF air cooled (heating mode)	< 65,000 Btu/h (cooling capacity)		VRF multisplit system	8.5 HSPF	AHRI 1230
	≥ 65,000 Btu/h and < 135,000 Btu/h (cooling capacity)		VRF multisplit system 47°F db/43°F wb *outdoor air*	3.40 COP_H	
			17°F db/15°F wb *outdoor air*	2.40 COP_H	
	≥ 135,000 Btu/h (cooling capacity)		VRF multisplit system 47°F db/43°F wb *outdoor air*	3.20 COP_H	
			17°F db/15°F wb *outdoor air*	2.10 COP_H	
VRF water source (heating mode)	< 135,000 Btu/h (cooling capacity)		VRF multisplit system 68°F entering water	4.60 COP_H	AHRI 1230
	≥ 135,000 Btu/h (cooling capacity)		VRF multisplit system 68°F entering water	4.20 COP_H	
VRF groundwater source (heating mode)	< 135,000 Btu/h (cooling capacity)		VRF multisplit system 50°F entering water	3.60 COP_H	AHRI 1230
	≥ 135,000 Btu/h (cooling capacity)		VRF multisplit system 50°F entering water	3.30 COP_H	
VRF ground source (heating mode)	< 135,000 Btu/h (cooling capacity)		VRF multisplit system 32°F entering fluid	3.10 COP_H	AHRI 1230
	≥ 135,000 Btu/h (cooling capacity)		VRF multisplit system 32°F entering fluid	2.80 COP_H	

a. Chapter 11 (Section 11) contains details for the referenced test procedure, including year version of the test procedure.

Informative Note: These tables are the same as Tables B101.1–B101.11 but are provided in SI units.

TABLE B101.1 (TABLE B-1)
ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS—MINIMUM EFFICIENCY REQUIREMENTS (SI)
(SUPERSEDES TABLE 6.8.1-1 IN ANSI/ASHRAE/IES STANDARD 90.1)

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITIONS	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
Air conditioners, air cooled	< 19 kW (one phase)	All	Split systems	4.40 $SCOP_C$ 3.66 COP_C	AHRI 210/240
			Single packaged	4.40 $SCOP_C$ 3.52 COP_C	
	< 19 kW (three phase)	All	Split systems	4.40 $SCOP_C$ 3.52 COP_C	
			Single packaged	4.10 $SCOP_C$ 3.40 COP_C	
Through-the-*wall*, air cooled	< 9 kW	All	Split systems	3.52 $SCOP_C$	
			Single packaged	3.52 $SCOP_C$	
Small duct, high velocity, air cooled	< 19 kW (one phase)	All	Split systems	3.52 $SCOP_C$	
	< 19 kW (three phase)	All	Split systems	3.52 $SCOP_C$	
Air conditioners air cooled	≥ 19 kW and < 40 kW	Electric resistance (or none)	Split systems and single package	3.58 COP_C 4.10 $ICOP_C$	ARI 340/360
		All other	Split systems and single package	3.52 COP_C 4.04 $ICOP_C$	
	≥ 40 kW and < 70 kW	Electric resistance (or none)	Split systems and single package	3.58 COP_C 3.87 $ICOP_C$	
		All other	Split systems and single package	3.52 COP_C 3.81 $ICOP_C$	
	≥ 70 kW and < 223 kW	Electric resistance (or none)	Split systems and single package	3.17 COP_C 3.60 $ICOP_C$	
		All other	Split systems and single package	3.11 COP_C 3.55 $ICOP_C$	
	≥ 223 kW	Electric resistance (or none)	Split systems and single package	3.05 COP_C 3.40 $ICOP_C$	
		All other	Split systems and single package	2.99 COP_C 3.34 $ICOP_C$	
Air conditioners, water cooled	< 19 kW	All	Split systems and single package	4.10 COP_C	AHRI 210/240
			Split systems and single package	4.48 $ICOP_C$	
	≥ 19 kW and < 140 kW	Electric resistance (or none)	Split systems and single package	4.10 COP_C 4.48 $ICOP_C$	AHRI 340/360
		All other	Split systems and single package	4.04 COP_C 4.43 $ICOP_C$	
	≥ 40 kW and < 70 kW	Electric resistance (or none)	Split systems and single package	4.10 COP_C 4.34 $ICOP_C$	
		All other	Split systems and single package	4.04 COP_C 4.28 $ICOP_C$	

	≥ 70 kW and < 223 kW	Electric resistance (or none)	Split systems and single package	4.10 COP_C 4.34 $ICOP_C$	
		All other	Split systems and single package	3.99 COP_C 4.28 $ICOP_C$	
	≥ 223 kW	Electric resistance (or none)	Split systems and single package	4.10 COP_C 4.34 $ICOP_C$	
		All other	Split systems and single package	4.04 COP_C 4.28 $ICOP_C$	
Air conditioners, evaporatively cooled	< 19 kW	All	Split systems and single package	4.10 COP_C 4.48 $ICOP_C$	AHRI 210/240
	≥ 19 kW and < 140 kW	Electric resistance (or none)	Split systems and single package	4.10 COP_C 4.48 $ICOP_C$	AHRI 340/360
		All other	Split systems and single package	4.04 COP_C 4.43 $ICOP_C$	
	≥ 40 kW and < 70 kW	Electric resistance (or none)	Split systems and single package	3.96 COP_C 4.19 $ICOP_C$	
		All other	Split systems and single package	3.90 COP_C 4.13 $ICOP_C$	
	≥ 70 kW and < 223 kW	Electric resistance (or none)	Split systems and single package	3.96 COP_C 4.19 $ICOP_C$	
		All other	Split systems and single package	3.90 COP_C 4.13 $ICOP_C$	
	≥ 223 kW	Electric resistance (or none)	Split systems and single package	3.96 COP_C 4.19 $ICOP_C$	
		All other	Split systems and single package	3.90 COP_C 4.13 $ICOP_C$	
Condensing units, air cooled	≥ 40 kW			Not applicable match with indoor coil	AHRI 365
Condensing, water or evaporatively cooled	40 kW			Not applicable match with indoor coil	

a. Chapter 11 (Section 11) contains a details on the referenced test procedures, including year and version of the test procedure.

Informative Note:

TABLE B101.2 (TABLE B-2)
ELECTRICALLY OPERATED UNITARY AND APPLIED HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS (SI)
(SUPERSEDES TABLE 6.8.1-2 IN ANSI/ASHRAE/IES STANDARD 90.1)

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITIONS	MINIMUM EFFICIENCY	TEST PROCEDURE [a]
Air conditioners, air cooled (cooling mode)	< 19 kW (one phase)	All	Split systems	4.40 $SCOP_C$ 3.66 COP_C	AHRI 210/240
			Single packaged	4.40 $SCOP_C$ 3.52 COP_C	
	< 19 kW (three phase)	All	Split systems	4.40 $SCOP_C$ 3.66 COP_C	
			Single packaged	4.40 $SCOP_C$ 3.52 COP_C	
	< 9 kW	All	Split systems	3.52 $SCOP_C$	

Through-the-*wall*, air cooled (cooling mode)			Single packaged	3.52 $SCOP_C$	
Small duct high velocity, air cooled (cooling mode)	< 19 kW (one phase)	All	Split systems	3.52 $SCOP_C$	
	< 19 kW (three phase)	All	Split systems	3.52 $SCOP_C$	
Air conditioners, air cooled (cooling mode)	≥ 19 kW and < 40 kW	Electric resistance (or none)	Split systems and single package	3.31 COP_C 3.60 $ICOP_C$	AHRI 340/360
		All other	Split systems and single package	3.25 COP_C 3.55 $ICOP_C$	
	≥ 40 kW and < 70 kW	Electric resistance (or none)	Split systems and single package	3.19 COP_C 3.40 $ICOP_C$	
		All other	Split systems and single package	3.14 COP_C 3.34 $ICOP_C$	
	≥ 70 kW	Electric resistance (or none)	Split systems and single package	3.02 COP_C 3.11 $ICOP_C$	
		All other	Split systems and single package	2.96 COP_C 3.05 $ICOP_C$	
Water-to-air water loop (cooling mode)	< 5 kW	All	30°C entering water	4.10 COP_C	ISO-13256-1
	≥ 5 kW and < 19kW	All	30°C entering water	4.10 COP_C	
	> 19kW and < 40 kW	All	30°C entering water	4.10 COP_C	
Water-to-air ground water (cooling mode)	< 40 kW	All	15°C entering water	5.28 COP_C	
Water-to-air ground loop (cooling mode)	< 40 kW	All	25°C entering water	4.13 COP_C	
Water-to-water water loop (cooling mode)	< 40 kW	All	30°C entering water	3.11 COP_C	ISO-13256-2
Water-to-water groundwa-ter (cooling mode)	< 40 kW	All	15°C entering water	4.78 COP_C	
Brine-to-water ground loop (cooing mode)	< 40 kW	All	30° C entering water	3.55 COP_C	
Air conditioners, air cooled (heating mode)	< 19kW (cooling capacity) (one phase)	All	Split systems	2.49 COP_H	AHRI 210/240
			Single packaged	2.40 COP_H	
	< 19kW (cooling capacity) (three phase)	All	Split systems	2.49 COP_H	
			Single packaged	2.40 COP_H	
Through-the-*wall*, air cooled (heating mode)	< 9 kW (cooling capacity)	All	Split systems	2.17 COP_H	AHRI 210/240
			Single packaged	2.17 COP_H	
Small-duct high velocity, air cooled (heating mode)	< 19kW (cooling capacity) (one phase)	All	Split systems	2.11 COP_H	
	< 19kW (cooling capacity) (three phase)	All	Split systems	2.11 COP_H	
Air cooled (heating mode)			8.3°C db/6.1°C wb *outdoor air*	3.40 COP_H	AHRI 340/360

	≥ 19kW and < 40 kW (cooling capacity)		–8.3°C db/9.4°C wb *outdoor air*	2.40 COP_H	
	≥ 40 kW (cooling capacity)		8.3°C db/6.1°C wb *outdoor air*	3.20 COP_H	
			–8.3°C db/9.4°C wb *outdoor air*	2.10 COP_H	
Water-to-air water loop (heating mode)	< 40 kW (cooling capacity)		20°C entering water	4.60 COP_H	ISO-1356-1
Water-to-air groundwater (heating mode)	< 40 kW (cooling capacity)		10°C entering water	3.70 COP_H	
Brine-to-air ground loop (heating mode)	< 40 kW (cooling capacity)		0°C entering fluid	3.20 COP_H	
Water-to-water water loop (heating mode)	< 40 kW (cooling capacity)		20°C entering water	3.70 COP_H	ISO-13256-2
Water-to-water groundwater (heating mode)	< 40 kW (cooling capacity)		10°C entering water	3.10 COP_H	
Brine-to-water ground loop (heating mode)	< 40 kW (cooling capacity)		0°C entering fluid	2.50 COP_H	

a. Chapter 11 (Section 11) contains details on the referenced test procedures, including year and version of the test procedure.

TABLE B101.3 (TABLE B-3)
ELECTRICALLY OPERATED SINGLE-PACKAGED VERTICAL AIR CONDITIONERS AND SINGLE-PACKAGED VERTICAL HEAT PUMPS AIR-CONDITIONER HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS (SI)
(SUPERSEDES TABLE 6.8.1-4 IN ANSI/ASHRAE/IES STANDARD 90.1)

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE [a]
PTAC (cooling mode) standard size	All capacities	35°C db *outdoor air*	4.22 – (0.300 × Cap/1000)[c] COP_C	AHRI 310/380
PTAC (cooling mode) nonstandard size[b]	All capacities	35°C db *outdoor air*	3.19 – (0.213 × Cap/1000)[c] COP_C	AHRI 310/380
PTHP (cooling mode) standard size	All capacities	35°C db *outdoor air*	4.22 – (0.300 × Cap/1000)[c] COP_C	ARI 310/380
PTHP (cooling mode) nonstandard size[b]	< 7,000 Btu/h	35°C db *outdoor air*	3.16 – (0.213 × Cap/1000)[c] COP_C	ARI 310/380
PTHP (heating mode) new constructions	All capacities	8.3°C db/6.1°C wb *outdoor air*	3.7 – (0.052 × Cap/1000)[c] COP_H	ARI 310/380
PTHP (heating mode) nonstandard size[b]	All capacities	8.3°C db/6.1°C wb *outdoor air*	2.9 – (0.026 × Cap/1000)[c] COP_H	ARI 310/380

a. Chapter 11 (Section 11) contains a complete specification of the referenced test procedures, including year version of the test procedure.

b. Replacement units shall 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 0.45 m. high and less than 1.0 m. wide and having a cross-sectional area less than 0.43 m^2.

c. "Cap" means the rated cooling capacity of the product in Btu/h. If the unit's capacity is less than 2.1 kW, use 2.1 kW in the calculation. If the unit's capacity is greater than 4.4 kW, use 4.4 kW in the calculation.

TABLE B101.4 (TABLE B-4)
SINGLE-PACKAGED VERTICAL AIR CONDITIONERS, SINGLE-PACKAGED VERTICAL HEAT PUMPS, ROOM AIR CONDITIONERS, AND ROOM AIR-CONDITIONER HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS (SI)
(SUPERSEDES TABLE 6.8.1-4 IN ANSI/ASHRAE/IES STANDARD 90.1)

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY BASE	MINIMUM EFFICIENCY CONNECTED[b]	TEST PROCEDURE[a]
SPVAC (cooling mode)	< 19 kW	35°C db/23.9°C wb *outdoor air*	4.10 $SCOP_C$		AHRI 210/240
	≥ 19 kW and < 40 kW	35°C db/23.9°C wb *outdoor air*	3.28 COP_C 3.78 $ICOP_C$		AHRI 340/360
	≥ 40 kW and < 70 kW	35°C db/23.9°C wb *outdoor air*	3.22 COP_C 3.63 $ICOP_C$		
SPVHP (cooling mode)	< 19 kW	35°C db/23.9°C wb *outdoor air*	4.10 $SCOP_C$		AHRI 210/240
	≥ 19 kW and < 40 kW	35°C db/23.9°C wb *outdoor air*	3.22 COP_C 3.58 $ICOP_C$		AHRI 340/360
	≥ 40 kW and < 70 kW	35°C db/23.9°C wb *outdoor air*	3.11 COP_C 3.40 $ICOP_C$		
SPVHP (heating mode)	< 19 kW	8.3°C db/6.1°C wb *outdoor air*	2.34 $SCOP_H$		AHRI 210/240
	≥ 19 kW and < 40 kW	8.3°C db/6.1°C wb *outdoor air*	3.30 COP_H		AHRI 340/360
	≥ 40 kW and < 70 kW	8.3°C db/6.1°C wb *outdoor air*	3.2 COP_H		
Room air conditioners, with louvered sides	< 1.8 kW		3.55 $CCOP_C$	3.37 $CCOP_C$	ANSI/AHAM RAC-1
	≥ 1.8 kW and < 2.3 kW		3.55 $CCOP_C$	3.37 $CCOP_C$	
	≥ 2.3 kW and < 4.1 kW		3.52 $CCOP_C$	3.37 $CCOP_C$	
	≥ 4.1 kW and < 5.9 kW		3.46 $CCOP_C$	3.28 $CCOP_C$	
	≥ 5.9 kW and < 8.2 kW		3.02 $CCOP_C$	2.87 $CCOP_C$	
	≥ 8.2 kW		2.90 $CCOP_C$	2.75 $CCOP_C$	
Room air conditioners, without louvered sides	< 1.8 kW		3.22 $CCOP_C$	3.08 $CCOP_C$	
	≥ 1.8 kW and < 2.3 kW		3.22 $CCOP_C$	3.08 $CCOP_C$	
	≥ 2.3 kW and < 3.2 kW		3.11 $CCOP_C$	2.96 $CCOP_C$	
	≥ 3.2 kW and < 4.1 kW		3.08 $CCOP_C$	2.93 $CCOP_C$	
	≥ 4.1 kW and < 5.9 kW		2.99 $CCOP_C$	2.84 $CCOP_C$	
	≥ 5.9 kW		3.02 $CCOP_C$	2.87 $CCOP_C$	
Room air conditioner heat pump, with louvered sides	< 5.9 kW		3.17 $CCOP_C$	3.02 $CCOP_C$	
	≥ 5.9 kW		2.99 $CCOP_C$	2.84 $CCOP_C$	
Room air conditioner heat pump, without louvered sides	< 4.1 kW		2.99 $CCOP_C$	2.84 $CCOP_C$	
	≥ 4.1 kW		2.81 $CCOP_C$	2.67 $CCOP_C$	
Room air conditioner, casement only	All capacities		3.08 $CCOP_C$	2.93 $CCOP_C$	
Room air conditioner, casement-slider	All capacities		3.34 $CCOP_C$	3.17 $CCOP_C$	

a. Chapter 11 (Section 11) contains details for the referenced test procedure, including the referenced year version of the test procedure.
b. Connected room air conditioners that are connected to utility programs are allowed a lower *CEER* value but must be in compliance with and certified per ENERGY STAR version 4.0 requirements for connected equipment.

TABLE B101.5 (TABLE B-5)
WARM-AIR FURNACES AND COMBINATION WARM-AIR FURNACES/AIR-CONDITIONING UNITS, WARM-AIR DUCT FURNACES, AND UNIT HEATERS—MINIMUM EFFICIENCY REQUIREMENTS (SI)
(SUPERSEDES TABLE 6.8.1-5 IN ANSI/ASHRAE/IES STANDARD 90.1)

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
Warm-air furnace, gas fired (weatherized)	< 65.9 kW	Maximum capacity [c]	78% AFUE or 80% E_t [b, d]	DOE 10 CFR Part 430 or Section 2.39, Thermal Efficiency, ANSI Z21.47
	≥ 65.9 kW		80% E_t [d]	Section 2.39, Thermal Efficiency, ANSI Z21.47
Warm-air furnace, gas fired (nonweatherized)	< 65.9 kW	Maximum capacity [c]	90% AFUE or 92% E_t [b, d]	DOE 10 CFR Part 430 or Section 2.39, Thermal Efficiency, ANSI Z21.47
	≥ 65.9 kW		92% E_t [d]	Section 2.39, Thermal Efficiency, ANSI Z21.47
Warm-air furnace, oil fired (weatherized)	< 65.9 kW	Maximum capacity [c]	78% AFUE or 80% E_t [b, d]	DOE 10 CFR Part 430 or Section 42, Combustion, UL 727
	> 65.9 kW		81% E_t [d]	Section 42, Combustion, UL 727
Warm-air furnace, oil fired (nonweatherized	< 65.9 kW	Maximum capacity [c]	85% AFUE or 87% E_t [b, d]	DOE 10 CFR Part 430 or Section 42, Combustion, UL 727
	≥ 65.9 kW		87% E_t [d]	Section 42, Combustion, UL 727
Warm-air duct furnaces, gas fired (weatherized)	All capacities	Maximum capacity [c]	80% E_c [e]	Section 2.10, Efficiency, ANSI Z83.8
Warm-air duct furnaces, gas fired (nonweatherized)	All capacities	Maximum capacity [c]	90% E_c [e]	Section 2.10, Efficiency, ANSI Z83.8
Warm-air unit heaters, gas fired (nonweatherized)	All capacities	Maximum capacity [c]	80% E_c [e, f]	Section 2.10, Efficiency, ANSI Z83.8
Warm-air unit heaters, oil fired (weatherized)	All capacities	Maximum capacity [c]	90% E_c [e, f]	Section 40, Combustion, UL 731

a. Chapter 11 (Section 11) contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
b. Combination units not covered by the US Department of Energy Code of Federal Regulations 10 CFR 430 (three-phase power or cooling capacity greater than or equal to 19 kW) may comply with either rating.
c. Compliance of multiple firing rate units shall be at the maximum firing rate.
d. 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 *flue damper* for those furnaces where combustion air is drawn from the *conditioned space*.
e. E_c = combustion *efficiency* (100% less flue losses). See test procedure for detailed discussion.
f. As of August 8, 2008, according to the Energy Policy Act of 2005, units must also include an interrupted or intermittent ignition device (IID) and have either power venting or an *automatic flue damper*.

TABLE B101.6 (TABLE B-6)
GAS- AND OIL-FIRED BOILERS—MINIMUM EFFICIENCY REQUIREMENTS (SI)
(SUPERSEDES TABLE 6.8.1-6 IN ANSI/ASHRAE/IES STANDARD 90.1)

EQUIPMENT TYPE[a]	SUBCATEGORY OR RATING CONDITION	SIZE CATEGORY (INPUT)	MINIMUM EFFICIENCY[b, c]	TEST PROCEDURE[g]
Boilers, hot water	Gas fired	< 87.9 kW[h, i]	89% AFUE[f]	10 CFR Part 430
		≥ 87.9 kW and < 732.7 kW[d]	89% E_t[f]	10 CFR Part 431
		≥ 732.7 kW[a]	91% E_c[f]	
	Oil fired[e]	< 87.9 kW	89% AFUE[f]	10 CFR Part 430
		≥ 87.9 kW and < 732.7 kW[d]	85% E_t[f]	10 CFR Part 431
		≥ 732.7 kW[a]	86% E_c[f]	
Boilers, steam	Gas fired	< 87.9 kW[i]	80% AFUE	10 CFR Part 430
	Gas fired all except natural draft	≥ 87.9 kW and < 732.7 kW[d]	79% E_t	10 CFR Part 431
		≥ 732.7 kW[a]	79% E_t	
	Gas fired natural draft	≥ 87.9 kW and < 732.7 kW[d]	77% E_t	
		≥ 732.7 kW[a]	77% E_t	
	Oil fired[e]	< 87.9 kW	82% AFUE	10 CFR Part 430
		≥ 87.9 kW and < 732.7 kW[d]	81% E_t	10 CFR Part 431
		≥ 732.7 kW[a]	81% E_t	

a. These requirements apply to boilers with rated input of 2344 kW or less that are not packaged boilers, and to all packaged boilers. Minimum efficiency requirements for boilers cover all capacities of packaged boilers.
b. E_c = thermal efficiency (100% less flue losses). See reference document for detailed information.
c. E_t = thermal efficiency. See reference document for detailed information.
d. Maximum capacity—minimum and maximum ratings as provided for and allowed by the unit's controls.
e. Includes oil fired (residual).
f. Systems shall be designed with lower operating return hot-water temperatures (< 55°C) and use hot-water reset to take advantage of the higher efficiencies of condensing boilers.
g. Chapter 11 (Section 11) contains details for the referenced test procedure, including the referenced year version of the test procedure.
h. A boiler not equipped with a tankless domestic water-heating coil shall be equipped with an *automatic* means for adjusting the temperature of the water such that an incremental change in inferred heat load produces a corresponding incremental change in the temperature of the water supplied.
i. Boilers shall not be equipped with a continuous pilot ignition system.

TABLE B101.7 (TABLE B-7)
PERFORMANCE REQUIREMENTS FOR HEAT REJECTION EQUIPMENT—MINIMUM EFFICIENCY REQUIREMENTS (SI)
(SUPERSEDES TABLE 6.8.1-7 IN ANSI/ASHRAE/IES STANDARD 90.1)

EQUIPMENT TYPE	TOTAL SYSTEM HEAT REJECTION CAPACITY AT RATED CONDITIONS	SUBCATEGORY OR RATING CONDITION[g]	PERFORMANCE REQUIRED [a, b, c, d, e, f, i]	TEST PROCEDURE[h]
Propeller or axial fan open-circuit cooling towers	All	35.0°C entering water 29.4°C leaving water 23.9°C entering wb	≥ 3.56 L/s kW	CTI ATC-105 and CTI STD-201RS
Centrifugal fan open-circuit cooling towers	All	35.0°C entering water 29.4°C leaving water 23.9°C entering wb	≥ 1.86 L/s kW	CTI ATC-105 and CTI STD-201RS
Propeller or axial fan closed-circuit cooling towers	All	38.9°C entering water 32.2°C leaving water 23.9°C entering wb	≥ 1.36 L/s kW	CTI ATC-105S and CTI STD-201RS
Centrifugal fan closed-circuit cooling towers	All	38.9°C entering water 32.2°C leaving water 23.9°C entering wb	≥ 0.68 L/s kW	CTI ATC-105S and CTI STD-201RS
Propeller or axial fan evaporative condensers	All	Ammonia test fluid 60.0°C entering gas temperature 35.7°C condensing temperature 23.9°C entering wb	≥ 52.6 COP	CTI ATC-106
Centrifugal fan evaporative condensers	All	Ammonia test fluid 60.0°C entering gas temperature 35.7°C condensing temperature 23.9°C entering wb	≥ 43.2 COP	CTI ATC-106
Propeller or axial fan evaporative condensers	All	R-507A test fluid 73.9°C entering gas temperature 40.6°C condensing temperature 23.9°C entering wb	≥ 61.7 COP	CTI ATC-106
Centrifugal fan evaporative condensers	All	R-507A test fluid 73.9°C entering gas temperature 40.6°C condensing temperature 23.9°C entering wb	≥ 53.1 COP	CTI ATC-106
Air-cooled condensers	All	88°C entering gas temperature 52°C condensing temperature 8°C subcooling 35°C entering wb	≥ 69 COP	AHRI 460

a. For purposes of this table, *open-circuit cooling tower performance* is defined as the water flow rating of the tower at the thermal rating condition listed in Table B101.8 (B-8) divided by the fan motor nameplate power.

b. For purposes of this table, *closed-circuit cooling tower performance* is defined as the process water flow rating of the tower at the thermal rating condition listed in Table B101.8 (B-8) divided by the sum of the fan motor nameplate power and the integral spray pump motor nameplate power.

c. For purposes of this table, *evaporative condenser performance* is defined as the heat rejected at the specified rating condition in the table divided by the sum of the fan motor nameplate power and the integral spray pump nameplate power.

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

e. The efficiencies and test procedures for both *open-* and *closed-circuit cooling towers* are not applicable to hybrid cooling towers that contain a combination of separate wet and dry heat exchange sections. The certification requirements do not apply to field erected cooling towers.

f. All cooling towers, closed-circuit coolers, evaporative condensers and air-cooled condensers shall comply with the minimum efficiency listed in the table for that specific type of equipment with the capacity effect of any project specific accessories and/or options included with the equipment.

g. Requirements for evaporative condensers are listed with ammonia (R-717) and R-507A as test fluids in the table. Evaporative condensers intended for use with halocarbon refrigerants other than R-507A must meet the minimum efficiency requirements listed for R-507A as the test fluid.

h. Informative Appendix G contains information on the referenced test procedures.

i. Not applicable for air-cooled condensers applied to condenserless chillers. The air-cooled condenser and condenserless chiller shall comply with the requirements for air-cooled chillers as defined in ANSI/ASHRAE/IES Standard 90.1, Table 6.8.1-3.

TABLE B101.8 (TABLE B-8)
PERFORMANCE REQUIREMENTS FOR SERVICE WATER HEATING EQUIPMENT (SI)
(SUPERSEDES TABLE 7.8 IN ANSI/ASHRAE/IES STANDARD 90.1)

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	RATED STORAGE VOLUME AND INPUT RATING (IF APPLICABLE)	DRAW PAT-TERN	PERFORMANCE REQUIRED[a, d]	TEST PROCEDURE[b]
Electric table-top water heaters[c]	≤ 12 kW	≥ 75.7 L and ≤ 454 L	Very small	UEF ≥ 0.6323 – 0.0015V	DOE 10 CFR Part 430
			Low	UEF ≥ 0.9188 – 0.00082V	
			Medium	UEF ≥ 0.9577 – 0.00061V	
			High	UEF ≥ 0.9844 – 0.00042V	
Electric resistance storage water heaters		≥ 75.7 L and ≤ 208 L	Very small	UEF ≥ 0.8808 – 0.00021V	DOE 10 CFR Part 430
			Low	UEF ≥ 0.9254 – 0.000079V	
			Medium	UEF ≥ 0.9307 – 0.000053V	
			High	UEF ≥ 0.9349 – 0.000026V	
		> 208 L		Must use heat-pump water heater	
Electric resistance grid-enabled water heaters		≥ 284 L	Very small	UEF ≥ 1.0136 – 0.00074V	DOE 10 CFR Part 430
			Low	UEF ≥ 0.09984 – 0.00037V	
			Medium	UEF ≥ 0.9853 – 0.00026V	
			High	UEF ≥ 0.9720 – 0.00018V	
Heat-pump water heaters		≤ 208 L		EF ≥ 2.00, FHR ≥ 190 L	DOE 10 CFR Part 430
		> 208 L		EF ≥ 2.20, FHR ≥ 190 L	
Gas-fired storage water heaters	≤22.0 kW	≤ 208 L		EF ≥ 0.67, FHR ≥ 250 L	DOE 10 CFR Part 430
		> 208 L		EF ≥ 0.77, FHR ≥ 250 L	
	>22.0 kWh	≤ 530 L		E_t ≥ 0.94 or EF ≥ 0.93 and SL ≤ 0.84 × (Q/234 + 56.5$\sqrt{V}$), W	ANSI Z21.10.3
Gas instantaneous water heaters	>14.6 kW and <58.6 kW	≥ 309.7 W/L and < 7.6 L		EF ≥ 0.90 and GPM ≥ 2.5 over a 25°C rise	DOE 10 CFR Part 430
	≥22.0 kW	≤ 530 L and ≥ 309.7 W/L		E_t ≥ 0.94 or EF ≥ 0.93 SL = 0.84 × (Q/234 + 56.5$\sqrt{V}$), W	ANSI Z21.10.3
Oil storage water heaters	≤30.7 kW	≤ 190 L	Very small	EF = 0.2509 – 0.00032V	DOE 10 CFR Part 430
			Low	EF = 0.5330 – 0.00042V	
			Medium	EF = 0.6078 – 0.00042V	
			High	EF = 0.6815 – 0.0037V	
	>30.7 kW	< 309.7 W/L		E_t ≥ 80% and SL ≤ (Q/234 + 56.5$\sqrt{V}$), W	ANSI Z21.10.3
Oil instantaneous water heaters	≤61.5 kW	≤ 190 L		EF ≥ 0.59 – 0.00050V	DOE 10 CFR Part 430
	>61.5 kW	≥ 309.7 W/L and < 38 L		E_t ≥ 80%	ANSI Z21.10.3
	>61.5 kW	≥ 309.7 W/L and ≥ 30 L		E_t ≥ 78% and SL ≤ (Q/234 + 56.5$\sqrt{V}$), W	
Solar water heater		Electric backup		SEF ≥ 1.8	ANSI Z21.10.3

		Gas backup		SEF ≥ 1.2	
Hot-water supply boilers, gas and oil	>88 kW and ≤3660 kW	≥ 309.7 W/L and < 30 L		E_t ≥ 80%	ANSI Z21.10.3
Hot-water supply boilers, gas		≥ 309.7 W/L and ≥ 30 L		E_t ≥ 80% SL ≤ (Q/234 + 56.5$\sqrt{V}$), W	ANSI Z21.10.3
Hot-water supply boilers, oil		≥ 309.7 W/L and ≥ 30 L		E_t ≥ 78% SL ≤ (Q/234 + 56.5$\sqrt{V}$), W	ANSI Z21.10.3
Pool heaters, gas	All sizes			E_t ≥ 82%	ASHRAE 146
Pool heaters, oil	All sizes			E_t ≥ 78%	ASHRAE 146
Heat-pump pool heaters	All sizes	10°C db 6.8°C wb outdoor air 26.7°C entering water		≥ 4.0 COP	ASHRAE 146
Unfired storage tanks	All sizes			≥ R-2.2°C × m^2/W	None

a. Energy factor (EF) and thermal efficiency (E_t) are minimum requirements, while standby loss (SL) is maximum W based on a 21°C temperature difference between stored water and ambient requirements. In the EF equation, V is the rated volume in liters. In the SL equation, V is the rated volume in liters and Q is the nameplate input rate in kW.
b. Chapter 11 (Section 11) contains details on the referenced test procedures, including the year/version of the referenced test procedure.
c. Section G.1 is titled "Test Method for Measuring Thermal Efficiency," and Section G.2 is titled "Test Method for Measuring Standby Loss."
d. UEF is the Uniform Energy Factor and is a dimensionless number that is calculated per DOE 10 CFR Part 430 test procedures.

TABLE B101.9 (TABLE B-9)
COMMERCIAL CLOTHES WASHERS (SI)

PRODUCT	MEF [a]	WF [b], L/L
All commercial clothes washers	48.7	0.53

a. MEF = modified energy factor, a combination of energy factor and remaining moisture content. MEF measures energy consumption of the total laundry cycle (washing and drying). It indicates how many liters of laundry can be washed and dried with one kWh of electricity; the higher the number, the greater the efficiency.
b. *WF = water factor* (in L/L).

TABLE B101.10 (TABLE B-10)
ELECTRICALLY OPERATED VARIABLE-REFRIGERANT-FLOW (VRF) AIR CONDITIONERS—MINIMUM EFFICIENCY REQUIREMENTS (SI)
(SUPERSEDES TABLE 6.8.1-9 IN ANSI/ASHRAE/IES STANDARD 90.1)

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE [a]
VRF air conditioners, air cooled	< 19 kW	All	VRF multisplit system	4.40 SCOP$_C$ 3.36 COP$_C$	AHRI 1230
	≥ 19 kW and < 40 kW	Electric resistance (or none)	VRF multisplit system	3.43 COP$_C$ 4.37 ICOP$_C$	
	≥ 40 kW and < 70 kW	Electric resistance (or none)	VRF multisplit system	3.43 COP$_C$ 4.22 ICOP$_C$	
	≥ 70 kW	Electric resistance (or none)	VRF multisplit system	3.08 COP$_C$ 3.81 ICOP$_C$	

a. Chapter 11 (Section 11) contains details for the referenced test procedure, including year version of the test procedure.

TABLE B101.11 (TABLE B-11)
ELECTRICALLY OPERATED VARIABLE-REFRIGERANT-FLOW AND APPLIED HEAT PUMP—MINIMUM EFFICIENCY REQUIREMENTS (SI)
(SUPERSEDES TABLE 6.8.1-10 IN ANSI/ASHRAE/IES STANDARD 90.1)

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
VRF air cooled (cooling mode)	< 19 kW	All	VRF multisplit system	4.40 $SCOP_C$ 3.66 COP_C	AHRI 1230
	≥ 19 kW < 40 kW	Electric resistance (or none)	VRF multisplit system	3.31 COP_C 4.28 $ICOP_C$	
	≥ 19 kW and < 40 kW	Electric resistance (or none)	VRF multisplit system with heat recovery	3.25 COP_C 4.22 $ICOP_C$	
	≥ 40 kW and < 70 kW	Electric resistance (or none)	VRF multisplit system	3.19 COP_C 4.07 $ICOP_C$	
	≥ 40 kW and < 70 kW	Electric resistance (or none)	VRF multisplit system with heat recovery	3.14 COP_C 4.02 $ICOP_C$	
	≥ 70 kW	Electric resistance (or none)	VRF multisplit system	3.02 COP_C 4.02 $ICOP_C$	
	≥ 70 kW	Electric resistance (or none)	VRF multisplit system with heat recovery	2.96 COP_C 3.66 $ICOP_C$	
VRF water source (cooling mode)	< 19 kW	All	VRF multisplit systems 30°C entering water	4.10 COP_C 4.69 $ICOP_C$	AHRI 1230
	< 19 kW	All	VRF multisplit systems with heat recovery 30°C entering water	4.04 COP_C 4.63 $ICOP_C$	
	≥ 19 kW and < 40 kW	All	VRF multisplit system 30°C entering water	4.10 COP_C 4.69 $ICOP_C$	
	≥ 19 kW and < 40 kW	All	VRF multisplit system with heat recovery 30°C entering water	4.04 COP_C 4.63 $ICOP_C$	
	≥ 40 kW	All	VRF multisplit system 30°C entering water	3.40 COP_C 4.10 $ICOP_C$	
	≥ 40 kW	All	VRF multisplit system with heat recovery 30°C entering water	3.28 COP_C 4.04 $ICOP_C$	
VRF groundwater source (cooling mode)	< 40 kW	All	VRF multisplit system 15°C entering water	4.75 COP_C	AHRI 1230
	< 40 kW	All	VRF multisplit system with heat recovery 15°C entering water	4.69 COP_C	
	≥ 40 kW	All	VRF multisplit system 15°C entering water	4.04 COP_C	
	≥ 40 kW	All	VRF multisplit system with heat recovery 15°C entering	3.99 COP_C	
VRF ground source (cooling mode)	< 40 kW	All	VRF multisplit system 25°C entering water	3.93 COP_C	AHRI 1230
	< 40 kW	All	VRF multisplit system with heat recovery 25°C entering water	3.87 COP_C	

	≥ 40 kW	All	VRF multisplit system 25°C entering water	3.22 COP_C	
	≥ 40 kW	All	VRF multisplit system with heat recovery 25°C entering water	3.17 COP_C	
VRF air cooled (heating mode)	< 19 kW (cooling capacity)		VRF multisplit system	2.49 $SCOP_H$	AHRI 1230
	≥ 19 kW and < 40 kW (cooling capacity)		VRF multisplit system 8.3°C db/6.1°C wb *outdoor air*	3.40 COP_H	
			–8.3°C db/–9.4°C wb *outdoor air*	2.40 COP_H	
	≥ 40 kW (cooling capacity)		VRF multisplit system 8.3°C db/6.1°C wb *outdoor air*	3.20 COP_H	
			–8.3°C db/–9.4°C wb *outdoor air*	2.10 COP_H	
VRF water source (heating mode)	< 40 kW (cooling capacity)		VRF multisplit system 20°C entering water	4.60 COP_H	AHRI 1230
	≥ 40 kW (cooling capacity)		VRF multisplit system 20°C entering water	4.20 COP_H	
VRF groundwater source (heating mode)	< 40 kW (cooling capacity)		VRF multisplit system 10°C entering water	3.60 COP_H	AHRI 1230
	≥ 40 kW (cooling capacity)		VRF multisplit system 10°C entering water	3.30 COP_H	
VRF ground source (heating mode)	< 40 kW (cooling capacity)		VRF multisplit system 0°C entering fluid	3.10 COP_H	AHRI 1230
	≥ 40 kW (cooling capacity)		VRF multisplit system 0°C entering fluid	2.80 COP_H	

a. Chapter 11 (Section 11) contains a complete specification of the reference test procedure, including year version of the test procedure.

INORMATIVE APPENDIX C

PERFORMANCE OPTION FOR ENERGY EFFICIENCY

This is a normative appendix and is part of this code.

SECTION C101 (C1)
GENERAL

C101.1 (C1.1) Renewable, recovered, and purchased energy. *On-site renewable energy systems* and *site* recovered energy: The modeling requirements for *on-site renewable energy systems* in the *proposed building performance* in ANSI/ASHRAE/IES Standard 90.1, Section G2.4.1, shall not apply and are superseded by Table C101.1 (C1.1), Section 15, "Renewable Energy Systems."

C101.2 (C1.2) Building performance calculations. In addition to the requirements of ANSI/ASHRAE/IES Standard 90.1, Table G3.1, the *proposed design* shall comply with all modifications and additions in Table C101.1 (C1.1). All references to Table G3.1 in Table C101.1 (C1.1) refer to ANSI/ASHRAE/IES Standard 90.1, Appendix G, Table G3.1.

C101.3 (C1.3) Energy storage. Electric and thermal storage systems, and ancillary energy consumption and charging, discharging, and standby losses associated with thermal and electric storage, shall be modeled in the *proposed design*.

C101.4 (C1.4) Modeling of district energy systems. A *building project* served in whole or in part by a *district energy plant* shall comply with either Section C101.4.1 (C1.4.1) or C101.4.2 (C1.4.2).

C101.4.1 (C1.4.1) Modeling purchased district *heating or cooling*. The *proposed building performance* and *baseline building performance* shall be calculated using the cost of purchased *district heating or cooling* for compliance with Section 701.5.1 (7.5.1) as defined in Standard 90.1, Sections G3.1.1.1, G3.1.1.2, and G3.1.1.3. CO_2e emission factors in Table 701.5.2 (7.5.2) for *district heating or cooling* shall be used for compliance with Section 701.5.2 (7.5.2).

C101.4.2 (C1.4.2) Performance modeling of district energy systems. Two model simulation runs shall be completed for both the *proposed building performance* and *baseline building performance* in accordance with Sections C101.4.2(a) [C1.4.2(a)] and C101.4.2(b) [C1.4.2(b)].

a. The *proposed building performance* and *baseline building performance* shall be calculated using the cost of purchased *district heating or cooling* as defined in Standard 90.1, Sections G3.1.1.1, G3.1.1.2, and G3.1.1.3. The *proposed building* shall comply with Standard 90.1 using the Performance Rating Method.

b. Model the *district heating or cooling* in the *building project* using Standard 90.1, Normative Appendix G, with the following additions and alterations. All demands on the *district energy system* from the *building project* shall be modeled using time steps no longer than one hour. Documentation of *district energy systems* in the *proposed building performance* model shall be provided in accordance with the requirements defined in Standard 90.1, Section G2.5, "Exceptional Calculation Methods." Projects shall comply with either Section C101.4.2(b)(1) [C1.4.2(b)(1)] or C101.4.2(b)(2) [C1.4.2(b)(2)].

1. **District energy system monitoring path.** Data from energy metering equipment on an existing *district energy plant* shall be used to derive energy performance. All input energy used to operate the *district energy plant*, and all output *district heating or cooling* delivered by the *district thermal distribution system*, shall be metered. All *district energy plant* monitoring equipment shall be in place for at least one full 12 month period. Metered energy performance figures shall be used for the *proposed building performance* model and shall be derived at a level of detail no longer than one month. The *baseline building performance* model shall be completed in accordance with the requirements outlined in Table C101.2 (C1.2).
2. **District energy system modeling path.** Complete the requirements of the *proposed* and *baseline building performance* models defined in Table C101.2 (C1.2).

C101.5 (C1.5) Modeling nonrenewable on-site generation and *combined heat and power systems*. Nonrenewable on-site generation and *combined heat and power systems* shall be simulated as follows:

a. ***Baseline building performance.*** The baseline building shall not include nonrenewable on-site generation or nonrenewable *combined heat and power systems*.

b. ***Proposed building performance*.** For proposed building designs that include nonrenewable on-site generation or nonrenewable *combined heat and power systems*, the system shall be modeled as designed, including consumption of all pumps and auxiliary equipment required for operation of the system, in accordance with the requirements of Section C101.4 (C1.4).

TABLE C101.1 (TABLE C1.1)
MODIFICATIONS AND ADDITIONS TO ANSI/ASHRAE/IES STANDARD 90.1, APPENDIX G, TABLE G3.1

PROPOSED BUILDING PERFORMANCE	BASELINE BUILDING PERFORMANCE
1. Design Model	
No modifications	No modifications
2. Additions and Alterations	
No modifications	No modifications
3. Space Use Classification	
No modifications	No modifications
4. Schedules	
No modifications	No modifications
5. Building Envelope	
When the total area of penetrations from mechanical equipment listed in ANSI/ASHRAE/IES Standard 90.1, Table 6.8.1-4, exceeds 1% of the opaque above-grade wall area, the mechanical equipment penetration area shall be calculated as a separate assembly with a default U-factor of 0.5 Btu/h × ft^2 × °F (3 W/m^2 × K).	No modifications
6. Lighting	
No modifications	No modifications
7. Thermal Blocks—HVAC Zones Designed	
No modifications	No modifications
8. Thermal Blocks—HVAC Zones Not Designed	
No modifications	No modifications
9. Thermal Blocks—Multifamily Residential Buildings	
No modifications	No modifications
10. HVAC Systems	
No modifications	No modifications
11. Service Hot-Water Systems	
No modifications	No modifications
12. Receptacle and Other Loads	
No modifications	No modifications
13. Modeling Limitations to the Simulation Program	
No modifications	No modifications
14. Exterior Conditions	
No modifications	No modifications
15. On-Site Renewable Energy Systems	

The reduction in the proposed building annual energy cost CO_2e emissions and source energy due to *renewable energy systems* shall be calculated as follows:

a. **Annual Energy Cost.** The annual energy cost of the *proposed design* shall be adjusted to account for renewable energy systems as follows:

1. **On-Site Thermal Energy Performance Calculation.** The hourly thermal loads of the *proposed design* shall be reduced by the hourly thermal energy production of the *on-site renewable energy system* (but thermal loads shall not be reduced to less than zero). When the on-site renewable thermal energy production exceeds the applicable thermal demands of the building for any hour, the excess generated energy may be used to displace thermal loads at other times, provided the system has the storage capability and storage losses are included in the calculation. The approved energy rate structure shall be applied to the reduced energy consumption.

2. **On-Site Electric Renewable Energy Systems—Net Metering.** The total electrical energy production of the *on-site renewable energy system* shall be calculated on an hourly basis, and the energy cost of the *proposed building performance* shall be calculated by applying the approved electrical rate structure to each hour's electrical usage, including any reduction from hourly electrical energy production of the *on-site renewable energy system*.

Exception: For *building projects* with no net metering agreement, feed-in tariff, or other electrical rate structure for net generated electricity, the cost of imported electricity from the grid is calculated by applying the approved electrical rate structure to each hour's electrical loads minus the hourly electrical energy production of the *on-site renewable energy system*, but the cost of imported electricity shall not be less than zero on a monthly basis.

Electricity production of the on-site renewable energy system that has a retail value in excess of the retail cost of electricity consumption on a monthly basis shall be credited as a reduction in energy costs to the building performance at the wholesale rate as follows:

$$\text{Credit} = \frac{(\text{ExRR} - \text{ImRR})}{\text{ExRR}} \times \text{ExkWh} \times \text{WR}$$

where:

Credit = cost reduction credit for month where retail value of exported electricity is greater than retail value of imported electricity.

ExRR = month's value of exported electricity at retail rate.

ImRR = month's value of imported electricity at retail rate.

ExkWh = total kilowatt-hours exported in month.

WR = average monthly wholesale rate for the region where the building located.

[***Informative Note:*** Thermal renewable energy is accounted for in (a)(1), so the renewable energy addressed in (a)(2) will always be on-site electricity. There is no need to apply the renewable energy procurement factors from Table 701.4.1.2 (7.4.1.2), as the multiplier will always be one (1).]

3. **Electricity Generation from Off-Site Community Renewable Energy Systems—Virtual-, Aggregated-, or Community- Net-Metering Tariff.** Renewable energy systems that credit the building project electricity account on an hourly basis shall be calculated according to (a)(2) except that the renewable energy procurement factor from Table 701.4.1.2 (7.4.1.2) shall be applied to each hour of electricity production from the community renewable energy system. The energy cost credit for other off-site renewable energy systems shall be calculated according to (a)(4).

4. **Electricity Generation from Other Off-Site Renewable Energy Systems.** The adjusted renewable energy is the actual renewable energy for each procurement source of renewable energy delivered to or credited to the building project multiplied by the appropriate renewable energy factors in Table 701.4.1.2 (7.4.1.2). The annual energy cost reduction credited to the proposed design shall be the total adjusted renewable energy multiplied by the virtual electric rate paid by the building. The virtual electric rate is the total retail cost for electricity for the year divided by the net consumption for the year in dollars per kWh ($/kWh).

b. **Annual CO_2e.** The annual CO_2e emissions of the proposed building shall be equal to the annual CO_2e associated with all building energy use minus the *adjusted renewable energy* multiplied by the electrical CO_2e emission factor from Table 701.5.2 (7.5.2). Each procurement source of renewable energy delivered to or credited to the building project shall be multiplied by the renewable energy factors in Table 701.4.1.2 (7.4.1.2). $\text{PD-}CO_2e = \sum \text{PDSE}_i \times e_i - \sum \text{RE}_k \times \text{REPF}_k \times e_k$ where: PD-CO_2e = CO_2e emissions for the proposed design. PDSE_i = Proposed design site energy use for energy type i. e_i = CO_2e emission factor for energy type i, taken from Table 701.5.2 (7.5.2). RE_k = Annual renewable energy production for renewable energy type k. RPEF_k = Renewable energy factor from Table 701.4.1.2 (7.4.1.2) for renewable energy type k. e_k = CO_2e emission factor for electricity taken from Table 701.5.2 (7.5.2). c. **Zero Energy Performance Index.** The adjusted renewable energy of the proposed *building* shall be credited using the source-site multiplier for electricity from Table 701.5.2 (7.5.2). On-site thermal energy from solar shall be directly modeled according to Table C101.1 (C1.1), (15)(a)(1) and accounted for through the displacement of on-site fossil fuel or electricity. **Documentation:** The documentation required in ANSI/ASHRAE/IES Standard 90.1, Section G2.5 (a), (b), and (e), shall be made available to the *AHJ*, upon request, for all *on-site renewable energy systems* in the *proposed design*.	

TABLE C101.2 (TABLE C1.2)
PERFORMANCE MODELING OF DISTRICT ENERGY SYSTEM REQUIREMENTS

PROPOSED BUILDING PERFORMANCE	BASELINE BUILDING PERFORMANCE
1. District Cooling Model all cooling systems at the *district energy plant*, including energy conversion equipment and associated controls. Include all energy-using equipment, whether new or existing, that will impact the delivery of *district cooling* to the *building project*. Required systems include but are not limited to the following: • Chillers • Makeup water pumping • Primary pumping • Heat rejection loop pumping • Heat rejection fans • Water treatment and pressurization systems • Heat exchanger losses	Model on-site cooling plant or packaged cooling as defined in Standard 90.1, Normative Appendix G, Tables G3.1.1-3 and G3.1.1-4, using energy performance values from Standard 90.1, Normative Appendix G.
2. District Heating Model all heating systems at the *district energy plant*, including energy conversion equipment and associated controls. Include all energy-using equipment, whether new or existing, that will impact the delivery of *district heating* to the *building project*. Required systems include but are not limited to the following: • Boilers • Makeup water pumping • Primary pumping • Water treatment and pressurization equipment • Heat exchanger losses	Model on-site heating plant or packaged heating as defined in Standard 90.1, Normative Appendix G, Tables G3.1.1-3 and G3.1.1-4, using energy performance values from Standard 90.1, Normative Appendix G.
3. District Thermal Distribution System Model all equipment involved with the *district thermal distribution system*. Required systems include but are not limited to the following: • Distribution and tertiary pumping • Heat exchanger and thermal distribution losses • Thermal distribution losses from leakage or nonreturn of distribution medium	Model thermal distribution systems in accordance with Standard 90.1, Normative Appendix G.

4. Combined Heat and Power Systems Model *combined heat and power systems* using the following methodology. Allocate electricity to the *building project* as a fraction of the total electricity output of the *district energy system*, where the fraction is the thermal energy provided to the *building project* divided by the total thermal energy output of the *district energy system*. Use Equation C-1 to determine the amount of electricity generated from the *CHP* system to be applied to the *building project*. Alternatively, use Equation C-2 if the *CHP* system includes cooling generation from recovered heat or if there is an additional waste heat recovery stream Z_{OTHER} (e.g., a *CHP* system could extract steam and hot water on two separate loops). (EQUATION C-1) $\text{CHP\_ELEC}_{BLDG} = (X_{HEAT} \times \text{BLDG}_{HEAT}) \times \text{CHP\_ELEC}_{TOTAL}$ (EQUATION C-2) $\text{CHP}_{ELEC\text{-}BLDG} = [(X_{HEAT} \times \text{BLDG}_{HEAT}) + (Y_{CHW} \times \text{BLDG}_{CHW}) + (Z_{OTHER} \times \text{BLDG}_{OTHER})] \times \text{CHP\_ELEC}_{TOTAL}$ where: CHP_ELEC_{BLDG} = *CHP* electricity generation allocated to the building. X_{HEAT} = Fraction of the *CHP* plant's total production of waste heat applied to the DES. BLDG_{HEAT} = Fraction of total district heat provided to the building. CHP_ELEC_{TOTAL} = Total *CHP* electricity generated at the DES plant. Y_{CHW} = Fraction of the *CHP* system's total production of waste heat applied to producing chilled water in the DES. BLDG_{CHW} = Fraction of total district chilled water provided to the building. Z_{OTHER} = Fraction of the *CHP* system's total production of waste heat applied to an additional form of district energy. BLDG_{OTHER} = Fraction of an additional form of district energy that is provided to the building.	Do not model *CHP*.
5. Utility Tariffs Utility tariffs shall reflect the rates used on the *building project* determined in accordance with Standard 90.1, Section G2.4.2.	Same as *proposed design*.
6. Carbon Dioxide Equivalent Emissions Factors *Carbon dioxide equivalent* emission factors shall be applied to the energy supplied to the *district energy* system and reflect the values used in Table 701.5.2 (7.5.2), and shall be applied uniformly for all *building project* and *district energy systems*.	Same as *proposed design*.

INORMATIVE APPENDIX D

BUILDING CONCENTRATIONS

This is a normative appendix and is part of this code.

SECTION D101 (D1)
BUILDING CONCENTRATIONS

Building concentrations shall be estimated based on the following parameters and criteria:

a. Laboratory-measured volatile organic compound (VOC) emission factors and actual surface area of all materials as described in (b) below.

b. At minimum, those materials listed in Section 801.5.2(a) through (g) [8.5.2(a) through (g)] to be installed shall be modeled.

c. The actual building parameters for volume, average weekly minimum ventilation rate, and ventilated volume fraction for the building being modeled shall be used.

d. Standard building scenarios or modeling from similar buildings shall not be allowed.

e. Average weekly minimum air change rates shall be calculated based on the *minimum outdoor airflow* and hours of operation for the specific building being modeled.

f. Steady-state conditions with respect to emission rates and building ventilation may be assumed.

g. Zero *outdoor air* concentrations, perfect mixing within the building, and no net losses of VOCs from air due to other effects such as irreversible or net sorption on surfaces (i.e., net sink effects) and chemical reactions may be assumed.

h. All assumptions shall be clearly stated in the design documents.

i. The estimated building concentration C_{Bi} ($\mu g/m^3$) of each target VOC shall be calculated using Equation 2 of CDPH/EHLB/Standard Method, as shown below. Estimated building concentrations of individual target VOCs with multiple sources shall be added to establish a single total estimated building concentration for individual target VOCs.

$$C_{Bi} = (EF_{Ai} \times A_B)/(V_B \times a_B \times 0.9)$$

where:

EF_{Ai} = Area specific emission rate or emission factor at 96 hours after placing a test specimen in the chamber (14 days total exposure time), $\mu g/m^2 \cdot h$.

A_B = Exposed surface area of the installed material in the building, m^2.

V_B = Building volume, m^3.

a_B = Average weekly minimum air change rate, 1/h.

INORMATIVE APPENDIX E

BUILDING ENVELOPE TABLES

(This appendix is not part of this code. It is merely informative and does not contain requirements necessary for conformance to the code. It has not been processed according to the ANSI requirements for a code and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

The first nine tables are in I-P units, followed by nine tables in SI units. U-factors, C-factors, F-factors, and *SHGC* in these tables meet the requirements of Section 701.4.2.1 (7.4.2.1), although the R-values in most cases provide more insulation than is required in Section 701.4.2.1 (7.4.2.1). These R-values represent common assemblies in building construction. Assemblies with lower R-values are allowed to be used the meet the criteria of Section 701.4.2.1 (7.4.2.1) when they meet the appropriate U-factor, C-factor, or *F*-factor criteria.

TABLE E101.0 (TABLE E-0)
EXAMPLE BUILDING ENVELOPE COMPLIANCE VALUES FOR CLIMATE ZONE 0 (A,B)* (I-P)
(SUPERSEDES TABLE 5.5-0 IN ANSI/ASHRAE/IES STANDARD 90.1)

OPAQUE ELEMENTS	NONRESIDENTIAL		RESIDENTIAL		SEMIHEATED	
	Assembly Maximum	Insulation Min. R-value**	Assembly Maximum	Insulation Min. R-value**	Assembly Maximum	Insulation Min. R-value**
Roofs						
Insulation entirely above deck	U-0.039	R-25 c.i.	U-0.032	R-30 c.i.	U-0.218	R-3.8 c.i.
Metal building [a]	U-0.041	R-10 + R-19 FC	U-0.041	R-10 + R-19 FC	U-0.115	R-10
Attic and other roofs	U-0.027	R-38	U-0.027	R-38	U-0.081	R-13
Walls, above grade						
Mass [b]	U-0.580	NR	U-0.151	R-5.7 c.i.	U-0.580	NR
Metal building	U-0.094	R-0 + R-9.8 ci	U-0.094	R-0 + R-9.8 ci	U-0.352	NR
Steel framed	U-0.124	R-13	U-0.124	R-13	U-0.352	NR
Wood framed and other	U-0.089	R-13	U-0.089	R-13	U-0.292	NR
Wall, below grade						
Below-grade *wall*	C-1.140	NR	C-1.140	NR	C-1.140	NR
Floors						
Mass	U-0.322	NR	U-0.322	NR	U-0.322	NR
Steel joist	U-0.350	NR	U-0.350	NR	U-0.350	NR
Wood framed and other	U-0.282	NR	U-0.282	NR	U-0.282	NR
Slab-on-grade floors						
Unheated	F-0.730	NR	F-0.730	NR	F-0.730	NR
Heated	F-1.020	R-7.5 for 12 in.	F-1.020	R-7.5 for 12 in.	F-1.020	R-7.5 for 12 in.
Opaque doors						

Swinging	U-0.370			U-0.370			U-0.700		
Nonswinging	U-0.310			U-0.310			U-1.450		
FENESTRATION	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**
Vertical glazing, 0% to 40% of *wall*									
Fixed	U-0.48	E&W-0.21, N&S-0.22	1.10 (for all types)	U-0.48	E&W-0.21, N&S-0.22	1.10 (for all types)	U-1.14	NR (for all types)	NR (for all types)
Operable	U-0.59	E&W-0.19, N&S-0.20		U-0.59	E&W-0.19, N&S-0.20		U-1.14		
Entrance door	U-0.79	E&W-0.19, N&S-0.20		U-0.79	E&W-0.19, N&S-0.20		U-1.05		
Skylight, 0% to 3% of *roof*									
All types	U-0.67	0.29	NR	U-0.67	0.29	NR	U-1.71	NR	NR

* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement; FC = filled cavity (see ANSI/ASHRAE/IES Standard 90.1, Section A2.3.2.5); E&W = east and west oriented, N&S = north and south oriented [see Sections 701.4.2.1 (7.4.2.1) and 701.4.2.8 (7.4.2.8)].

** The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1 (7.4.2.1) but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1 (7.4.2.1).

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).

b. Exception applies for mass *walls* above grade where the requirement is for a maximum assembly U-0.151 (see ANSI/ASHRAE/IES Standard 90.1, Section 5.5.3.2).

TABLE E101.1 (TABLE E-1)
EXAMPLE BUILDING ENVELOPE COMPLIANCE VALUES FOR CLIMATE ZONE 1 (A,B)* (I-P)
(SUPERSEDES TABLE 5.5-1 IN ANSI/ASHRAE/IES STANDARD 90.1)

OPAQUE ELEMENTS	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
	Assembly Maximum	Insulation Min. R-value**		Assembly Maximum	Insulation Min. R-value**		Assembly Maximum	Insulation Min. R-value**	
Roofs									
Insulation entirely above deck	U-0.048	R-20 c.i.		U-0.039	R-25 c.i.		U-0.218	R-3.8 c.i.	
Metal building [a]	U-0.041	R-10 + R-19 FC		U-0.041	R-10 + R-19 FC		U-0.115	R-10	
Attic and other roofs	U-0.027	R-38		U-0.027	R-38		U-0.081	R-13	
Walls, above grade									
Mass [b]	U-0.580	NR		U-0.151	R-5.7 c.i.		U-0.580	NR	
Metal building	U-0.094	R-0 + R-9.8 c.i.		U-0.094	R-0 + R-9.8 c.i.		U-0.352	NR	
Steel framed	U-0.124	R-13		U-0.124	R-13		U-0.352	NR	
Wood framed and other	U-0.089	R-13		U-0.089	R-13		U-0.292	NR	
Wall, below grade									
Below-grade *wall*	C-1.140	NR		C-1.140	NR		C-1.140	NR	
Floors									
Mass	U-0.322	NR		U-0.322	NR		U-0.322	NR	
Steel joist	U-0.350	NR		U-0.350	NR		U-0.350	NR	
Wood framed and other	U-0.282	NR		U-0.282	NR		U-0.282	NR	
Slab-on-grade floors									
Unheated	F-0.730	NR		F-0.730	NR		F-0.730	NR	
Heated	F-1.020	R-7.5 for 12 in.		F-1.020	R-7.5 for 12 in.		F-1.020	R-7.5 for 12 in.	
Opaque doors									
Swinging	U-0.370			U-0.370			U-0.700		
Nonswinging	U-0.310			U-0.310			U-1.450		
FENESTRATION	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**
Vertical glazing, 0% to 40% of *wall*									
Fixed	U-0.48	E&W-0.22, N&S-0.23	1.10 (for all types)	U-0.48	E&W-0.22, N&S-0.23	1.10 (for all types)	U-1.14	NR (for all types)	NR (for all types)
Operable	U-0.59	E&W-0.20, N&S-0.21		U-0.59	E&W-0.20, N&S-0.21		U-1.14		
Entrance door	U-0.79	E&W-0.20, N&S-0.21		U-0.79	E&W-0.20, N&S-0.21		U-1.05		
Skylight, 0% to 3% of *roof*									
All types	U-0.67	0.29	NR	U-0.67	0.29	NR	U-1.71	NR	NR

* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement; FC = filled cavity (see ANSI/ASHRAE/IES Standard 90.1, Section A2.3.2.5); E&W = east and west oriented, N&S = north and south oriented [see Sections 701.4.2.1 (7.4.2.1) and 701.4.2.8 (7.4.2.8)].

** The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1 (7.4.2.1) but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1 (7.4.2.1).

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).

b. Exception applies for mass *walls* above grade where the requirement is for a maximum assembly U-0.151 (see ANSI/ASHRAE/IES Standard 90.1, Section 5.5.3.2).

TABLE E101.2 (TABLE E-2)
EXAMPLE BUILDING ENVELOPE COMPLIANCE VALUES FOR CLIMATE ZONE 2 (A,B)* (I-P)
(SUPERSEDES TABLE 5.5-2 IN ANSI/ASHRAE/IES STANDARD 90.1)

OPAQUE ELEMENTS	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
	Assembly Maximum	Insulation Min. R-value**		Assembly Maximum	Insulation Min. R-value**		Assembly Maximum	Insulation Min. R-value**	
Roofs									
Insulation entirely above deck	U-0.039	R-25 c.i.		U-0.039	R-25 c.i.		U-0.173	R-5 c.i.	
Metal building [a]	U-0.041	R-10 + R-19 FC		U-0.041	R-10 + R-19 FC		U-0.096	R-16	
Attic and other roofs	U-0.027	R-38		U-0.027	R-38		U-0.053	R-19	
Walls, above grade									
Mass[b]	U-0.151	R-5.7 c.i.		U-0.123	R-7.6 c.i.		U-0.580	NR	
Metal building	U-0.094	R-0 + R-9.8 c.i.		U-0.094	R-0 + R-9.8. c.i.		U-0.162	R-13	
Steel framed	U-0.084	R-13 + R-3.8 c.i.		U-0.064	R-13 + R-7.5 c.i.		U-0.124	R-13	
Wood framed and other	U-0.089	R-13		U-0.089	R-13		U-0.089	R-13	
Wall, below grade									
Below-grade *wall*	C-1.140	NR		C-1.140	NR		C-1.140	NR	
Floors									
Mass	U-0.107	R-6.3 c.i.		U-0.087	R-8.3 c.i.		U-0.322	NR	
Steel joist	U-0.038	R-30		U-0.038	R-30		U-0.069	R-13	
Wood framed and other	U-0.033	R-30		U-0.033	R-30		U-0.066	R-13	
Slab-on-grade floors									
Unheated	F-0.730	NR		F-0.730	NR		F-0.730	NR	
Heated	F-0.900	R-10 for 24 in.		F-0.860	R-15 for 24 in.		F-1.020	R-7.5 for 12 in.	
Opaque doors									
Swinging	U-0.370			U-0.370			U-0.700		
Nonswinging	U-0.310			U-0.310			U-1.450		
FENESTRATION	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**
Vertical glazing, 0% to 40% of *wall*									
Fixed	U-0.43	E&W-0.24, N&S-0.25	1.10 (for all types)	U-0.43	E&W-0.24, N&S-0.25	1.10 (for all types)	U-0.48	NR (for all types)	NR (for all types)
Operable	U-0.57	E&W-0.22, N&S-0.23		U-0.57	E&W-0.22, N&S-0.23		U-0.62		
Entrance door	U-0.73	E&W-0.22, N&S-0.23		U-0.73	E&W-0.22, N&S-0.23		U-0.73		
Skylight, 0% to 3% of *roof*									

All types	U-0.62	0.29	NR	U-0.62	0.29	NR	U-0.86	NR	NR

* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement; FC = filled cavity (see ANSI/ASHRAE/IES Standard 90.1, Section A2.3.2.5); E&W = east and west oriented, N&S = north and south oriented [see Sections 701.4.2.1 (7.4.2.1) and 701.4.2.8 (7.4.2.8)].

** The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1 (7.4.2.1) but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1 (7.4.2.1).

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).

b. Exception applies for mass *walls* above grade where the requirement is for a maximum assembly U-0.151 (see ANSI/ASHRAE/IES Standard 90.1, Section 5.5.3.2).

TABLE E101.3 (TABLE E-3)
EXAMPLE BUILDING ENVELOPE COMPLIANCE VALUES FOR CLIMATE ZONE 3 (A,B,C)* (I-P)
(SUPERSEDES TABLE 5.5-3 IN ANSI/ASHRAE/IES STANDARD 90.1)

OPAQUE ELEMENTS	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
	Assembly Maximum	Insulation Min. R-value**		Assembly Maximum	Insulation Min. R-value**		Assembly Maximum	Insulation Min. R-value**	
Roofs									
Insulation entirely above deck	U-0.039	R-25 c.i.		U-0.039	R-25 c.i.		U-0.119	R-7.6 c.i.	
Metal building[a]	U-0.041	R-10 + R-19 FC		U-0.041	R-10 + R-19 FC		U-0.096	R-16	
Attic and other roofs	U-0.027	R-38		U-0.027	R-38		U-0.053	R-19	
Walls, above grade									
Mass	U-0.123	R-7.6 c.i.		U-0.104	R-9.5 c.i.		U-0.580	NR	
Metal building	U-0.094	R-0 + R-9.8 c.i.		U-0.072	R-0 + R-13 c.i.		U-0.162	R-13	
Steel framed	U-0.077	R-13 + R-5 c.i.		U-0.064	R-13 + R-7.5 c.i.		U-0.124	R-13	
Wood framed and other	U-0.089	R-13		U-0.064	R-13 + R-3.8 c.i.		U-0.089	R-13	
Wall, below grade									
Below-grade *wall*	C-1.140	NR		C-1.140	NR		C-1.140	NR	
Floors									
Mass	U-0.074	R-10 c.i.		U-0.074	R-10 c.i.		U-0.137	R-4.2 c.i.	
Steel joist	U-0.038	R-30		U-0.038	R-30		U-0.052	R-19	
Wood framed and other	U-0.033	R-30		U-0.033	R-30		U-0.051	R-19	
Slab-on-grade floors									
Unheated	F-0.730	NR		F-0.540	R-10 for 24 in.		F-0.730	NR	
Heated	F-0.860	R-15 for 24 in.		F-0.860	R-15 for 24 in.		F-1.020	R-7.5 for 12 in.	
Opaque doors									
Swinging	U-0.370			U-0.370			U-0.370		
Nonswinging	U-0.310			U-0.310			U-0.360		
FENESTRATION	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**
Vertical glazing, 0% to 40% of *wall*									
Fixed	U-0.40	E&W-0.24, N&S-0.25	1.10 (for all types)	U-0.33	E&W-0.24, N&S-0.25	1.10 (for all types)	U-0.48	NR	NR
Operable	U-0.51	E&W-0.22, N&S-0.23		U-0.47	E&W-0.22, N&S-0.23		U-0.62		
Entrance door	U-0.65	E&W-0.22, N&S-0.23		U-0.57	E&W-0.22, N&S-0.23		U-0.73		
Skylight, 0% to 3% of *roof*									

All types	U-0.52	0.29	NR	U-0.52	0.29	NR	U-0.86	NR	NR

* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement; FC = filled cavity (see ANSI/ASHRAE/IES Standard 90.1, Section A2.3.2.5); E&W = east and west oriented, N&S = north and south oriented [see Sections 701.4.2.1 (7.4.2.1) and 701.4.2.8 (7.4.2.8)].

** The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1 (7.4.2.1) but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1 (7.4.2.1).

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).

TABLE E101.4 (TABLE E-4)
EXAMPLE BUILDING ENVELOPE COMPLIANCE VALUES FOR CLIMATE ZONE 4 (A,B,C)* (I-P)
(SUPERSEDES TABLE 5.5-4 IN ANSI/ASHRAE/IES STANDARD 90.1)

OPAQUE ELEMENTS	NONRESIDENTIAL		RESIDENTIAL		SEMIHEATED	
	Assembly Maximum	Insulation Min. R-value**	Assembly Maximum	Insulation Min. R-value**	Assembly Maximum	Insulation Min. R-value**
Roofs						
Insulation entirely above deck	U-0.030	R-35 c.i.	U-0.030	R-35 c.i.	U-0.088	R-11 c.i.
Metal building[a]	U-0.035	R-11 + R-19 c.i.	U-0.035	R-11 + R-19 c.i.	U-0.078	R-19 + R-6.5 c.i.
Attic and other roofs	U-0.020	R-60	U-0.020	R-60	U-0.032	R-38
Walls, above grade						
Mass	U-0.099	R-11.4 c.i.	U-0.086	R-13.3 c.i.	U-0.580	NR
Metal building	U-0.057	R-11 + R-13 c.i.	U-0.048	R-11 + R-15.8 c.i.	U-0.154	R-19
Steel framed	U-0.061	R-13 + R-12.5 c.i.	U-0.061	R-13 + R-12.5 c.i.	U-0.118	R-13 + R-3.8 c.i.
Wood framed and other	U-0.061	R-13 + R-7.5 c.i.	U-0.061	R-13 + R-7.5 c.i.	U-0.085	R-13 + R-3.8 c.i.
Wall, below grade						
Below-grade *wall*	C-0.113	R-10.0 c.i.	C-0.087	R-12.5 c.i.	C-1.140	NR
Floors						
Mass	U-0.054	R-16.7 c.i.	U-0.048	R-18.7 c.i.	U-0.102	R-8.3 c.i.
Steel joist	U-0.036	R-38	U-0.036	R-38	U-0.049	R-30
Wood framed and other	U-0.031	R-38	U-0.031	R-38	U-0.048	R-30
Slab-on-grade floors						
Unheated	F-0.494	R-20 for 48 in.	F-0.494	R-20 for 48 in.	F-0.730	NR
Heated	F-0.801	R-20 for 48 in.	F-0.654	R-20 full slab	F-0.855	R-20 for 24 in.
Opaque doors						
Swinging	U-0.352		U-0.352		U-0.352	
Nonswinging	U-0.295		U-0.295		U-0.342	

FENESTRATION	Assembly Max. U	Assembly Max. SHGC	Assembly Min. VT/SHGC	Assembly Max. U	Assembly Max. SHGC	Assembly Min. VT/SHGC	Assembly Max. U	Assembly Max. SHGC	Assembly Min. VT/SHGC
Vertical glazing, 0% to 40% of *wall*									
Fixed	U-0.34	E&W-0.34, N&S-0.36	1.10 (for all types)	U-0.34	E&W-0.34, N&S-0.36	1.10 (for all types)	U-0.48	NR (for all types)	NR (for all types)
Operable	U-0.43	E&W-0.31, N&S-0.33		U-0.43	E&W-0.31, N&S-0.33		U-0.62		
Entrance door	U-0.60	E&W-0.31, N&S-0.33		U-0.60	E&W-0.31, N&S-0.33		U-0.73		
Skylight, 0% to 3% of *roof*									

All types	U-0.48	0.38	NR	U-0.48	0.38	NR	U-0.71	NR	NR

* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement; E&W = east and west oriented, N&S = north and south oriented [see Sections 701.4.2.1 (7.4.2.1) and 701.4.2.8 (7.4.2.8)].

** The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1 (7.4.2.1) but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1 (7.4.2.1).

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).

TABLE E101.5 (TABLE E-5)
EXAMPLE BUILDING ENVELOPE COMPLIANCE VALUES FOR CLIMATE ZONE 5 (A,B,C)* (I-P)
(SUPERSEDES TABLE 5.5-5 IN ANSI/ASHRAE/IES STANDARD 90.1)

OPAQUE ELEMENTS	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
	Assembly Maximum	Insulation Min. R-value**		Assembly Maximum	Insulation MiN. R-value**		Assembly Maximum	Insulation Min. R-value**	
Roofs									
Insulation entirely above deck	U-0.030	R-35 c.i.		U-0.030	R-35 c.i.		U-0.060	R-17 c.i.	
Metal building[a]	U-0.035	R-11 + R-19 c.i.		U-0.035	R-11 + R-19 c.i.		U-0.078	R-19 + R-6.5 c.i.	
Attic and other roofs	U-0.020	R-60		U-0.020	R-60		U-0.032	R-38	
Walls, above grade									
Mass	U-0.086	R-13.3 c.i.		U-0.076	R-15.0 c.i.		U-0.143	R-7.5 c.i.	
Metal building	U-0.048	R-11 + R-15.8 c.i.		U-0.048	R-11 + R-15.8 c.i.		U-0.089	R-11 + R-6.5 c.i.	
Steel framed	U-0.052	R-13 + R-12.5 c.i.		U-0.052	R-13 + R-12.5 c.i.		U-0.080	R-13 + R-5.0 c.i.	
Wood framed and other	U-0.048	R-13 + R-12.5 c.i.		U-0.048	R-13 + R-12.5 c.i.		U-0.085	R-13 + R-3.8 c.i.	
Wall, below grade									
Below-grade *wall*	C-0.113	R-10.0 c.i.		C-0.087	R-12.5 c.i.		C-1.140	NR	
Floors									
Mass	U-0.054	R-16.7 c.i.		U-0.048	R-18.7 c.i.		U-0.102	R-8.3 c.i.	
Steel joist	U-0.036	R-38		U-0.036	R-38		U-0.049	R-30	
Wood framed and other	U-0.031	R-38		U-0.031	R-38		U-0.048	R-30	
Slab-on-grade floors									
Unheated	F-0.494	R-20 for 48 in.		F-0.485	R-20 for 48 in.		F-0.730	NR	
Heated	F-0.654	R-20 full slab		F-0.654	R-20 full slab		F-0.855	R-20 for 24 in.	
Opaque doors									
Swinging	U-0.352			U-0.352			U-0.352		
Nonswinging	U-0.295			U-0.295			U-0.342		
FENESTRATION	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**
Vertical glazing, 0% to 40% of *wall*									
Fixed	U-0.34	E&W-0.36, S-0.38, N-0.48	1.10 (for all types)	U-0.34	E&W-0.36, S-0.38, N-0.48	1.10 (for all types)	U-0.48	NR (for all types)	NR (for all types)
Operable	U-0.43	E&W-0.31, S-0.33, N-0.43		U-0.43	E&W-0.31, S-0.33, N-0.43		U-0.62		
Entrance door	U-0.60	E&W-0.31, S-0.33, N-0.43		U-0.60	E&W-0.31, S-0.33, N-0.43		U-0.73		

Skylight, 0% to 3% of *roof*									
All types	U-0.48	0.38	NR	U-0.48	0.38	NR	U-0.71	NR	NR

* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement; E&W = east and west oriented, S = south oriented, N = within 22.5 degrees of north in the Northern Hemisphere [see Sections 701.4.2.1 (7.4.2.1) and 701.4.2.8 (7.4.2.8)].

** The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1 (7.4.2.1) but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1 (7.4.2.1).

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).

TABLE E101.6 (TABLE E-6)
EXAMPLE BUILDING ENVELOPE COMPLIANCE VALUES FOR CLIMATE ZONE 6 (A,B)* (I-P)
(SUPERSEDES TABLE 5.5-6 IN ANSI/ASHRAE/IES STANDARD 90.1)

OPAQUE ELEMENTS	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
	Assembly Maximum	Insulation Min. R-value**		Assembly Maximum	Insulation Min. R-value**		Assembly Maximum	Insulation Min. R-value**	
Roofs									
Insulation entirely above deck	U-0.030	R-35 c.i.		U-0.030	R-35 c.i.		U-0.060	R-17 c.i.	
Metal building[a]	U-0.029	R-30 + R-11 *Ls*		U-0.028	R-10 + R-19 + R-13 c.i.		U-0.057	R-10 + R-10 + R-6.5 c.i.	
Attic and other roofs	U-0.020	R-60		U-0.020	R-60		U-0.032	R-38	
Walls, above grade									
Mass	U-0.076	R-15.0 c.i.		U-0.067	R-17.5 c.i.		U-0.143	R-7.5 c.i.	
Metal building	U-0.048	R-11 + R-15.8 c.i.		U-0.048	R-11 + R-15.8 c.i.		U-0.089	R-11 + R-6.5 c.i.	
Steel framed	U-0.047	R-13 + R-15.6 c.i.		U-0.047	R-13 + R-15.6 c.i.		U-0.080	R-13 + R-5 c.i.	
Wood framed and other	U-0.048	R-13 + R-12.5 c.i.		U-0.048	R-13 + R-12.5 c.i.		U-0.085	R-13 + R-3.8 c.i.	
Wall, below grade									
Below-grade *wall*	C-0.087	R-12.5 c.i.		C-0.060	R-17.5 c.i.		C-0.113	R-10.0 c.i.	
Floors									
Mass	U-0.048	R-18.7 c.i.		U-0.048	R-18.7 c.i.		U-0.083	R-10 c.i.	
Steel joist	U-0.030	R-49.0		U-0.030	R-49		U-0.049	R-30	
Wood framed and other	U-0.026	R-38+ R-7.5 c.i.		U-0.026	R-38 + R-7.5 c.i.		U-0.048	R-30	
Slab-on-grade floors									
Unheated	F-0.485	R-20 for 48 in.		F-0.412	R-15 full slab		F-0.730	NR	
Heated	F-0.654	R-20 full slab		F-0.637	R-20 full slab		F-0.817	R-20 for 48 in.	
Opaque doors									
Swinging	U-0.352			U-0.352			U-0.352		
Nonswinging	U-0.295			U-0.295			U-0.342		
FENESTRATION	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**
Vertical glazing, 0% to 40% of *wall*									
Fixed	U-0.32	E&W-0.36, S-0.38, N-0.48	1.10 (for all types)	U-0.29	E&W-0.36, S-0.38, N-0.48	1.10 (for all types)	U-0.37	NR (for all types)	NR (for all types)
Operable	U-0.40	E&W-0.32, S-0.34, N-0.44		U-0.34	E&W-0.32, S-0.34, N-0.44		U-0.46		
Entrance door	U-0.60	E&W-0.32, S-0.34, N-0.44		U-0.43	E&W-0.32, S-0.34, N-0.44		U-0.65		

Skylight, 0% to 3% of *roof*									
All types	U-0.48	0.38	NR	U-0.48	0.38	NR	U-0.71	NR	NR

* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement; Ls = liner system (see ANSI/ASHRAE/IES Standard 90.1, Section A2.3.2.4); E&W = east and west oriented, S = south oriented, N = within 22.5 degrees of north in the Northern Hemisphere [see Sections 701.4.2.1 (7.4.2.1) and 701.4.2.8 (7.4.2.8)].

** The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1 (7.4.2.1) but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1 (7.4.2.1).

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).

TABLE E101.7 (TABLE E-7)
EXAMPLE BUILDING ENVELOPE COMPLIANCE VALUES FOR CLIMATE ZONE 7* (I-P)
(SUPERSEDES TABLE 5.5-7 IN ANSI/ASHRAE/IES STANDARD 90.1)

OPAQUE ELEMENTS	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
	Assembly Maximum	Insulation Min. R-value**		Assembly Maximum	Insulation Min. R-value**		Assembly Maximum	Insulation Min. R-value**	
Roofs									
Insulation entirely above deck	U-0.027	R-40 c.i.		U-0.027	R-40 c.i.		U-0.037	R-26 c.i.	
Metal building [a]	U-0.028	R-10 + R-19 + R-13 c.i.		U-0.028	R-10 + R-19 + R-13 c.i.		U-0.035	R-11 + R-19 c.i.	
Attic and other roofs	U-0.016	R-71		U-0.016	R-71		U-0.026	R-49	
Walls, above grade									
Mass	U-0.067	R-17.5 c.i.		U-0.067	R-17.5 c.i.		U-0.117	R-9.5 c.i.	
Metal building	U-0.042	R-11 + R-19 c.i.		U-0.042	R-11 + R-19 c.i.		U-0.068	R-11 + R-9.8 c.i.	
Steel framed	U-0.047	R-13 + R-15.6 c.i.		U-0.040	R-13 + R-18.8 c.i.		U-0.061	R-13 + R-12.5 c.i.	
Wood framed and other	U-0.048	R-13 + R-12.5 c.i.		U-0.048	R-13 + R-12.5 c.i.		U-0.061	R-13 + R-7.5 c.i.	
Wall, below grade									
Below-grade *wall*	C-0.060	R-17.5 c.i.		C-0.060	R-17.5 c.i.		C-0.113	R-10.0 c.i.	
Floors									
Mass	U-0.040	R-23 c.i.		U-0.040	R-23 c.i.		U-0.070	R-12.5 c.i.	
Steel joist	U-0.030	R-49		U-0.030	R-49		U-0.049	R-30	
Wood framed and other	U-0.026	R-38 + R-7.5 c.i.		U-0.026	R-38 + R-7.5 c.i.		U-0.048	R-30	
Slab-on-grade floors									
Unheated	F-0.485	R-20 for 48 in.		F-0.412	R-15 full slab		F-0.730	NR	
Heated	F-0.637	R-20 full slab		F-0.637	R-20 full slab		F-0.817	R-20 for 48 in.	
Opaque doors									
Swinging	U-0.352			U-0.352			U-0.352		
Nonswinging	U-0.295			U-0.295			U-0.295		
FENESTRATION	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**
Vertical glazing, 0% to 40% of *wall*									
Fixed	U-0.28	E&W-0.38, S-0.40, N-0.50	1.10 (for all types)	U-0.28	E&W-0.38, S-0.40, N-0.50	1.10 (for all types)	U-0.34	NR (for all types)	NR (for all types)
Operable	U-0.34	E&W-0.34, S-0.36, N-0.46		U-0.34	E&W-0.34, S-0.36, N-0.46		U-0.42		
Entrance door	U-0.60	E&W-0.34, S-0.36, N-0.46		U-0.60	E&W-0.34, S-0.36, N-0.46		U-0.60		

Skylight, 0% to 3% of *roof*									
All types	U-0.42	NR	NR	U-0.42	NR	NR	U-0.71	NR	NR

* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement; E&W = east and west oriented, S = south oriented, N = within 22.5 degrees of north in the Northern Hemisphere [see Sections 701.4.2.1 (7.4.2.1) and 701.4.2.8 (7.4.2.8)].

** The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1 (7.4.2.1) but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1 (7.4.2.1).

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).

TABLE E101.8 (TABLE E-8)
EXAMPLE BUILDING ENVELOPE COMPLIANCE VALUES FOR CLIMATE ZONE 8* (I-P)
(SUPERSEDES TABLE 5.5-8 IN ANSI/ASHRAE/IES STANDARD 90.1)

OPAQUE ELEMENTS	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
	Assembly Maximum	Insulation Min. R-value**		Assembly Maximum	Insulation Min. R-value**		Assembly Maximum	Insulation Min. R-value**	
Roofs									
Insulation entirely above deck	U-0.027	R-40 c.i.		U-0.027	R-40 c.i.		U-0.037	R-26 c.i.	
Metal building [a]	U-0.025	R-19 + R-19 + R-25 c.i.		U-0.025	R-19 + R-19 + R-25 c.i.		U-0.035	R-11 + R-19 c.i.	
Attic and other roofs	U-0.016	R-71		U-0.016	R-71		U-0.026	R-49	
Walls, above grade									
Mass	U-0.046	R-21.0 c.i.		U-0.046	R-21.0 c.i.		U-0.099	R-11.4 c.i.	
Metal building	U-0.037	R-11 + R-22.1 c.i.		U-0.037	R-11 + R-22.1 c.i.		U-0.057	R-11 + R-13 c.i.	
Steel framed	U-0.035	R-13 + R-21.9 c.i.		U-0.035	R-13 + R-21.9 c.i.		U-0.061	R-13 + R-12.5 c.i.	
Wood framed and other	U-0.030	R-13 + R-21.9 c.i.		U-0.030	R-13 + R-21.9 c.i.		U-0.048	R-13 + R-12.5 c.i.	
Wall, below grade									
Below-grade *wall*	C-0.060	R-17.5 c.i.		C-0.060	R-17.5 c.i.		C-0.113	R-10.0 c.i.	
Floors									
Mass	U-0.036	R-25.1 c.i.		U-0.036	R-25.1 c.i.		U-0.061	R-14.6 c.i.	
Steel joist	U-0.030	R-49		U-0.030	R-49		U-0.049	R-30	
Wood framed and other	U-0.026	R-38 + R-7.5 c.i.		U-0.026	R-38 + R-7.5 c.i.		U-0.031	R-38	
Slab-on-grade floors									
Unheated	F-0.412	R-15 full slab		F-0.403	R-15 full slab		F-0.513	R-20 for 24 in.	
Heated	F-0.637	R-20 full slab		F-0.354	R-25 full slab		F-0.817	R-20 for 48 in.	
Opaque doors									
Swinging	U-0.352			U-0.352			U-0.352		
Nonswinging	U-0.295			U-0.295			U-0.295		
FENESTRATION	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**
Vertical glazing, 0% to 40% of *wall*									
Fixed	U-0.25	E&W-0.38, S-0.40, N-0.50	1.10 (for all types)	U-0.25	E&W-0.38, S-0.40, N-0.50	1.10 (for all types)	U-0.34	NR (for all types)	NR (for all types)
Operable	U-0.30	E&W-0.34, S-0.36, N-0.46		U-0.30	E&W-0.34, S-0.36, N-0.46		U-0.42		

Entrance door	U-0.60	E&W-0.34, S-0.36, N-0.46		U-0.60	E&W-0.34, S-0.36, N-0.46		U-0.60		
Skylight, 0% to 3% of *roof*									
All types	U-0.39	NR	NR	U-0.39	NR	NR	U-0.71	NR	NR

* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement; E&W = east and west oriented, S = south oriented, N = within 22.5 degrees of north in the Northern Hemisphere [see Sections 701.4.2.1 (7.4.2.1) and 701.4.2.8 (7.4.2.8)].

** The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1 (7.4.2.1) but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1 (7.4.2.1).

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).

Informative Note: These tables are the same as Tables E101.0–E101.8 but are provided in SI units.

TABLE E101.0 (TABLE E-0)
EXAMPLE BUILDING ENVELOPE COMPLIANCE VALUES FOR CLIMATE ZONE 0 (A,B)* (SI)
(SUPERSEDES TABLE 5.5-0 IN ANSI/ASHRAE/IES STANDARD 90.1)

OPAQUE ELEMENTS	NONRESIDENTIAL		RESIDENTIAL		SEMIHEATED	
	Assembly Maximum	Insulation Min. R-value**	Assembly Maximum	Insulation Min. R-value**	Assembly Maximum	Insulation Min. R-value**
Roofs						
Insulation entirely above deck	U-0.222	R-4.4 c.i.	U-0.184	R-5.3 c.i.	U-1.240	R-0.7 c.i.
Metal building[a]	U-0.233	R-1.8 + R-3.3 FC	U-0.233	R-1.8 + R-3.3 FC	U-0.653	R-1.8
Attic and other roofs	U-0.153	R-6.7	U-0.153	R-6.7	U-0.459	R-2.3
Walls, above grade						
Mass[b]	U-3.293	NR	U-0.857	R-1.0 c.i.	U-3.293	NR
Metal building	U-0.533	R-0 + R-1.7 ci	U-0.533	R-0 + R-1.7 ci	U-1.998	NR
Steel framed	U-0.705	R-2.3	U-0.705	R-2.3	U-1.998	NR
Wood framed and other	U-0.504	R-2.3	U-0.504	R-2.3	U-1.660	NR
Wall, below grade						
Below-grade *wall*	C-6.473	NR	C-6.473	NR	C-6.473	NR
Floors						
Mass	U-1.825	NR	U-1.825	NR	U-1.825	NR
Steel joist	U-1.986	NR	U-1.986	NR	U-1.986	NR
Wood framed and other	U-1.599	NR	U-1.599	NR	U-1.599	NR
Slab-on-grade floors						
Unheated	F-1.264	NR	F-1.264	NR	F-1.264	NR
Heated	F-1.766	R-1.3 for 300 mm	F-1.766	R-1.3 for 300 mm	F-1.766	R-1.3 for 300 mm
Opaque doors						
Swinging	U-2.101		U-2.101		U-3.975	
Nonswinging	U-1.760		U-1.760		U-8.233	

FENESTRATION	Assembly Max. U	Assembly Max. SHGC	Assembly Min. VT/SHGC	Assembly Max. U	Assembly Max. SHGC	Assembly Min. VT/SHGC	Assembly Max. U	Assembly Max. SHGC	Assembly Min. VT/SHGC
Vertical glazing, 0% to 40% of *wall*									
Fixed	U-2.70	E &W-0.21, N&S-0.22	1.10 (for all types)	U-2.70	E &W-0.21, N&S-0.22	1.10 (for all types)	U-6.48	NR (for all types)	NR (for all types)

Operable	U-3.34	E &W-0.19, N&S-0.20		U-3.34	E &W-0.19, N&S-0.20		U-6.48		
Entrance door	U-4.48	E &W-0.19, N&S-0.20		U-4.48	E &W-0.19, N&S-0.20		U-5.94		
Skylight, 0% to 3% of *roof*									
All types	U-3.77	0.29	NR	U-3.77	0.29	NR	U-9.71	NR	NR

* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement; FC = filled cavity (see ANSI/ASHRAE/IES Standard 90.1, Section A2.3.2.5); E&W = east and west oriented, N&S = north and south oriented [see Sections 701.4.2.1 (7.4.2.1) and 701.4.2.8 (7.4.2.8)].

** The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1 (7.4.2.1) but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1 (7.4.2.1).

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).

b. Exception applies for mass *walls* above grade where the requirement is for a maximum assembly U-0.151 (see ANSI/ASHRAE/IES Standard 90.1, Section 5.5.3.2).

Informative Note:

Informative Note:

TABLE E101.1 (TABLE E-1)
EXAMPLE BUILDING ENVELOPE COMPLIANCE VALUES FOR CLIMATE ZONE 1 (A,B)* (SI)
(SUPERSEDES TABLE 5.5-1 IN ANSI/ASHRAE/IES STANDARD 90.1)

OPAQUE ELEMENTS	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
	Assembly Maximum	Insulation Min. R-value**		Assembly Maximum	Insulation Min. R-value**		Assembly Maximum	Insulation Min. R-value**	
Roofs									
Insulation entirely above deck	U-0.273	R-3.5 c.i.		U-0.220	R-4.4 c.i.		U-1.240	R-0.7 c.i.	
Metal building [a]	U-0.233	R-1.8 + R-3.3 FC		U-0.233	R-1.8 + R-3.3 FC		U-0.653	R-1.8	
Attic and other roofs	U-0.153	R-6.7		U-0.153	R-6.7		U-0.459	R-2.3	
Walls, above grade									
Mass [b]	U-3.293	NR		U-0.857	R-1.0 c.i.		U-3.293	NR	
Metal building	U-0.533	R-0 + R-1.7 c.i.		U-0.533	R-0 + R-1.7 c.i.		U-1.998	NR	
Steel framed	U-0.705	R-2.3		U-0.705	R-2.3		U-1.998	NR	
Wood framed and other	U-0.504	R-2.3		U-0.504	R-2.3		U-1.660	NR	
Wall, below grade									
Below-grade *wall*	C-6.473	NR		C-6.473	NR		C-6.473	NR	
Floors									
Mass	U-1.825	NR		U-1.825	NR		U-1.825	NR	
Steel joist	U-1.986	NR		U-1.986	NR		U-1.986	NR	
Wood framed and other	U-1.599	NR		U-1.599	NR		U-1.599	NR	
Slab-on-grade floors									
Unheated	F-1.264	NR		F-1.264	NR		F-1.264	NR	
Heated	F-1.766	R-1.3 for 300 mm		F-1.766	R-1.3 for 300 mm		F-1.766	R-1.3 for 300 mm	
Opaque doors									
Swinging	U-2.101			U-2.101			U-3.975		
Nonswinging	U-1.760			U-1.760			U-8.233		
FENESTRATION	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**
Vertical glazing, 0% to 40% of *wall*									
Fixed	U-2.70	E&W-0.22, N&S-0.23	1.10 (for all types)	U-2.70	E&W-0.22, N&S-0.23	1.10 (for all types)	U-6.48	NR (for all types)	NR (for all types)
Operable	U-3.34	E&W-0.20, N&S-0.21		U-3.34	E&W-0.20, N&S-0.21		U-6.48		
Entrance door	U-4.47	E&W-0.20, N&S-0.21		U-4.47	E&W-0.20, N&S-0.21		U-5.94		
Skylight, 0% to 3% of *roof*									

All types	U-3.77	0.29	NR	U-3.77	0.29	NR	U-9.71	NR	NR

* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement; FC = filled cavity (see ANSI/ASHRAE/IES Standard 90.1, Section A2.3.2.5); E&W = east and west oriented, N&S = north and south oriented [see Sections 701.4.2.1 (7.4.2.1) and 701.4.2.8 (7.4.2.8)].

** The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1 (7.4.2.1) but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1 (7.4.2.1).

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).

b. Exception applies for mass *walls* above grade where the requirement is for a maximum assembly U-0.151 (see ANSI/ASHRAE/IES Standard 90.1, Section 5.5.3.2).

TABLE E101.2 (TABLE E-2)
EXAMPLE BUILDING ENVELOPE COMPLIANCE VALUES FOR CLIMATE ZONE 2 (A,B)* (SI)
(SUPERSEDES TABLE 5.5-2 IN ANSI/ASHRAE/IES STANDARD 90.1)

OPAQUE ELEMENTS	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
	Assembly Maximum	Insulation Min. R-value**		Assembly Maximum	Insulation Min. R-value**		Assembly Maximum	Insulation Min. R-value**	
Roofs									
Insulation entirely above deck	U-0.220	R-4.4 c.i.		U-0.220	R-4.4 c.i.		U-0.982	R-0.9 c.i.	
Metal building [a]	U-0.233	R-1.8 + R-3.3 FC		U-0.233	R-1.8 + R-3.3 FC		U-0.545	R-2.8	
Attic and other roofs	U-0.153	R-6.7		U-0.153	R-6.7		U-0.300	R-3.3	
Walls, above grade									
Mass [b]	U-0.857	R-1.0 c.i.		U-0.701	R-1.3 c.i.		U-3.293	NR	
Metal building	U-0.533	R-0 + R-1.7 c.i.		U-0.533	R-0 + R-1.7 c.i.		U-0.920	R-2.3	
Steel framed	U-0.479	R-2.3 + R-0.7 c.i.		U-0.365	R-2.3 + R-1.3 c.i.		U-0.705	R-2.3	
Wood framed and other	U-0.504	R-2.3		U-0.504	R-2.3		U-0.504	R-2.3	
Wall, below grade									
Below-grade *wall*	C-6.473	NR		C-6.473	NR		C-6.473	NR	
Floors									
Mass	U-0.606	R-1.1		U-0.496	R-1.5		U-1.825	NR	
Steel joist	U-0.214	R-5.3		U-0.214	R-5.3		U-0.390	R-2.3	
Wood framed and other	U-0.188	R-5.3		U-0.188	R-5.3		U-0.376	R-2.3	
Slab-on-grade floors									
Unheated	F-1.264	NR		F-1.264	NR		F-1.264	NR	
Heated	F-1.558	R-1.8 for 600 mm		F-1.489	R-2.6 for 600 mm		F-1.766	R-1.3 for 300 mm	
Opaque doors									
Swinging	U-2.101			U-2.101			U-3.975		
Nonswinging	U-1.760			U-1.760			U-8.233		
FENESTRATION	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**
Vertical glazing, 0% to 40% of *wall*									
Fixed	U-2.43	E&W-0.24, N&S-0.25	1.10 (for all types)	U-2.43	E&W-0.24, N&S-0.25	1.10 (for all types)	U-2.70	NR (for all types)	NR (for all types)
Operable	U-3.23	E&W-0.22, N&S-0.23		U-3.23	E&W-0.22, N&S-0.23		U-3.50		
Entrance door	U-4.15	E&W-0.22, N&S-0.23		U-4.15	E&W-0.22, N&S-0.23		U-4.15		
Skylight, 0% to 3% of *roof*									

All types	U-3.51	0.29	NR	U-3.51	0.29	NR	U-4.85	NR	NR

* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement; FC = filled cavity (see ANSI/ASHRAE/IES Standard 90.1, Section A2.3.2.5); E&W = east and west oriented, N&S = north and south oriented [see Sections 701.4.2.1 (7.4.2.1) and 701.4.2.8 (7.4.2.8)].

** The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1 (7.4.2.1) but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1 (7.4.2.1).

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).

b. Exception applies for mass *walls* above grade where the requirement is for a maximum assembly U-0.151 (see ANSI/ASHRAE/IES Standard 90.1, Section 5.5.3.2).

TABLE E101.3 (TABLE E-3)
EXAMPLE BUILDING ENVELOPE COMPLIANCE VALUES FOR CLIMATE ZONE 3 (A,B,C)* (SI)
(SUPERSEDES TABLE 5.5-3 IN ANSI/ASHRAE/IES STANDARD 90.1)

OPAQUE ELEMENTS	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
	Assembly Maximum	Insulation Min. R-value**		Assembly Maximum	Insulation Min. R-value**		Assembly Maximum	Insulation Min. R-value**	
Roofs									
Insulation entirely above deck	U-0.220	R-4.4 c.i.		U-0.220	R-4.4 c.i.		U-0.677	R-1.3 c.i.	
Metal building [a]	U-0.233	R-1.8 + R-3.3 FC		U-0.233	R-1.8 + R-3.3 FC		U-0.545	R-2.8	
Attic and other roofs	U-0.153	R-6.7		U-0.153	R-6.7		U-0.300	R-3.3	
Walls, above grade									
Mass	U-0.701	R-1.3 c.i.		U-0.592	R-1.7 c.i.		U-3.293	NR	
Metal building	U-0.533	R-0 + R-1.7 c.i.		U-0.409	R-0 + R-2.3 c.i.		U-0.920	R-2.3	
Steel framed	U-0.435	R-2.3 + R-0.9 c.i.		U-0.365	R-2.3 + R-1.3 c.i.		U-0.705	R-2.3	
Wood framed and other	U-0.504	R-2.3		U-0.365	R-2.3 + R-0.7 c.i.		U-0.504	R-2.3	
Wall, below grade									
Below-grade *wall*	C-6.473	NR		C-6.473	NR		C-6.473	NR	
Floors									
Mass	U-0.420	R-1.8 c.i.		U-0.420	R-1.8 c.i.		U-0.780	R-0.7 c.i.	
Steel joist	U-0.214	R-5.3		U-0.214	R-5.3		U-0.296	R-3.3	
Wood framed and other	U-0.188	R-5.3		U-0.188	R-5.3		U-0.288	R-3.3	
Slab-on-grade floors									
Unheated	F-1.264	NR		F-0.935	R-1.8 for 600 mm		F-1.264	NR	
Heated	F-1.489	R-2.6 for 600 mm		F-1.489	R-2.6 for 600 mm		F-1.766	R-1.3 for 300 mm	
Opaque doors									
Swinging	U-2.101			U-2.101			U-2.101		
Nonswinging	U-1.760			U-1.760			U-2.044		
FENESTRATION	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**
Vertical glazing, 0% to 40% of *wall*									
Nonmetal framing, all	U-2.26	E&W-0.24, N&S-0.25	1.10 (for all types)	U-2.26	E&W-0.24, N&S-0.25	1.10 (for all types)	U-2.70	NR (for all types)	NR (for all types)
Metal framing, fixed	U-2.91	E&W-0.22, N&S-0.23		U-2.91	E&W-0.22, N&S-0.23		U-3.50		
Metal framing, operable	U-3.76	E&W-0.22, N&S-0.23		U-3.76	E&W-0.22, N&S-0.23		U-4.15		
Skylight, 0% to 3% of *roof*									
All types	U-2.97	0.29	NR	U-2.97	0.29	NR	U-4.85	NR	NR

* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement; FC = filled cavity (see ANSI/ASHRAE/IES Standard 90.1, Section A2.3.2.5); E&W = east and west oriented, N&S = north and south oriented [see Sections 701.4.2.1 (7.4.2.1) and 701.4.2.8 (7.4.2.8)].

** The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1 (7.4.2.1) but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1 (7.4.2.1).

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).

TABLE E101.4 (TABLE E-4)
EXAMPLE BUILDING ENVELOPE COMPLIANCE VALUES FOR CLIMATE ZONE 4 (A,B,C)* (SI)
(SUPERSEDES TABLE 5.5-4 IN ANSI/ASHRAE/IES STANDARD 90.1)

OPAQUE ELEMENTS	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
	Assembly Maximum	Insulation Min. R-value**		Assembly Maximum	Insulation Min. R-value**		Assembly Maximum	Insulation Min. R-value**	
Roofs									
Insulation entirely above deck	U-0.173	R-6.2 c.i.		U-0.173	R-6.2 c.i.		U-0.502	R-1.9 c.i.	
Metal building [a]	U-0.200	R-1.9 + R-3.3 c.i.		U-0.200	R-1.9 + R-3.3 c.i.		U-0.442	R-3.3 + R-1.1 c.i.	
Attic and other roofs	U-0.113	R-10.6		U-0.113	R-10.6		U-0.183	R-6.7	
Walls, above grade									
Mass	U-0.561	R-2.0 c.i.		U-0.486	R-2.3 c.i.		U-3.294	NR	
Metal building	U-0.324	R-1.9 + R-2.3 c.i.		U-0.270	R-1.9 + R-2.8 c.i.		U-0.874	R-3.3	
Steel framed	U-0.345	R-2.3 + R-2.2 c.i.		U-0.345	R-2.3 + R-2.2 c.i.		U-0.669	R-2.3 + R-0.7 c.i.	
Wood framed and other	U-0.345	R-2.3 + R-1.3 c.i.		U-0.345	R-2.3 + R-1.3 c.i.		U-0.480	R-2.3 + R-0.7 c.i.	
Wall, below grade									
Below-grade *wall*	C-0.642	R-1.8 c.i.		C-0.496	R-2.2 c.i.		C-6.475	NR	
Floors									
Mass	U-0.308	R-2.9 c.i.		U-0.275	R-3.3 c.i.		U-0.577	R-1.5 c.i.	
Steel joist	U-0.205	R-6.7		U-0.205	R-6.7		U-0.281	R-5.3	
Wood framed and other	U-0.178	R-6.7		U-0.178	R-6.7		U-0.275	R-5.3	
Slab-on-grade floors									
Unheated	F-0.855	R-3.5 for 1200 mm		F-0.855	R-3.5 for 1200 mm		F-1.264	NR	
Heated	F-1.386	R-3.5 for 1200 mm		F-1.131	R-3.5 full slab		F-1.480	R-3.5 for 600 mm	
Opaque doors									
Swinging	U-1.997			U-1.997			U-1.997		
Nonswinging	U-1.673			U-1.673			U-1.943		
FENESTRATION	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**
Vertical glazing, 0% to 40% of *wall*									
Fixed	U-1.94	E&W-0.34, N&S-0.36	1.10 (for all types)	U-1.94	E&W-0.34, N&S-0.36	1.10 (for all types)	U-2.70	NR (for all types)	NR (for all types)
Operable	U-2.43	E&W-0.31, N&S-0.33		U-2.43	E&W-0.31, N&S-0.33		U-3.50		
Entrance door	U-3.40	E&W-0.31, N&S-0.33		U-3.40	E&W-0.31, N&S-0.33		U-4.15		

Skylight, 0% to 3% of *roof*									
All types	U-2.70	0.38	NR	U-2.70	0.38	NR	U-4.04	NR	NR

* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement; E&W = east and west oriented, N&S = north and south oriented [see Sections 701.4.2.1 (7.4.2.1) and 701.4.2.8 (7.4.2.8)].

** The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1 (7.4.2.1) but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1 (7.4.2.1).

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).

TABLE E101.5 (TABLE E-5)
EXAMPLE BUILDING ENVELOPE COMPLIANCE VALUES FOR CLIMATE ZONE 5 (A, B, C)* (SI)
(SUPERSEDES TABLE 5.5-5 IN ANSI/ASHRAE/IES STANDARD 90.1)

OPAQUE ELEMENTS	NONRESIDENTIAL		RESIDENTIAL		SEMIHEATED	
	Assembly Maximum	Insulation Min. R-value**	Assembly Maximum	Insulation Min. R-value**	Assembly Maximum	Insulation Min. R-value**
Roofs						
Insulation entirely above deck	U-0.173	R-6.2 c.i.	U-0.173	R-6.2 c.i.	U-0.340	R-3.0 c.i.
Metal building [a]	U-0.200	R-1.9 + R-3.3 c.i.	U-0.200	R-1.9 + R-3.3 c.i.	U-0.442	R-3.3 + R-1.1 c.i.
Attic and other roofs	U-0.113	R-10.6	U-0.113	R-10.6	U-0.183	R-6.7
Walls, above grade						
Mass	U-0.486	R-2.3 c.i.	U-0.432	R-2.6 c.i.	U-0.815	R-1.3 c.i.
Metal building	U-0.270	R-1.9 + R-2.8 c.i.	U-0.270	R-1.9 + R-2.8 c.i.	U-0.507	R-1.9 + R-1.1 c.i.
Steel framed	U-0.297	R-2.3 + R-2.2 c.i.	U-0.297	R-2.3 + R-2.2 c.i.	U-0.453	R-2.3 + R-0.9 c.i.
Wood framed and other	U-0.275	R-2.3 + R-2.2 c.i.	U-0.275	R-2.3 + R-2.2 c.i.	U-0.480	R-2.3 + R-0.7 c.i.
Wall, below grade						
Below-grade *wall*	C-0.642	R-1.8 c.i.	C-0.496	R-2.2 c.i.	C-6.475	NR
Floors						
Mass	U-0.308	R-2.9 c.i.	U-0.275	R-3.3 c.i.	U-0.577	R-1.5 c.i.
Steel joist	U-0.205	R-6.7	U-0.205	R-6.7	U-0.281	R-5.3
Wood framed and other	U-0.178	R-6.7	U-0.178	R-6.7	U-0.275	R-5.3
Slab-on-grade floors						
Unheated	F-0.855	R-3.5 for 1200 mm	F-0.839	R-3.5 for 1200 mm	F-1.264	NR
Heated	F-1.131	R-3.5 full slab	F-1.131	R-3.5 full slab	F-1.480	R-3.5 for 600 mm
Opaque doors						
Swinging	U-1.997		U-1.997		U-1.997	
Nonswinging	U-1.673		U-1.673		U-1.943	

FENESTRATION	Assembly Max. U	Assembly Max. SHGC	Assembly Min. VT/SHGC	Assembly Max. U	Assembly Max. SHGC	Assembly Min. VT/SHGC	Assembly Max. U	Assembly Max. SHGC	Assembly Min. VT/SHGC
Vertical glazing, 0% to 40% of *wall*									
Fixed	U-1.94	E&W-0.36, S-0.38, N-0.48	1.10 (for all types)	U-1.94	E&W-0.36, S-0.38, N-0.48	1.10 (for all types)	U-2.70	NR (for all types)	NR (for all types)
Operable	U-2.43	E&W-0.31, S-0.33, N-0.43		U-2.43	E&W-0.31, S-0.33, N-0.43		U-3.50		

Entrance door	U-3.40	E&W-0.31, S-0.33, N-0.43		U-3.40	E&W-0.31, S-0.33, N-0.43		U-4.15		
Skylight, 0% to 3% of *roof*									
All types	U-2.70	0.38	NR	U-2.70	0.38	NR	U-4.04	NR	NR

* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement; E&W = east and west oriented, S = south oriented, N = within 22.5 degrees of north in the Northern Hemisphere [see Sections 701.4.2.1 (7.4.2.1) and 701.4.2.8 (7.4.2.8)].

** The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1 (7.4.2.1) but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1 (7.4.2.1).

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).

TABLE E101.6 (TABLE E-6)
EXAMPLE BUILDING ENVELOPE COMPLIANCE VALUES FOR CLIMATE ZONE 6 (A,B)* (SI)
(SUPERSEDES TABLE 5.5-6 IN ANSI/ASHRAE/IES STANDARD 90.1)

OPAQUE ELEMENTS	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
	Assembly Maximum	Insulation Min. R-value**		Assembly Maximum	Insulation Min. R-value**		Assembly Maximum	Insulation Min. R-value**	
Roofs									
Insulation entirely above deck	U-0.173	R-6.2 c.i.		U-0.173	R-6.2 c.i.		U-0.340	R-3.0 c.i.	
Metal building [a]	U-0.167	R-5.3 + R-1.9 *Ls*		U-0.156	R-1.8 + R-3.3 + R-2.3 c.i.		U-0.324	R-1.8 + R-1.8 + R-1.1 c.i.	
Attic and other roofs	U-0.113	R-10.6		U-0.113	R-10.6		U-0.183	R-6.7	
Walls, above grade									
Mass	U-0.432	R-2.6 c.i.		U-0.383	R-3.1 c.i.		U-0.815	R-1.3 c.i.	
Metal building	U-0.270	R-1.9 + R-2.8 c.i.		U-0.270	R-1.9 + R-2.8 c.i.		U-0.507	R-1.9 + R-1.1 c.i.	
Steel framed	U-0.264	R-2.3 + R-2.7 c.i.		U-0.264	R-2.3 + R-2.7 c.i.		U-0.453	R-2.3 + R-0.9 c.i.	
Wood framed and other	U-0.275	R-2.3 + R-2.2 c.i.		U-0.275	R-2.3 + R-2.2 c.i.		U-0.480	R-2.3 + R-0.7 c.i.	
Wall, below grade									
Below-grade *wall*	C-0.496	R-2.2 c.i.		C-0.340	R-3.1 c.i.		C-0.642	R-1.8 c.i.	
Floors									
Mass	U-0.275	R-3.3 c.i.		U-0.275	R-3.3 c.i.		U-0.469	R-1.8 c.i.	
Steel joist	U-0.173	R-8.6		U-0.173	R-8.6		U-0.281	R-5.3	
Wood framed and other	U-0.146	R-6.7 + R-1.3 c.i.		U-0.146	R-6.7 + R-1.3 c.i.		U-0.275	R-5.3	
Slab-on-grade floors									
Unheated	F-0.839	R-3.5 for 1200 mm		F-0.714	R-2.6 full slab		F-1.264	NR	
Heated	F-1.131	R-3.5 full slab		F-1.103	R-3.5 full slab		F-1.414	R-3.5 for 1200 mm	
Opaque doors									
Swinging	U-1.997			U-1.997			U-1.997		
Nonswinging	U-1.673			U-1.673			U-1.943		
FENESTRATION	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**
Vertical glazing, 0% to 40% of *wall*									
Fixed	U-1.83	E&W-0.36, S-0.38, N-0.48	1.10 (for all types)	U-1.83	E&W-0.36, S-0.38, N-0.48	1.10 (for all types)	U-2.10	NR (for all types)	NR (for all types)
Operable	U-2.26	E&W-0.32, S-0.34, N-0.44		U-2.26	E&W-0.32, S-0.34, N-0.44		U-2.59		

Entrance door	U-3.40	E&W-0.32, S-0.34, N-0.44		U-3.40	E&W-0.32, S-0.34, N-0.44		U-3.67		
Skylight, 0% to 3% of *roof*									
All types	U-2.53	0.38	NR	U-2.70	0.38	NR	U-4.04	NR	NR

* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement; Ls = liner system (see ANSI/ASHRAE/IES Standard 90.1, Section A2.3.2.4); E&W = east and west oriented, S = south oriented, N = within 22.5 degrees of north in the Northern Hemisphere [see Sections 701.4.2.1 (7.4.2.1) and 701.4.2.8 (7.4.2.8)].

** The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1 (7.4.2.1) but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1 (7.4.2.1).

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).

TABLE E101.7 (TABLE E-7)
EXAMPLE BUILDING ENVELOPE COMPLIANCE VALUES FOR CLIMATE ZONE 7* (SI)
(SUPERSEDES TABLE 5.5-7 IN ANSI/ASHRAE/IES STANDARD 90.1)

OPAQUE ELEMENTS	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
	Assembly Maximum	Insulation Min. R-value**		Assembly Maximum	Insulation Min. R-value**		Assembly Maximum	Insulation Min. R-value**	
Roofs									
Insulation entirely above deck	U-0.151	R-7.0 c.i.		U-0.151	R-7.0 c.i.		U-0.210	R-4.6 c.i.	
Metal building [a]	U-0.156	R-1.8 + R-3.3 +R-2.3 c.i.		U-0.156	R-1.8 + R-3.3 + R-2.3 c.i.		U-0.200	R-1.9 + R-3.3 c.i.	
Attic and other roofs	U-0.092	R-12.5		U-0.092	R-12.5		U-0.146	R-8.6	
Walls, above grade									
Mass	U-0.383	R-3.1 c.i		U-0.383	R-3.1 c.i.		U-0.664	R-1.7 c.i.	
Metal building	U-0.237	R-1.9 + R-3.3 c.i.		U-0.237	R-1.9 + R-3.3 c.i.		U-0.389	R-1.9 + R-1.7 c.i.	
Steel framed	U-0.264	R-2.3 + R-2.7 c.i.		U-0.227	R-2.3 + R-3.3 c.i.		U-0.345	R-2.3 + R-2.2 c.i.	
Wood framed and other	U-0.275	R-2.3 + R-2.2 c.i.		U-0.275	R-2.3 + R-2.2 c.i.		U-0.345	R-2.3 + R-1.3 c.i.	
Wall, below grade									
Below-grade *wall*	C-0.340	R-3.1 c.i.		C-0.340	R-3.1 c.i.		C-0.642	R-1.8 c.i.	
Floors									
Mass	U-0.227	R-4.1 c.i.		U-0.227	R-4.1 c.i.		U-0.399	R-2.2 c.i.	
Steel joist	U-0.173	R-8.6		U-0.173	R-8.6		U-0.281	R-5.3	
Wood framed and other	U-0.146	R-6.7+ R-1.3 c.i.		U-0.146	R-6.7 + R-1.3 c.i.		U-0.275	R-5.3	
Slab-on-grade floors									
Unheated	F-0.839	R-3.5 for 1200 mm		F-0.714	R-2.6 full slab		F-1.264	NR	
Heated	F-1.103	R-3.5 full slab		F-1.103	R-3.5 full slab		F-1.414	R-3.5 for 1200 mm	
Opaque doors									
Swinging	U-1.997			U-1.997			U-1.997		
Nonswinging	U-1.673			U-1.673			U-1.673		
FENESTRATION	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**
Vertical glazing, 0% to 40% of *wall*									
Fixed	U-1.56	E&W-0.38, S-0.40, N-0.50	1.10 (for all types)	U-1.40	E&W-0.38, S-0.40, N-0.50	1.10 (for all types)	U-1.94	NR (for all types)	NR (for all types)
Operable	U-1.94	E&W-0.34, S-0.36, N-0.46		U-1.73	E&W-0.34, S-0.36, N-0.46		U-2.37		

Entrance door	U-3.40	E&W-0.34, S-0.36, N-0.46		U-3.40	E&W-0.34, S-0.36, N-0.46		U-3.40		
Skylight, 0% to 3% of *roof*									
All types	U-2.37	NR	NR	U-2.37	NR	NR	U-4.04	NR	NR

* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement; E&W = east and west oriented, S = south oriented, N = within 22.5 degrees of north in the Northern Hemisphere [see Sections 701.4.2.1 (7.4.2.1) and 701.4.2.8 (7.4.2.8)].

** The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1 (7.4.2.1) but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1 (7.4.2.1).

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).

TABLE E101.8 (TABLE E-8)
EXAMPLE BUILDING ENVELOPE COMPLIANCE VALUES FOR CLIMATE ZONE 8* (SI)
(SUPERSEDES TABLE 5.5-8 IN ANSI/ASHRAE/IES STANDARD 90.1)

OPAQUE ELEMENTS	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
	Assembly Maximum	Insulation Min. R-value**		Assembly Maximum	Insulation Min. R-value**		Assembly Maximum	Insulation Min. R-value**	
Roofs									
Insulation entirely above deck	U-0.151	R-7.0 c.i.		U-0.151	R-7.0 c.i.		U-0.210	R-4.6 c.i.	
Metal building [a]	U-0.140	R-3.3 + R-3.3 + R-4.4 c.i.		U-0.140	R-3.3 + R-3.3 + R-4.4 c.i.		U-0.200	R-1.9 + R-3.3 c.i.	
Attic and other roofs	U-0.092	R-12.5		U-0.092	R-12.5		U-0.146	R-8.6	
Walls, above grade									
Mass	U-0.259	R-3.7 c.i.		U-0.259	R-3.7 c.i.		U-0.561	R-2.0 c.i.	
Metal building	U-0.210	R-1.9 + R-3.9 c.i.		U-0.210	R-1.9 + R-3.9 c.i.		U-0.324	R-1.9 + R-2.3 c.i.	
Steel framed	U-0.200	R-2.3 + R-3.9 c.i.		U-0.200	R-2.3 + R-3.9 c.i.		U-0.345	R-2.3 + R-2.2 c.i.	
Wood framed and other	U-0.173	R-2.3 + R-3.9 c.i.		U-0.173	R-2.3 + R-3.9 c.i.		U-0.275	R-2.3 + R-2.2 c.i.	
Wall, below grade									
Below-grade *wall*	C-0.340	R-3.1 c.i.		C-0.340	R-3.1 c.i.		C-0.642	R-1.8 c.i.	
Floors									
Mass	U-0.205	R-4.4 c.i.		U-0.205	R-4.4 c.i.		U-0.345	R-2.6 c.i.	
Steel joist	U-0.173	R-8.6		U-0.173	R-8.6		U-0.281	R-5.3	
Wood framed and other	U-0.146	R-6.7 + R-1.3 c.i.		U-0.146	R-6.7 + R-1.3 c.i.		U-0.178	R-6.7	
Slab-on-grade floors									
Unheated	F-0.714	R-2.6 full slab		F-0.697	R-2.6 full slab		F-0.888	R-3.5 for 600 mm	
Heated	F-1.103	R-3.5 full slab		F-0.613	R-4.4 full slab		F-1.414	R-3.5 for 1200 mm	
Opaque doors									
Swinging	U-1.997			U-1.997			U-1.997		
Nonswinging	U-1.673			U-1.673			U-1.673		
FENESTRATION	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**
Vertical glazing, 0% to 40% of *wall*									
Fixed	U-1.40	E&W-0.38, S-0.40, N-0.50	1.10 (for all types)	U-1.40	E&W-0.38, S-0.40, N-0.50	1.10 (for all types)	U-1.94	NR (for all types)	NR (for all types)
Operable	U-1.73	E&W-0.34, S-0.36, N-0.46		U-1.73	E&W-0.34, S-0.36, N-0.46		U-2.37		

Entrance door	U-3.40	E&W-0.34 , S-0.36, N-0.46		U-3.40	E&W-0.34 , S-0.36, N-0.46		U-3.40		
Skylight, 0% to 3% of *roof*									
All types	U-2.21	NR	NR	U-2.21	NR	NR	U-4.04	NR	NR

* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement; E&W = east and west oriented, S = south oriented, N = within 22.5 degrees of north in the Northern Hemisphere [see Sections 701.4.2.1 (7.4.2.1) and 701.4.2.8 (7.4.2.8)].

** The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1 (7.4.2.1) but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1 (7.4.2.1).

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).

INORMATIVE APPENDIX F

INTEGRATED DESIGN

(This appendix is not part of this code. It is merely informative and does not contain requirements necessary for conformance to the code. It has not been processed according to the ANSI requirements for a code and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

SECTION F101 (F1)
Integrated Design Process/Integrated Project Delivery

Integrated design, and related concepts such as *integrated project delivery* and integrative design, leverages early stakeholder collaboration through the sharing of knowledge and expertise among project team members to develop stronger, more balanced design solutions. This *integrated design process* stands in contrast to traditional design methods, where there is limited use of the skills and knowledge of all stakeholders. An *integrated design process* provides increased predictability of project outcomes earlier and enables the construction of *high-performance green buildings* that consume fewer resources and provide better comfort and functionality.

Integrated design introduces major issues and key participants into the project early, where more opportunities occur for creative problem solving. The complex interactions of sophisticated building systems require early coordination to maximize their effectiveness and output. Early team building and goal setting may also reduce total project costs. The collaborative process can inform *building envelope*, mechanical, electrical, plumbing, and other building system design. The later in the design process that systems are introduced, the more expensive their implementation will be. Information technology can also be a valuable asset in increasing predictability of outcomes earlier in the project and is recommended for all integrated teams.

In contrast with a linear design process, which addresses problems sequentially, an integrated process approaches each problem with input from the various viewpoints of the participants and the domains they represent, circling back after each design decision to collectively evaluate the impact on all stakeholders. This process acknowledges the complex interdependency of building systems and their relationship to resource consumption and occupant well being.

Several existing, and currently evolving, models for collaboration should be considered, including *ASHRAE Handbook—HVAC Applications*, Chapter 57; the MTS 1.0 WSIP Guide, *Whole Systems Integrated Process Guide for Sustainable Buildings and Communities*; and *Integrated Project Delivery: A Guide* by the AIA and AIA California Council.

Project-specific integrated design and/or *integrated project delivery* processes should be determined with full participation of the stakeholder team. What works for one project may not be the best approach for the next. Additionally, the team should collectively identify the performance standards and the associated metrics by which project success will be evaluated. Design charrettes of varying duration may be an effective tool to consider, though ultimately it is the responsibility of the stakeholder team to determine the process that will best fit a specific problem or project.

F101.1 (F1.1) Design charrette. The following outlines one type of design charrette process that resulted in a successful integrated design. A charrette process can be initiated at the initial stages of building design, and the members of the process should include all stakeholders.

F101.1.1 (F1.1.1) Charrette process. Experienced personnel representing each specialty should participate in the charrette process. A discussion of all systems and all items that affect the *integrated design* should be discussed. Stakeholders should be able to decide and vote on the best integrated system.

The integrative team process should entail the following steps of design optimization:

a. The original goals and budget of the project should be revisited to see whether the overall intentions of the project are intact.

b. The project should be compared with this code or at least one existing green rating system.

c. Each of the building and *site* components should be scrutinized to help ensure that natural systems for energy conservation, lighting, ventilation, and passive heating and cooling are maximized before mechanical systems are engaged.

d. The appropriateness and integration logic of the building's primary systems should be confirmed.

e. The impact of the design on the *site* and its larger context should be evaluated, including the environmental impact on a life-cycle cost basis.

f. Building information modeling (BIM) software, design tools, and the experience of the design team should be used, where practical, to help optimize the design.

g. All members of the design team should be included when making design decisions.

h. Commissioning and consideration of future operation and maintenance (O&M) requirements should be included within the design optimization process.

F101.1.2 (F1.1.2) Design charrette matrix. At the end of the charrette process, a matrix for each proposed building scheme can be developed and evaluated to summarize the impact on the *site*, water, energy, materials, and indoor environmental quality and to help in deciding on the best integrated system. The matrix contains cells indicating the high-performance value, grading a particular building system to its appropriate high-performance criteria. Each high-performance value is qualitatively rated from 1 to 10, with 1 being the lowest (minimal energy savings, low air quality, low water efficiency, high cost) and 10 being the highest (high energy savings, high air quality, high water efficiency, low cost). The average of the high-performance values for each building system is the aggregate index. Selection of the best system should be based on a comparison of the aggregate indices for each matrix.

Scheme #1—with Atrium, maximum exposure on the south, three-story ofice building.

BUILDING SYSTEM	HIGH-PERFORMANCE CRITERIA						
	Site	IAQ	IEQ	Energy	Comm. M&V	Initial Cost	O & M
Arch	8	7	6	1	6	1	6
HVAC	—	5	6	2	6	2	7
Plumbing	NA	—	—	—	—	2	7
Structural	—	—	—	—	—	2	—
Aggregate index	8	6	6	1.5	6	2	6.8

Result:

Least numbers under energy and cost column defines consumption of substantial energy with high initial cost.

Scheme #2—without Atrium, three-story, minimum exposure on the south and west side.

BUILDING SYSTEM	HIGH-PERFORMANCE CRITERIA						
	Site	IAQ	IEQ	Energy	Comm. M&V	Initial Cost	O & M
Arch	6	7	7	7	7	7	6
HVAC	NA	5	7	7	7	7	7
Plumbing	NA	—	—	—	7	7	7
Structural	—	—	—	—	—	—	—
Aggregate index	6	6	7	7	7	7	6.8

Result:

High numbers on all columns indicate the building is conceived optimally.

FIGURE F101.1 (FIGURE F-1)
SAMPLE CHARRETTE DESIGN MATRICES

INORMATIVE APPENDIX G

INFORMATIVE REFERENCES

(This appendix is not part of this code. It is merely informative and does not contain requirements necessary for conformance to the code. It has not been processed according to the ANSI requirements for a code and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

This appendix contains informative references for the convenience of users of this code and to acknowledge source documents when appropriate. Section numbers indicate where the reference occurs in this document.

AIA

American Institute of Architects
1735 New York Avenue NW
Washington, DC 20006

AIA National/AIA California Council

Integrated Project Delivery: A Guide, v. 1—2007
Appendix F

AISC

American Institute of Steel Construction
130 East Randolph, Suite 2000
Chicago, Illinois 60601

Brochure

Steel Takes LEED® with Recycled Content
901.4.1.1 (9.4.1.1)

ASHRAE

ASHRAE
180 Technology Parkway NW
Peachtree Corners, GA 30092

ASHRAE Guideline 0—2013

The Commissioning Process
1001.3.2 (10.3.2)

ASHRAE Guideline 1.1—2007

HVAC&R Technical Requirements for the Commissioning Process
1001.3.2 (10.3.2)

ASHRAE Guideline 4—2008 (RA 2013)

Preparation of Operating and Maintenance Documentation for Building Systems
1001.3.2 (10.3.2)

ASHRAE Handbook, 2021

Fundamentals
Appendix C

ASHRAE Handbook, 2020

HVAC Applications
Appendix F

APBP

Association of Pedestrian and Bicycle Professionals
PO Box 93
Cedarburg, WI 53012

Bicycle Parking Guidelines, 2nd Edition, 2010

501.3.7.2 (5.3.7.2)

ASTM

ASTM International
100 Barr Harbor Dr.
West Conshohocken, PA 19428-2959

ASTM C755—20

Standard Practice for Selection of Water Vapor Retarders for Thermal Insulation, Appendix X1 Problem Analysis
801.3.6 (8.3.6)

ASTM E1331—15 (2019)

Standard Test Method for Reflectance Factor and Color by Spectrophotometry Using Hemispherical Geometry
801.4.1 (8.4.1)

ASTM E1477—98a (2017)e1

Standard Test Method for Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers
801.4.1 (8.4.1)

ASTM E2813—12e1

Standard Practice for Building Enclosure Commissioning
1001.3.1.3.5 (10.3.1.3.5)

BSI

British Standards Institute
389 Chiswick High Road
London, W4 4AL, United Kingdom

BS 8493:2008+A1:2010

Light reflectance value (LRV) of a surface. Method of test.
801.4.1 (8.4.1)

BUSMethodology

BUS Methodology

Occupant Satisfaction Evaluation Survey

https://busmethodology.org.uk/
1001.3.2.1.5 (10.3.2.1.5)

CBE

Center for the Built Environment
University of California, 390 Wurster Hall #1839
Berkeley, CA 94720-1839

https://cbe.berkeley.edu/research/occupant-survey-and-building-benchmarking/

Indoor Environmental Quality (IEQ) Survey™
1001.9.7 (10.9.7)

CRI

Carpet and Rug Institute
730 College Drive
Dalton, Georgia 30720

Green Label Plus

(https://carpet-rug.org/testing/green-label-plus)
801.4.2.3 (8.4.2.3)

CSA

Canadian Standards Association
5060 Spectrum Way, Suite 100
Mississauga, Ontario, L4W 5N6, Canada

CSA S478—95 (R2007)

Guideline on Durability for Buildings
901.4.1 (9.4.1), 1001.10 (10.10)

DGS

State of California, Department of General Services, Procurement Division
Ziggurat Building
707 Third Street
West Sacramento, CA 95605-2811

RFP DGS-56275

Section 5.7, "Indoor Air Quality Requirements for Open Office Panel Systems"
Appendix D

DHHS ATSDR

United States Department of Health and Human Services
Agency for Toxic Substances and Disease Registry
4770 Buford Hwy NE
Atlanta, GA 30341

www.atsdr.cdc.gov/mrls

Minimal Risk Levels (MRLs)
Table 1001.7.2 (10.7.2)

EPA

United States Environmental Protection Agency
1200 Pennsylvania Ave NW
Washington, DC 20460

Portfolio Manager

1001.9.3.2 (10.9.3.2)

FSC

Forest Stewardship Council
1155 30th Street NW, Suite 300
Washington, DC 20007

901.4.1.3.1 (9.4.1.3.1)

GSA

United States General Services Administration
1800 F Street, NW
Washington, DC 20405

US GSA—2005

The Building Commissioning Guide
1001.3.1 (10.3.1)

ICC

International Code Council
500 New Jersey Ave NW, 6th Floor
Washington, DC 20001

IBC—2021

International Building Code®
106.1, 801.3.1.8 (8.3.1.8), I201.1 (I2.1)

IECC—2021

International Energy Conservation Code®
Appendix H

IFC—2021

International Fire Code®
601.3.2.6 (6.3.2.6)

IPC—2021

International Plumbing Code®
601.3.1.2.1 (6.3.1.2.1)

ICC/ASHRAE 700—2015:

National Green Building Standard
J101.1.1, J101.1.2, J101.1.3, J101.1.4, J101.1.5

IES

Illuminating Engineering Society
120 Wall Street, Floor 17
New York, NY 10005-4001

IES MLO—11

Model Lighting Ordinance (MLO)
501.3.6 (5.3.6)

IES HB—11

The Lighting Handbook: Reference and Application
701.4.6 (7.4.6), 801.3.5 (8.3.5)

ITE

Institute of Transportation Engineers
1099 14th Street NW, Suite 300 West
Washington, DC 20005-3438

4th Edition, 2004

Parking Generation
1001.11 (10.11)

MTS

Market Transformation to Sustainability
1511 Wisconsin Avenue, N.W.
Washington, D.C. 20007

MTS 2012:1

Integrative Process (IP)—ANSI Consensus National Standard Guide—Design and Construction of Sustainable Buildings and Communities
Appendix F

NIBS

National Institute of Building Sciences
1090 Vermont Avenue, NW, Suite 700
Washington, DC 20005-4905

NIBS Guideline 3—2012

Building Enclosure Commissioning Process BECx
1001.6 (10.6)

NIST

National Institute of Standards and Technology
100 Bureau Drive
Gaithersburg, MD 20899

BEES Online 2.0

Building Environmental and Economic Sustainability (BEES)
901.4.1.4.4 (9.4.1.4.4)

NREL

National Renewable Energy Laboratory
1617 Cole Blvd.
Golden, CO 80401-3393

NREL/TP-550-38617

Source Energy and Emissions Factors for Energy Use in Buildings
Table 701.5.2 (7.5.2)

RFCI

Resilient Floor Covering Institute
115 Broad Street, Suite 201
LaGrange, GA 30240

801.4.2.3 (8.4.2.3)

SFI

Sustainable Forestry Initiative, Inc.
1600 Wilson Blvd, Suite 810
Arlington, VA 22209

901.4.1.3.1 (9.4.1.3.1)

SMACNA

Sheet Metal and Air Conditioning Contractors National Association
4201 Lafayette Center Drive
Chantilly, VA 20151

ANSI/SMACNA 008—2008

IAQ Guidelines for Occupied Buildings under Construction, Second Edition
1001.4.2 (10.4.2)

SRI

Steel Recycling Institute
680 Andersen Drive
Pittsburgh, PA 15220

Brochure

Steel Takes LEED® with Recycled Content
901.4.1.1 (9.4.1.1)

UL

Underwriters Laboratory
2211 Newmarket Parkway, #110
Marietta, GA 30067

UL2762—2011

EcoLogo Sustainability for Adhesives
801.4.2.1.2 (8.4.2.1.2)

UL2818—2013

Greenguard Certification Program for Chemical Emissions for Building Materials, Finishes and Furnishing
801.4.2 (8.4.2), 801.5.2 (8.5.2)

UL2821—2013

Greenguard Certification Program Method for Measuring and Evaluating Chemical Emissions from Building Materials, Finishes and Furnishings

801.4.2 (8.4.2), 801.5.2 (8.5.2)

INORMATIVE APPENDIX H

OPTION FOR ENERGY EFFICIENCY USING THE IECC PRESCRIPTIVE COMPLIANCE PATH

(This appendix is not part of this code. It is merely informative and does not contain requirements necessary for conformance to the code. It has not been processed according to the ANSI requirements for a code and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

The purpose of this appendix is to provide users of the prescriptive energy path of the IECC a correlated version of ANSI/ASHRAE/ICC/USGBC/IES Standard 189.1, Section 7, that facilitates the use of the prescriptive provisions of the IECC without directly relying on the energy provisions of ANSI/ASHRAE/IES Standard 90.1. Section numbers in this appendix, unless otherwise specified, refer to Standard 189.1. Where ASHRAE standards are referenced in this appendix, ASHRAE provides free online access to read-only versions of the standards. See www.ashrae.org/previewstandards. The 2021 IECC is also available online at https://codes.iccsafe.org/content/IECC2021P1.

SECTION H101 (H1)
GENERAL

H101.1 (H1.1) Scope. This section specifies prescriptive requirements for energy efficiency for buildings and appliances, for *on-site renewable energy systems*, and for energy measuring.

SECTION H201 (H2)
COMPLIANCE

H201.1 (H2.1) Compliance. The energy systems shall comply with Sections 701.3.2 through 701.3.5 (7.3.2 through 7.3.5) and with the *International Energy Conservation Code* (IECC), Sections C402 through C405. In addition, commercial buildings shall comply with the IECC, Section C406, except as modified by this appendix. Tenant *spaces* shall comply with the IECC, Section C406.1.1. (***Note to User:*** IECC Section C406.1 requires compliance with additional efficiency package options for base code compliance.)

Where requirements are provided below, they shall supersede the requirements of the IECC. For all other criteria, the *building project* shall comply with the requirements of the IECC.

SECTION H301 (H3)
PRESCRIPTIVE REQUIREMENTS

H301.1 (H3.1) On-site renewable energy systems. *Building projects* shall comply with either the standard renewables approach or the Alternate Renewables Approach in Section 701.4.1.1 (7.4.1.1) and Table 701.4.1.1 (7.4.1.1). The Alternate Renewables Approach shall apply only to building projects where the sum of the gross conditioned and semiheated floor areas of the building project are less than 25,000 ft^2 (2300 m^2).

Where renewable capacity credit is claimed for IECC, Section C406.5, the total minimum ratings of on-site renewable energy systems shall be in accordance with IECC, Sections C406.5.1 or C406.5.2, and shall not include systems used for credits under IECC, Section C406.7.2 or used for compliance under Section 701.3.2 (7.3.2).

H301.2 (H3.2) Building envelope and continuous air barriers. The *building envelope* shall comply with the IECC, Sections C301, C401.3, and C402, with the following modifications and additions.

The exceptions to the requirement for a *continuous air barrier* in the IECC, Section C402.5.2, for specific climate zones and constructions shall not apply.

H301.2.1 (H3.2.1) Building envelope requirements. The *building envelope* shall comply with the requirements in the IECC, Table C402.1.4, with the following modifications to values in the table.

For the opaque elements, each U-factor, C-factor, and *F*-factor in the table shall be reduced by 5%. For *vertical fenestration* and *skylights*, each U-factor in the IECC, Table C402.4, shall be reduced by 5%. For *skylights* and east-oriented and west-oriented *vertical fenestration*, each *solar heat gain coefficient* (*SHGC*) in the IECC, Table C402.4, shall be reduced by 5%. These adjustments shall also be applicable where the intent is to comply with the component performance alternative of the IECC, Section C402.1.5.

Where enhanced envelope performance credit is claimed in accordance with IECC, Section C406.8, the total UA of the *building envelope* as designed shall be not less than 15% less than the total UA of the *building envelope* in accordance with this section.

Exceptions:

1. The U-factor, C-factor, or *F*-factor shall not be modified where the corresponding R-value requirement is designated as "NR" (no requirement) in the IECC, Table C402.1.3.
2. The *SHGC* shall not be modified where the *SHGC* requirement is designated as "NR" (no requirement) in the IECC, Table C402.4.
3. *Spaces* that meet the requirements of Section 801.4.1 (8.4.1), regardless of *space* area, are exempt from the *SHGC* criteria for *skylights*.

Notes to User:

1. U-factors, C-factors, and *F*-factors for many common assemblies are provided in ANSI/ASHRAE/ IES Standard 90.1, Normative Appendix A.
2. Section 501.3.5.3 (5.3.5.3) includes additional provisions related to *roofs*.

H301.2.2 (H3.2.2) Mechanical equipment penetration requirements. Mechanical equipment penetrating the *building envelope* shall comply with Section 701.4.2.2 (7.4.2.2).

H301.2.3 (H3.2.3) Single-rafter roof insulation. *Single-rafter roofs* shall comply with the requirements in Normative Appendix A, Table A101.1 (A-1). These requirements supersede the requirements in the IECC, Tables C402.1.3 and C402.1.4.

H301.2.4 (H3.2.4) High-speed doors. *High-speed doors* that are intended to operate, on average, not less than 75 cycles per day shall not exceed a maximum U-factor of 1.20 Btu/h • ft^2 • °F (6.81 W/m^2 • K). Opening rate, closing rate, and average cycles per day shall be included in the *construction documents*. IECC, Table C402.1.3, shall not apply for *high-speed doors* complying with all criteria in this section.

H301.2.5 (H3.2.5) Air curtains. Where provided, air curtains shall comply with Section 701.4.2.5 (7.4.2.5).

H301.2.6 (H3.2.6) Vertical fenestration area. *Vertical fenestration area* shall comply with the IECC, Sections C402.4.1 and C402.4.1.1.

H301.2.7 (H3.2.7) Permanent projections. *Vertical fenestration* shall comply with Section 701.4.2.7 (7.4.2.7).

H301.2.8 (H3.2.8) SHGC of vertical fenestration. *Vertical fenestration* shall comply with the IECC, Table C402.4.

H301.2.9 (H3.2.9) Building envelope trade-off option. The *building envelope* component performance alternative of the IECC, Section C402.1.5, shall not apply except where the modifications and additions of Section H301.2 (H3.2) are incorporated.

H301.2.10 (H3.2.10) Orientation. The *vertical fenestration* shall comply with either (a) or (b):

a. $A_W \le (A_N + A_S)/4$ and $A_E \le (A_N + A_S)/4$

b. $A_W \times SHGC_W \le (A_N \times SHGC_C + A_S \times SHGC_C)/6$ and $A_E \times SHGC_E \le (A_N \times SHGC_C + A_S \times SHGC_C)/6$

where:

$SHGC_X$ = The *SHGC* for orientation *x* that complies with Section H301.2.7 (H3.2.7).

$SHGC_C$ = The *SHGC* criteria for each climate zone from Section H301.2.1 (H3.2.1).

A_X = *Fenestration area* for orientation *x*.

N = North (oriented less than 45 degrees of true north).

S = South (oriented less than 45 degrees of true south).

E = East (oriented less than or equal to 45 degrees of true east).

W = West (oriented less than or equal to 45 degrees of true west).

Exceptions:

1. Buildings with shade on 75% of the west- and east-oriented *vertical fenestration areas* from permanent projections, existing buildings, existing permanent infrastructure, or topography at 9 a.m. and 3 p.m. on the summer solstice (***Note to User:*** June 21 in the northern hemisphere).
2. Alterations and additions with no increase in *vertical fenestration area*.
3. Buildings where the west- and east-oriented *vertical fenestration areas* do not exceed 20% of the *gross wall area* for each of those façades, and the *SHGC* on those façades is not greater than 90% of the criteria in Section H301.2.1 (H3.2.1).
4. Buildings in Climate Zone 8.

H301.3 (H3.3) Heating, ventilating, and air conditioning. The heating, ventilating, and air conditioning shall comply with the IECC, Sections C301 and C403, with the following modifications and additions.

H301.3.1 (H3.3.1) Minimum equipment efficiencies for the alternate renewables approach. *Building projects* complying with the Alternate Renewables Approach in Section 701.4.1.1 (7.4.1.1) and Table 701.4.1.1 (7.4.1.1) shall comply with Section 701.4.3.1 (7.4.3.1).

H301.3.2 (H3.3.2) Ventilation controls for densely occupied spaces. The requirements in this section supersede those in the IECC, Section C403.7.1. *Demand control ventilation* (*DCV*) shall be provided for *densely occupied spaces* served by systems with one or more of the following:

a. An air-side economizer.

b. *Automatic* modulating control of the *outdoor air* dampers.

c. A design outdoor airflow greater than 1000 cfm (500 L/s).

The *DCV* system shall be designed to be in compliance with ANSI/ASHRAE Standard 62.1, Section 6.2.6.1. Occupancy assumptions shall be shown in the design documents for *spaces* provided with *DCV*. All CO_2 sensors used as part of a *DCV* system or any other system that dynamically controls *outdoor air* shall meet the following requirements:

d. *Spaces* with CO_2 sensors or air-sampling probes leading to a central CO_2 monitoring station shall be provided with not less than one sensor or probe for each 10,000 ft^2 (1000 m^2) of floor *space*. Sensors or probes shall be installed between 3 and 6 ft (1 and 2 m) above the floor.

e. CO_2 sensors shall have a rated accuracy of ±50 ppm at 1000 ppm.

f. *Outdoor air* CO_2 concentrations shall be determined by one of the following:

   1. *Outdoor air* CO_2 concentrations shall be dynamically measured using one or multiple CO_2 sensors. The CO_2 sensor locations shall be identified on the *construction documents*.

   2. Where documented statistical data are available on the local ambient CO_2 concentrations, a fixed value typical of the location where the building is located shall be allowed in lieu of an outdoor sensor.

g. Occupant CO_2 generation rate assumptions shall be shown in the design documents.

Exceptions:

1. Systems with exhaust air energy recovery complying with Section H301.3.7 (H3.3.7).

2. Systems with a design outdoor airflow less than 750 cfm (350 L/s).

3. *Spaces* where more than 75% of the *space* design outdoor airflow is used as *makeup air* or *transfer air* to provide *makeup air* for other *spaces*.

4. *Spaces* with one of the following occupancy categories as defined in ASHRAE Standard 62.1: cells in correctional facilities; daycare sickrooms; science laboratories; barbershops; beauty and nail salons; and bowling alleys (seating).

H301.3.3 (H3.3.3) Duct leakage tests. Leakage tests shall be performed in compliance with the requirements in ANSI/ASHRAE/IES Standard 90.1, Section 6.4.4.2.2, with the following modification. Ductwork that is designed to operate at static pressures in excess of 2 in. of water (500 Pa), and all ductwork located outdoors, shall be leak-tested according to industry-accepted test procedures.

H301.3.4 (H3.3.4) Economizers. Where economizers are required by Section 701.4.3.4 (7.4.3.4), economizers shall meet the requirements in the IECC, Section C403.5, except as modified by the following:

a. Rooftop units with a capacity of less than 54,000 Btu/h (16 kW) shall have two stages of capacity control, with the first stage controlling the economizer and the second stage controlling *mechanical cooling*. Units with a capacity equal to or greater than 54,000 Btu/h (16 kW) shall comply with the integrated economizer requirements specified in the IECC, Section C403.5.1, except that DX units with a rated capacity of not less than 65,000 Btu/h (19 kW), and which control the capacity of the mechanical cooling directly based on occupied space temperature, shall have not less than two stages of mechanical cooling capacity.

b. For systems that control to a fixed leaving air temperature (i.e., *variable-air-volume* [*VAV*] systems), the system shall be capable of resetting the supply air temperature up at least 5°F (3°C) during economizer operation.

All of the exceptions in the IECC, Section C403.5, shall apply except as modified by the following:

c. Where the reduced renewable approach defined in Section 701.4.1.1 (7.4.1.1) and Table 701.4.1.1 (7.4.1.1) is used, the IECC, Section C403.5, Exception 5, shall be permitted to eliminate the economizer requirement, provided the requirements in the IECC, Table C403.5(2), are applied to the efficiency requirements required by Section 701.4.1.1 (7.4.1.1). Where the standard renewable approach in Section 701.4.1.1 (7.4.1.1) and Table 701.4.1.1 (7.4.1.1) is chosen, the requirements in the IECC, Table C403.5(2), shall be applied to the efficiency requirements in the IECC, Tables C403.3.2(1) through C403.3.2(16).

d. For water-cooled units with a capacity less than 54,000 Btu/h (16 kW) that are used in systems where heating and cooling loads are transferred within the building, such as water-source heat pump systems, the requirement for an

air or water economizer can be eliminated if the condenser-water temperature controls are capable of being set to maintain full-load heat rejection capacity down to a 55°F (12°C) condenser-water supply temperature, and the HVAC equipment is capable of operating with a 55°F (12°C) condenser-water supply temperature.

H301.3.5 (H3.3.5) Zone controls. Zone controls shall comply with Section 701.4.3.5 (7.4.3.5).

H301.3.6 (H3.3.6) Fan system power and efficiency.

H301.3.6.1 (H3.3.6.2) Fan system power limitation. Systems shall have fan power limitations 10% below the limitations specified in the IECC, Table C403.8.1(1). This requirement supersedes the requirement in the IECC, Section C403.8, and the IECC, Table C403.8.1(2). All exceptions in the IECC, Section C403.8, shall apply.

H301.3.6.2 (H3.3.6.2) Fan efficiency. The fan efficiency requirements defined in the IECC, Section C403.8.3, shall be used, except that the *fan energy index* at the design point of operation shall be 1.10 or greater. All exceptions in the IECC, Section C403.8.3, shall apply.

H301.3.6.3 (H3.3.6.3) Low-power ventilation systems. Ventilation systems shall comply with Section 701.4.3.6.3 (7.4.3.6.3).

H301.3.7 (H3.3.7) Exhaust air energy recovery. The exhaust air energy recovery shall comply with the requirements defined in the IECC, Section C403.7.4, including the requirements in Tables C403.7.4(1) and C403.7.4(2). The energy recovery effectiveness shall not be less than 60%, and this shall supersede the requirement of the IECC.

H301.3.8 (H3.3.8) Kitchen exhaust systems. The requirements in the IECC, Section C403.7.5, shall apply, except as modified by Sections 701.4.3.8.1 (7.4.3.8.1) and 701.4.3.8.2 (7.4.3.8.2).

H301.3.9 (H3.3.9) Duct insulation. The requirements in the IECC, Section C403.12.1, shall apply.

H301.3.10 (H3.3.10) Automatic control of HVAC and lights in hotel/motel guest rooms. Controls in hotel and motel guest rooms shall comply with Section 701.4.3.9 (7.4.3.9).

H301.3.11 (H3.3.11) HVAC equipment performance requirements. Equipment shall meet the minimum efficiency requirements of IECC, Section C403.3.2.

H301.3.12 (H3.3.12) Occupied standby controls. Zones shall comply with the occupied standby requirements of ANSI/ASHRAE/IES Standard 90.1, Section 6.5.3.8, where serving only rooms required to have occupant sensor controls by IECC Section C405.2.1, and where ASHRAE Standard 62.1 permits ventilation air to be reduced to zero where the space is in occupied standby mode.

H301.4 (H3.4) Service water heating. The *service water heating* shall comply with the IECC, Section C404, with the following modifications and additions.

H301.4.1 (H3.4.1) Equipment efficiency for the alternate renewables approach. *Building projects* complying with the Alternate Renewables Approach in Section 701.4.1.1 (7.4.1.1) and Table 701.4.1.1 (7.4.1.1) shall comply with the applicable equipment efficiency requirements in Normative Appendix B, Table B101.8 (B-8), and the applicable requirements in Section 701.4.7.3 (7.4.7.3). These requirements supersede the requirements in the IECC, Table C404.2.

H301.4.2 (H3.4.2) Buildings with high-capacity service water heating systems. New buildings with service water heating systems with a total installed water heating input capacity of 1,000,000 Btu/h (300 kW) or greater shall comply with Section 701.4.4.2 (7.4.4.2).

H301.4.3 (H3.4.3) Insulation for spa pools. Insulation for spa pools shall comply with Section 701.4.4.3 (7.4.4.3).

H301.5 (H3.5) Power. The power shall comply with the IECC, Section C405.6 through C405.13.

H301.6 (H3.6) Lighting. The lighting shall comply with the IECC, Sections C405.2 through C405.5, with the following modifications and additions.

H301.6.1 (H3.6.1) Lighting power allowance.

H301.6.1.1 (H3.6.1.1) Interior lighting power densities (LPDs). The interior *lighting power allowance* shall comply with Section 701.4.6.1.1 (7.4.6.1.1).

Where reduced lighting power is claimed for credit in accordance with IECC, Section C406.3.1, the section shall be modified so that the total connected interior lighting power shall be calculated in accordance with Section 701.4.6.1.1 (7.4.6.1.1) and shall be less than 90% of the total lighting power allowance calculated in accordance with Section 701.4.6.1.1 (7.4.6.1.1).

Where reduced lighting power is claimed for credit in accordance with IECC, Section C406.3.2, and where the total connected interior lighting power calculated in accordance with Section 701.4.6.1.1 (7.4.6.1.1) is less than 85% of the total lighting power allowance calculated in accordance with Section 701.4.6.1.1 (7.4.6.1.1), additional energy efficiency credits shall be determined based on IECC, Equation 4-13, except as modified by the following:

AEECLPA = IECC, Section C406.3.2, additional energy efficiency credits.

LPD = Total connected interior lighting power calculated in accordance with Section 701.4.6.1.1 (7.4.6.1.1).

LPA = Total lighting power allowance calculated in accordance with Section 701.4.6.1.1 (7.4.6.1.1).

AEEC10 = IECC, Section C406.3.1, credits from IECC, Tables C406.1(1) through C406.1(5).

H301.6.1.2 (H4.5.1.2) Exterior LPDs. The exterior *lighting power allowance* shall be determined using the IECC, Section C405.4.2, with the following modification: the LPDs from the IECC, Table C405.4.2(2), shall be multiplied by the applicable LPD Factor from Table 701.4.6.1.2 (7.4.6.1.2).

H301.6.2 (H3.6.2) Interior lighting controls. The interior lighting control requirements in this section are in addition to the control requirements in IECC, Section C405.2.

H301.6.2.1 (H3.6.2.1) Occupancy sensor controls occupancy sensor controls in commercial and industrial storage stacks. Lighting in commercial and industrial storage stack areas shall comply with Section 701.4.6.3.1 (7.4.6.3.1).

H301.6.2.2 (H3.6.2.2) Occupancy sensing control in large office spaces. *General lighting* in office *spaces* greater than 250 ft^2 (23 m^2) shall comply with the IECC Section C405.2.1.3.

H301.6.3 (H3.6.3) Automatic controls for egress and security lighting. *Automatic* controls for egress and security lighting shall comply with Section 701.4.6.3.2 (7.4.6.3.2).

H301.6.4 (H3.6.4) Controls for exterior sign lighting. Controls for exterior sign lighting shall comply with Section 701.4.6.4.1 (7.4.6.4.1).

H301.6.5 (H3.6.5) Parking and outdoor sales lighting. Outdoor luminaires serving uncovered parking areas and open areas in outdoor sales lots shall comply with Section 701.4.6.4.2 (7.4.6.4.2).

H301.6.6 (H3.6.6) Dwelling unit lighting controls. *Dwelling unit* light controls shall comply with Section 701.4.6.5 (7.4.6.5).

H301.6.7 (H3.6.7) Other equipment. The other equipment shall comply with the IECC, Sections C405.5 through C405.9, with the following additions.

H301.6.7.1 (H3.6.7.1) Equipment efficiency for the alternate renewables approach. *Building projects* complying with the Alternate Renewables Approach in Section 701.4.1.1 (7.4.1.1) and Table 701.4.1.1 (7.4.1.1) shall comply with the applicable equipment efficiency requirements in Normative Appendix B and the applicable requirements in Section 701.4.7.3.2 (7.4.7.3.2).

H301.6.7.2 (H3.6.7.2) Supermarket heat recovery. Supermarkets shall comply with Section 701.4.7.2 (7.4.7.2), as applicable.

H301.6.7.3 (H3.6.7.3) ENERGY STAR equipment. All *building projects* shall comply with Section 701.4.7.3 (7.4.7.3).

H301.6.7.4 (H3.6.7.4) Programmable thermostats. Residential programmable thermostats shall comply with Section 701.4.7.4 (7.4.7.4).

H301.6.7.5 (H3.6.7.5) Refrigerated display cases. Refrigerated display cases shall comply with Section 701.4.7.5 (7.4.7.5).

H301.6.7.6 (H3.6.7.6) Elevator power conversion system. In new buildings, traction elevators with a rise of 75 ft (23 m) or more shall comply with Section 701.4.7.6 (7.4.7.6).

H301.6.7.7 (H3.6.7.7) Pump efficiency. All pumps in buildings complying with the Alternate Renewables Approach in Section 701.4.1.1 (7.4.1.1) and Table 701.4.1.1 (7.4.1.1) that are subject to the requirements of ASHRAE/IES Standard 90.1, Section 10.4.7, shall have a *Pump Energy Index* no greater than 0.97.

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