COMPARISON BETWEEN
THE 2009 ICC INTERNATIONAL BUILDING CODE *(IBC®)*, CH.13
– THE 2009 ICC INTERNATIONAL ENERGY CONSERVATION CODE *(IECC®)* (the Code) –
AND
THE AMERICAN SOCIETY OF HEATING, REFRIGERATING & AIR-CONDITIONING ENGINEERS'
STANDARD 90.1-2007 (the Standard)

(Purpose: Identify key similarities and recognizable differences. This is opinion and not comprehensive.)

ASHRAE STANDARD 90.1-2007 *Section*	**2009 ICC INTERNATIONAL BUILDING CODE® (IBC®)** **Chapter13 — ENERGY EFFICIENCY (IECC®)** *Comparable Section(s)*	**COMMENTS** *This is opinion and not comprehensive.*
OVERVIEW. **1 PURPOSE.** The purpose of this standard is to provide minimum requirements for the energy-efficient design of buildings except low-rise residential buildings.	**OVERVIEW.** **101.2 Scope.** This code applies to residential and commercial buildings. **101.3 Intent.** This code shall regulate the design and construction of buildings for the effective use of energy…	Both the code and the standard represent minimum principles of construction practice, addressing new commercial and high-rise residential buildings, additions and alterations to existing buildings, systems and equipment. a. Both provide for prescriptive designs and designs utilizing building performance (i.e., annual energy cost) for compliance assessment. b. Both provide for the efficient design of the following energy-using systems in buildings: 1. Heating, ventilating, and air conditioning systems, 2. Service water heating systems, 3. Electric power distribution systems (Standard only), 4. Electric power metering systems, 5. Other electric motors/belt drives (e.g., vertical transportation and passenger conveyance) (Standard only), and 6. Lighting systems.

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➔ **1 PURPOSE. The purpose of this standard is to provide minimum requirements for the energy-efficient design of buildings except low-rise residential buildings.**	➔ **SCOPE AND APPLICATION** ***IBC®* 101.3 Intent.** The purpose of this code is to establish the minimum requirements to safeguard the public health, safety and general welfare through structural strength, means of egress facilities, stability, sanitation, adequate light and ventilation, energy conservation, and safety to life and property from fire and other hazards attributed to the built environment and to provide safety to fire fighters and emergency responders during emergency operations. **101.2 Scope.** This code applies to residential and commercial buildings. **101.3 Intent.** This code shall regulate the design and construction of buildings for the effective use of energy…	ASHRAE 90.1 (the Standard) is comparable to the IBC, Chapter 13, addressing *Energy Efficiency*. The energy conservation requirements of the IBC (Ch. 13) rely primarily on the technical provisions of the IECC (the Code) as they address all buildings. The scope of the Standard is limited to commercial and high-rise residential buildings only.
➔ **2. SCOPE.** **2.1 This standard provides:** **a. minimum energy-efficient requirements for the design and construction of:** **1. new buildings and systems** **2. new portions of buildings and systems** **3. new systems and equipment in existing buildings** **b. criteria for determining compliance with these requirements.**	**101.4 Applicability.** **101.4.1 Existing buildings.** **101.4.3 Additions, alterations, renovations, repairs.** **501.1 Scope.** The requirements contained in this chapter are applicable to commercial buildings, or portions of commercial buildings.	Both the Code and the Standard address new commercial and high-rise residential buildings, additions and alterations to existing buildings, new and existing systems and equipment. The Code exempts new work to Historic buildings. The Standard does not.
2.2 The provisions of this standard apply to: a. the envelope of buildings, provided that the enclosed spaces are: 1. heated by a heating system whose output	**101.3 Intent.** This code shall regulate the design and construction of buildings for the effective use of energy… **101.5.2 Low energy buildings.** The following	a. The Standard defines *conditioned spaces* as: 1. Those heated directly at or above the rate of 3.4 Btu/h·ft2 or cooled directly at or below the rate of 5 Btu/h·ft2,

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capacity is greater than or equal to 3.4 Btu/h·ft2 2. cooled by a cooling system whose sensible output capacity is greater than or equal to 5 Btu/h·ft2, and b. the following systems and equipment used in conjunction with buildings: 1. heating, ventilating, and air conditioning, 2. service water heating, 3. electric power distribution and metering provisions, 4. electric motors and belt drives, and 5. lighting. **3.2 Definitions. SPACE**	buildings, or portions thereof, separated from the remainder of the building by *building thermal envelope* assemblies complying with this code shall be exempt from the *building thermal envelope* provisions of this code: 1. Those with a peak design rate of energy usage less than 3.4 Btu/h·ft2 (10.7 W/m2) or 1.0 watt/ft2 (10.7 W/m2) of floor area for space conditioning purposes. 2. Those that do not contain *conditioned space*. **202 General Definitions.** CONDITIONED SPACE **501.1 Scope.** The requirements contained in this chapter are applicable to commercial buildings, or portions of commercial buildings… **501.2 Application.** The commercial building project shall comply with the requirements in Sections 502 (Building envelope requirements), 503 (Building mechanical systems), 504 (Service water heating) and 505 (Electrical power and lighting systems) in its entirety…	2.While the Code defines them as heated (or cooled) directly or indirectly at or above (at or below) the rate of 3.4 Btu/h·ft2. 3. The Standard includes added qualifying provisions for heated spaces based on climate zone as well as the subcategories *indirectly conditioned* and *semi-conditioned*. b. Both provide for the efficient design of the following energy-using systems in buildings: 1. Heating, ventilating, and air conditioning, 2. Service water heating, 3. Electric power distribution (Standard only), 4. Electric power metering (Code only), 5. Other electric motors/belt drives (e.g., vertical transportation and passenger conveyance) (Standard only), and 6.Lighting.
2.3 The provisions of the standard do not apply to a. single-family houses, multi-family structures of three stories or fewer above grade, manufactured houses (mobile homes), and manufactured houses (modular), b. buildings that do not use either electricity or fossil fuel, or c. equipment and portions of building systems that use energy primarily to provide for industrial, manufacturing, or commercial processes. **4.2.1.3 Alterations of Existing Buildings.**	**101.4 Applicability.** **101.4.1 Existing buildings.** **101.4.2 Historic buildings.** **101.4.3 Additions, alterations, renovations, repairs.** **501.1 Scope.** The requirements contained in this chapter are applicable to commercial buildings, or portions of commercial buildings.	The Code applies to all buildings [i.e., single-family houses, multi-family structures of three stories or fewer above grade, manufactured houses (mobile homes), and manufactured houses (modular)] additions and alterations thereto. The Standard applies only to commercial and high-rise residential buildings, additions and alterations thereto. Both the Code and Standard do not apply to buildings which do not use electricity or fossil fuel, or equipment and systems using energy primarily

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		commercial, industrial or manufacturing processes. The Code exempts all new work to historic buildings. The Standard exempts envelope alterations to historic buildings only.
2.4 and 2.5 (No Impact)	(No Impact)	(N/A)
➔ 3. DEFINITIONS, ABBREVIATIONS AND ACRONYMS	**➔ CHAPTER 2 DEFINITIONS**	The Code harbors ~70 words and terms having specific denotations and literal meanings as defined, the Standard harbors ~302 such words and terms.
3. DEFINITIONS, ABBREVIATIONS AND ACRONYMS – (Specifics)	**CHAPTER 2 DEFINITIONS** – (Specifics) **SECTION 106 REFERENCED STANDARDS** **106.1 General.** The codes and standards referenced in this code shall be those listed in Chapter 6, and such codes and standards shall be considered as part of the requirements of this code to the prescribed extent of each such reference. * **106.2 Conflicting requirements.** Where the provisions of this code and the referenced standards conflict, the provisions of this code shall take precedence. * **106.3Application 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. **501.1 Scope.** The requirements contained in this chapter are applicable to commercial buildings, or portions of commercial buildings. These commercial buildings shall meet either the requirements of Standard 90.1 or the requirements contained in this chapter.	**Definitions.** Both the code and standard define certain terms, abbreviations, and acronyms that fit their requisite style, prose, form and syntax as is established users of codes and standards, respectively. There are relatively insignificant differences, with exception of the following identified (not exhaustive) for study: a. Code – ABOVE-GRADE WALL (≥ 15% above grade) v. Standard – ABOVE-GRADE WALL (not entirely buried) b. Code – BELOW-GRADE WALL (≥ 85% buried) v. Standard – BELOW-GRADE WALL (entirely buried) c. Code – BUILDING THERMAL ENVELOPE v. Standard – BUILDING ENVELOPE, EXTERIOR and SEMI-EXTERIOR d. Code – DWELLING UNIT v. Standard – RESIDENTIAL e. Code – CONDITIONED SPACE v. Standard – CONDITIONED SPACE f. Code – LISTED v. Standard – No Requirement

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	* ((Wherever there exists conflict among certain terms, abbreviations, and acronyms, the provisions of the Code take precedence))	(NR) g. Code – NR v. Standard – ENVELOPE PERFORMANCE FACTOR h. Code – NR v. Standard – PROCESS ENERGY
➔ **4. ADMINISTRATION & ENFORCEMENT.** **4.1.1.1 New Buildings.** **4.1.1.2 Additions to Existing Buildings.** **4.1.1.3 Alterations of Existing Buildings.** **4.1.1.4 Replacement, Portions of Existing Buildings.** **4.1.1.5 Changes in Space Conditioning.** **5.1.1 New Buildings. (ENV)** **5.1.2 Additions to Existing Buildings.** **5.1.3 Envelope Alterations.** **6.1.1.1 New Buildings. (HVAC)** **6.1.1.2 Additions to Existing Buildings.** **6.1.1.3 Alterations to Heating, Ventilating, and Air Conditioning in Existing Buildings.** **7.1.1.1 New Buildings. (SWH)** **7.1.1.2 Additions to Existing Buildings.** **7.1.1.3 Alterations to Existing Buildings.** **9.1.1 Scope. (LTG)** **9.1.2 Lighting Alterations.**	**101.4.1 Existing buildings.** **101.4.3 Additions, alterations, renovations, repairs** **101.4.4 Change in occupancy or use.** **101.4.5 Change in space conditioning.** **101.4.6 Mixed occupancy.** **501.1 Scope.** The requirements contained in this chapter are applicable to commercial buildings, or portions of commercial buildings.	Both Code and Standard apply to new buildings, additions and alterations thereto, and changes to space conditioning. **Additions, alterations, renovations or repairs.** Both Code and Standard address certain building envelope, mechanical, service water heating, lighting and electrical systems alterations, renovations and repairs considered exempt from compliance. There are relatively insignificant differences, with exception of the following exempt alterations (not exhaustive) for study: a. Code – Exposed cavities No Requirement (NR v. Standard – Exposed cavities (min. R-3/in.) b. Code – NR v. Standard – Precludes staged-permits in fenestration replacement (≤ 25%) c. Code – NR v. Standard – Replacement of equipment requiring extensive revisions; Refrigerant changes of existing equipment; and Ducts and pipes with insufficient space or access d. Code – Bulb and ballast replacements only v. Standard – NR The Code addresses mixed occupancy conditions such that internally load-dominated spaces are considered “Commercial patterns of energy use,” and externally load-dominated occupancies are considered “Residential patterns of energy use,” and addressed accordingly. It is unclear whether

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		this provision is limited to RESIDENTIAL BUILDINGS only. The Standard addresses these differences in COMMERCIAL BUILDINGS only.
4.1.2 Administrative Requirements. **4.1.3 Alternative Materials, Methods of Construction or Design.** **4.1.4 Validity.** **4.1.5 Other Laws.** **4.1.6 Referenced Standards.**	**SECTION 102 ALTERNATE MATERIALS—METHOD OF CONSTRUCTION, DESIGN OR INSULATING SYSTEMS** **102.1.1 Above code programs.** **SECTION 105 VALIDITY** **SECTION 106 REFERENCED STANDARDS** **106.4 Other Laws**	With the exception of "Above code programs," both Code and Standard address these topics. There are relatively insignificant differences here (not exhaustive). The Standard does not address "Above code programs."
4.1.7 Normative Appendices. **Normative Appendix A: Rated R-Value of Insulation and Assembly U-Factor, C-Factor, and F-Factor Determinations** **Normative Appendix B: Building Envelope Climate Criteria** **Normative Appendix C: Methodology for Building Envelope Trade-Off Option in Subsection 5.6** **Normative Appendix D: Climatic Data** **5.1.4 Climate.** **5.1.4.1 United States Locations.** **5.1.4.2 International Locations.** **5.8.2 Fenestration and Doors. (Labeling)** **6.4.2 Load Calculations.** Heating and cooling system design loads for the purpose of sizing systems and equipment shall be determined in accordance with generally accepted engineering standards and handbooks acceptable to the *adopting authority* (for example, *ASHRAE*	**SECTION 301 CLIMATE ZONES** **SECTION 302 DESIGN CONDITIONS** **Table 303.1.3(1) Default Glazed Fenestration *U*-factor** **Table 303.1.3(2) Default Door *U*-factors** **Table 303.1.3(2) Default Glazed Fenestration SHGC** **Table 502.2(2) Building Envelope Requirements – Opaque Assemblies**	The Code does not include appendices (at this time), nor does it distinguish among Normative and Informative appendices. The code provides certain default metal building, fenestration U-factor and SHGC requirements. The standard affords significantly more detail in this regard relative to nearly all building thermal envelope systems. * (see ATTACHMENT for efficiency differences identified) Both Code and Standard include climatic data which accommodate commercial and high-rise residential buildings constructed internationally (outside U.S. and including U.S. Territories). The Code specifies interior design temperatures used for heating and cooling load calculations. The Standard stipulates such interior design temperatures are to be determined in accordance with "generally accepted engineering standards and handbooks" acceptable to the authority having jurisdiction (AHJ).

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Handbook—Fundamentals).		
4.1.8 Informative Appendices. **Informative Appendix E: Informative References** **Informative Appendix F: Addenda Description Information** **Informative Appendix G: Performance Method**	(No Impact)	The Code does not include non-mandatory appendices, nor does it distinguish among Normative and Informative appendices.
4.2 Compliance **4.2.1 Compliance Paths**	(No Impact)	(N/A)
4.2 Compliance **4.2.2 Compliance Documentation** **4.2.2.1 Construction Details.** **4.2.2.2 Supplemental Information.** **4.2.2.3 Manuals.** **4.2.3 Labeling of Material and Equipment.** **5.7 Submittals.** **5.8.1.2 Compliance with Manufacturers' Requirements.** **5.8.1.3 Loose-fill Insulation Limitation.** **5.8.1.4 Baffles.** **5.8.1.5 Substantial contact.** **5.8.1.6 Recessed equipment.** **5.8.1.7 Insulation protection.** **5.8.1.8 Location of roof insulation.** **5.8.1.9 Extent of insulation.**	➔ **ADMINISTRATION & ENFORCEMENT.** **101.5 Compliance.** **SECTION 103 CONSTRUCTION DOCUMENTS** **103.1 General.** **103.2 Information on construction documents.** **103.3 Examination of documents.** **103.4 Amended construction documents.** **103.5 Retention of construction documents.** **SECTION 303 MATERIALS, SYSTEMS AND EQUIPMENT**	Both Code and Standard address these topics. There are relatively insignificant differences here (not exhaustive).
4.2.4 Inspections.	**SECTION 104 INSPECTIONS** **104.1 General.**	The Code has the advantage of being designed, formatted and targeted for enforcement at the jurisdiction level.

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	104.2 Required approvals. **104.3 Final inspections.** **104.4 Reinspection.** **104.5 Approved inspection agencies.** **104.6 Inspection requests.** **104.7 Reinspection testing.** **104.8 Approval.**	
No Requirement (NR)	**SECTION 107 FEES** **SECTION 108 STOP WORK ORDER** **SECTION 109 BOARD OF APPEALS**	The Code has the advantage of being designed, formatted and targeted for enforcement at the jurisdiction level. The Code provides mechanisms to connect a fair and equitable fee structure; stop work orders and a board of appeals necessary to coordinate the community services a building department renders with code administration (see also IBC Section 108.3).
➔ **5. BUILDING ENVELOPE** **5.2 Compliance Paths** **5.2.1 Compliance.** For the appropriate climate, *space-conditioning category*, and *class of construction*, the *building envelope* shall comply with Section 5.1, General; Section 5.4, Mandatory Provisions; Section 5.7, Submittals; and Section 5.8, Product Information and Installation Requirements; and either **a. 5.5, Prescriptive Building Envelope Option.** Tables 5.5-1 through 5.5-8 Building Envelope Requirements by Climate Zone	➔ **SECTION 502 BUILDING ENVELOPE REQUIREMENTS** **502.1 General (Prescriptive)** **Table 502.1.2, Building Envelope Requirements Opaque Element (Maximum U-Factors)** **Table 502.2(1), Building Envelope Requirements Opaque Assemblies (Minimum *R*-values)** **Table 502.2(2), Building Envelope Requirements Opaque Assemblies** **Table 502.3, Building Envelope Requirements Fenestration** **506 TOTAL BUILDING PERFORMANCE**	Both Code and Standard provide for prescriptive designs – 1. The Code being limited to buildings having fenestration ≤ 40% of wall area and skylights ≤3% of roof area. 2. The Standard limited to buildings having fenestration ≤ 40% of wall area and skylights ≤5% of roof area. * (see ATTACHMENT for efficiency differences identified) Both Code and Standard address energy-cost-based designs of all parametric configurations, utilizing building performance (i.e., annual energy

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b. 5.6, Building Envelope Trade-Off Option. **5.2.2 Projects using the Energy Cost Budget Method. (Section 11 of this standard)**		cost).
5.4 Mandatory Provisions. **5.4.1 Insulation.** **5.4.2 Fenestration and doors**		Both Code and Standard address these topics. There are relatively insignificant differences here (not exhaustive).
5.4.3 Air leakage. **5.4.3.1 Building envelope sealing.** **5.4.3.2 Fenestration and doors** **5.4.3.3 Vestibules**		With the exception of "Vestibules," both Code and Standard address these topics. There are relatively insignificant differences here (not exhaustive). The Standard requires vestibules for building entrance doors opening into: 1. spaces > 1,000 s.f. in Zones 5 – 8, 2. spaces > 3,000 s.f. in buildings > three-stories and 10,000 ft2 in Zones 3 and 4, and 3. exempts all buildings in all other locations. The code achieves additional energy savings through infiltration reductions by requiring vestibules for entrance doors leading to all spaces >3,000 s.f. in buildings of all shapes and sizes.
5.5 Prescriptive Building Envelope Option.	**502.1 General (Prescriptive).** **502.1.1 Insulation and fenestration criteria.**	Both Code and Standard provide for prescriptive designs. * (see ATTACHMENT for efficiency differences identified)
5.5.3 Opaque Areas. **5.5.3.1 Roof Insulation.** **5.5.3.2 Above-Grade Wall Insulation.** **5.5.3.3 Below-Grade Wall Insulation.**	**502.2 Specific insulation requirements (Prescriptive).** **502.1 Roof assembly.** **502.2.2 Classification of walls.** **502.2.3 Above-grade walls.**	**Roofs (U-factors).** For above-deck systems, the Code accommodates improved efficiency in Zones 7 and 8. For metal buildings, the Code harbors improved efficiency across Zones 2 – 8. For attic and other systems, the Standard shows improved efficiency in Zone 8. Roof requirements are

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5.5.3.4 Floor Insulation. **5.5.3.5 Slab-on-Grade Floor Insulation.** **5.5.3.6 Opaque Doors.**	**502.2.4 Below-grade walls.** **502.2.5 Floors over outdoor air or unconditioned space.** **502.2.6 Slabs on grade.** **502.2.7 Opaque doors.**	otherwise identical. **Walls, Above-grade (*U*-factors).** For metal buildings, the Code accommodates improved efficiency across Zones 1 – 6 through energy savings where wall U-factors and Total UA are utilized for compliance assessment. Above-grade Wall requirements are otherwise identical, with exception of the following definition dilemma: Code – ABOVE-GRADE WALL (≥ 15% above grade) vs. Standard – ABOVE-GRADE WALL (not entirely buried). This definition dilemma has the effect of permitting greater vertical fenestration areas (perhaps up to 2%) in buildings evaluated to the Code opposed to the Standard. **Walls, Below-grade (*U*-factors).** Below-grade wall requirements are otherwise identical, with exception to the following definition dilemma: b. Code – BELOW-GRADE WALL (≥ 85% buried) v. Standard – BELOW-GRADE WALL (entirely buried). This definition dilemma has the effect of permitting greater vertical fenestration areas (up to 2%) in buildings evaluated to the Code opposed to the Standard. **Floors (*U*-factors).** The Code accommodates improved efficiency across Zones 1-7 through energy savings in steel joist floor *U*-factors. The Standard's steel joist floor *U*-factors are lower than those of the Code. Floor requirements are otherwise identical across all zones and construction types. **Slab-on-Grade Floors (*U*-factors).** For slab-on-grade floors (heated and unheated), both are identical.

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		Opaque Doors (*U*-factors). For opaque doors, both Code and Standard are virtually identical.
5.5.4 Fenestration. **5.5.4.3 Fenestration *U*-factor.** **5.5.4.4 Fenestration SHGC.**	**502.3 Fenestration.** **502.3.2 Maximum *U*-factor and SHGC.**	**Fenestration Heat Transmission (*U*-Factor).** For vertical fenestration, both Code and Standard are identical for products in affected markets (i.e., Zones). For skylights, the Code accommodates up to 2x improved efficiency over glass products in affected markets, lesser over plastic products. **Fenestration Solar Gain (SHGC).** For vertical fenestration, both the Code and Standard are identical for products in affected markets (i.e., zones). For skylights, the Code accommodates energy savings in fenestration solar heat gain over all products in affected markets, with the exception of Zone 7.
5.5.3.1.1 High Albedo Roofs. **5.6 Building Envelope Trade-Off Option.**	No Requirement (NR)	The Standard improves energy savings and flexibility for system designers as follows: 1. Provisions for reflective and emissive (i.e., high albedo) roof systems to mitigating the effects of the urban heat island phenomenon. The code does not include this provision as a Prescriptive option. However, the Total Building Performance approach to compliance assessment (i.e., Section 506) mirrors the Standard [see TABLE 506.5.1(1)] with respect to comparison of the STANDARD REFERENCE and PROPOSED DESIGNS. 2. A detailed calculation-based (pencil and paper/spreadsheet) envelope trade-off option is offered by the standard. The code does not include these provisions or otherwise offer the trade-off approach, yet the U.S. DOE COMcheck

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		Code compliance tool (i.e., widely used by the U.S. building regulatory community) affords this option in the form of a UA trade-off.
➔ 6. HEATING, VENTILATING, AIR CONDITIONING **SIMPLE SYSTEMS, GENERAL.** **COMPLEX SYSTEMS, GENERAL.**	**➔ SECTION 503 BUILDING MECHANICAL SYSTEMS** **SIMPLE SYSTEMS, GENERAL.** **COMPLEX SYSTEMS, GENERAL.**	Both Code and Standard provide for simple HVAC systems: The Code limited to buildings served by unitary or packaged equipment serving one zone and responding to one thermostat. The Standard limited to buildings two-stories or less and 25,000 s.f. or less and served by unitary or packaged equipment serving one zone and responding to one thermostat. Both Code and Standard address complex HVAC systems – designs of all HVAC system types and configurations. Unless specified otherwise, both afford identical requirements for mechanical systems as follows:
6.3 Simplified Approach Option for HVAC Systems **6.4 Mandatory Provisions.** **6.3.2 Criteria.** The HVAC system must meet ALL of the following criteria: a. Serves a single HVAC zone. b. Cooling (if any) shall be provided by a unitary packaged or split-system air conditioner, air-cooled or evaporatively cooled with NAECA efficiency for the applicable equipment category. c. Is equipped with an air economizer and controls where indicated, with either barometric or powered relief sized to prevent over-pressurization. Where the cooling efficiency meets or exceeds the efficiency requirement of Table	**503.2 Provisions applicable to all mechanical systems (Mandatory).** **503.3 Simple HVAC systems and equipment (Prescriptive).** a. **503.3.** Serves a single HVAC zone. b. **503.2.3, 503.3.** Cooling (if any) shall be provided by a unitary packaged or split-system air conditioner, air-cooled or evaporatively cooled with NAECA efficiency for applicable category. c. **502.4.5, 503.3.1, T503.3.1(1), T503.3.1(2).** Is equipped with an air economizer and controls where indicated, with either barometric or powered relief sized to prevent overpressurization. Where the cooling efficiency meets or exceeds the	With respect to "Mandatory Provisions," both Code and Standard address these topics. There are relatively insignificant differences here (not exhaustive). However: **Economizer Thresholds.** The Code and Standard vary in this respect. For the Code, economizer control is not required for Zones 1A, 1B, 2A, 7 and 8 (i.e., Zones 1A, 1B, 2A, 3A and 4A for the Standard). For the Code, economizer control is then required on cooling systems ≥ 54,000 Btu/h

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6.3.2, no economizer is required. Outdoor air dampers for economizer use shall be provided with blade and jamb seals. d. Heating (if any) shall be provided by a unitary packaged or split-system heat pump that meets the applicable NAECA efficiency for the applicable equipment category. e. The *outdoor air* quantity supplied by the system shall be less than or equal to 3,000 cfm and less than 70% of the supply air quantity at minimum *outdoor air* design conditions unless an energy recovery ventilation system is provided. f. The *system* shall be controlled by a manual changeover or dual set-point thermostat. g. If a heat pump, controls shall be provided that prevent supplemental heater operation when the heating load can be met by the heat pump alone. h. The *system* controls shall not permit reheat or any other form of simultaneous heating and cooling for humidity control. i. *Systems* serving spaces other than hotel/motel guest rooms, and other than those requiring continuous operation, which have both a cooling or heating capacity greater than 15,000 Btu/h and a supply fan motor power greater than ¾ hp, shall be provided with a time clock. j. Except for piping within manufacturers' units, HVAC piping shall be insulated. k. Ductwork and plenums shall be insulated and sealed. l. Construction documents shall require a ducted	efficiency requirement of Table 6.3.2, no economizer is required. Outdoor air dampers for economizer use shall be provided with blade and jamb seals. d. **503.2.3, 503.3.** Heating (if any) shall be provided by a unitary packaged or split-system heat pump that meets the applicable NAECA efficiency for the applicable equipment category. e. **503.2.6.** The *outdoor air* quantity supplied by the system shall be less than or equal to 3,000 cfm and less than 70% of the supply air quantity at minimum *outdoor air* design conditions unless an energy recovery ventilation system is provided. f. **503.2.4.1.** The *system* shall be controlled by a manual changeover or dual set-point thermostat. g. **503.2.4.2.** If a heat pump, controls shall be provided that prevent supplemental heater operation when the heating load can be met by the heat pump alone. h. **503.2.3. 503.2.4.1.** The *system* controls shall not permit reheat or any other form of simultaneous heating and cooling for humidity control. i. **503.2.4.3.** *Systems* serving spaces other than hotel/motel guest rooms, and other than those requiring continuous operation, which have both a cooling or heating capacity greater than 15,000 Btu/h and a supply fan motor power greater than ¾ hp, shall be provided with a time clock. j. **503.2.8.** Except for piping within manufacturers' units, HVAC piping shall be insulated. k. **503.2.7.** Ductwork and plenums shall be	(4½ tons) for all other Zones. From here on, the Standard requires economizer control for cooling systems ≥ 65,000 Btu/h (5.4 tons) in Zones 2B, 5A, 6A, 7 and 8; and for cooling systems ≥ 135,000 Btu/h (11¼ tons) in Zones 3B, 3C, 4B, 4C, 5B, 5C and 6B. **High-Limit Shutoff Control Options & Settings.** The Standard improves energy savings in providing detailed requirements for economizer control types and settings. The Code has no such provision. **Off-hour Controls.** The Standard applies this provision to systems with design heating capacity and cooling capacity >15,000 Btu/h and ¾ hp. The code improves energy savings over the Standard by applying this provision to systems >6,800 Btu/h. **Pipe Insulation.** The Code specifies 1 ½ or 3-inch-thick, R-3.7 insulation as required. The Standard's specifications vary from ½- to 4-inch-thick and R-2.9 to R-4.5 insulation as required, based on system, fluid temperature, conductivity (k), and

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system to be air balanced in accordance with industry accepted procedures. m. Where separate heating and cooling equipment serves the same temperature zone, thermostats shall be interlocked to prevent simultaneous heating and cooling. n. Exhausts with a design capacity of over 300 cfm on systems that do not operate continuously shall be equipped with gravity or motorized dampers. o. Systems with a design supply air capacity greater than 10,000 cfm shall have optimum start controls.	insulated and sealed. l. **503.2.9.1.** Construction documents shall require a ducted system to be air balanced in accordance with industry accepted procedures. m. **503.2.4.1, 503.2.4.2.** Where separate heating and cooling equipment serves the same temperature zone, thermostats shall be interlocked to prevent simultaneous heating and cooling. *[[The Code's system requirements for manual changeover or dual set-point control accomplish this.]]* n. **503.2.4.4.** Exhausts with a design capacity of over 300 cfm on systems that do not operate continuously shall be equipped with gravity or motorized dampers. o. **NR.** Systems with a design supply air capacity greater than 10,000 cfm shall have optimum start controls.	nominal pipe diameter (o.d.). **Duct Insulation.** The Code specifies R-5 for ducts in unconditioned spaces and R-8 for ducts outside the building structure. The Standard's specifications vary based on location, supply-return and heating only-cooling only configurations from R-1.9 to R-8. **Duct Sealing.** Both Code and Standard specify provisions based on operating static pressure, and require leak testing in accordance with SMACNA for ducts designed to operate at >3 in. w.g. The Standard uses seal class (i.e., A,B,C), while the Code uses the more contemporary, pressure classifications as required on the construction documents in accordance with the ICC *International Mechanical Code®* (*IMC®*). **Items of a Specific Nature.** The Code improves energy efficiency as follows: (i) Multiple-packaged boiler operation shall be sequenced, (ii) Single boilers >500,000 Btu/h shall be equipped with a multistage or modulating burner. The Standard calls for this (ii) when a boiler plant includes more than one boiler. The Standard improves energy efficiency as follows: (i) Optimum start controls on systems supplying greater than 10,000 cfm at design conditions, (ii) Systems serving zones intended to be occupied nonsimultaneously shall be isolated, (iii) Precluding simultaneous humidification and dehumidification, (iv) Specifies static pressure sensor locations for controlling VAV fans *[[For a Standard? A design choice?]],* and (v) Kitchen exhaust and fume hood make-up air options. **Note:** Such make-up air options are addressed by

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		the *IMC®*, and require study as they differ from those espoused by the Standard for safety and comfort.
6.4.1 Equipment Efficiencies, Verification, and Labeling Requirements.	**SECTION 303 MATERIALS, SYSTEMS AND EQUIPMENT** **503.2.3 HVAC equipment performance requirements.**	Both Code and Standard address these topics. There are relatively insignificant differences here (not exhaustive).
6.4.2 Load Calculations.	**503.2.1 Calculation of heating and cooling loads.** **503.2.2 Equipment and system sizing.**	Both Code and Standard address these topics. There are relatively insignificant differences here (not exhaustive). However: **Load Calculations and System Sizing.** The Code specifies design loads calculated in accordance with ASHRAE/ACCA 183-2007 or equivalent. The Code limits sizing for systems to the loads calculated and not in excess thereof with exceptions. The Standard stipulates design loads and system sizing are to be determined in accordance with "generally accepted engineering standards" and handbooks acceptable to the AHJ. *[[How to define "generally accepted engineering standards?"]]*
6.4.3 Controls. **6.4.3.1 Zone Thermostatic Controls.** **6.4.3.2 Set point Overlap Restriction.** **6.4.3.3 Off-Hour Controls.** **6.4.3.4 Ventilation System Controls.** *(below)* **6.4.3.5 Heat Pump Auxiliary Heat Control.** **6.4.3.6 Humidifier Preheat.** **6.4.3.7 Humidification and Dehumidification.** **6.4.3.8 Freeze Protection, Snow/Ice Melt Systems.**	**503.2.4 HVAC system controls.** **503.2.4.1 Thermostatic Controls.** **503.2.4.2 Set point Overlap Restriction.** **503.2.4.3 Off-Hour Controls.** **503.2.5 Ventilation.** *(below)* **503.2.4.1.1 Heat Pump Supplementary Heat.** **NR** **503.2.4.1 Thermostatic Controls.** **503.2.4.5 Snow Melt System Controls.**	Both Code and Standard address these topics. There are relatively insignificant differences here (not exhaustive). However: **Humidifier Preheat.** A detail addressing humidifiers with preheating jackets mounted in the airstream is offered by the Standard. The Code does not include such provisions.

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6.4.3.4 Ventilation System Controls.	**503.2.5 Ventilation.** *** 106.2 Conflicting requirements.** *** 106.3Application of references.** * ((Wherever there exists conflict among the provisions of the Code and those of a referenced Standard, the provisions of the Code take precedence))	Both Code and Standard address these topics. However: **Ventilation for Acceptable Indoor Air Quality.** For ventilation issues, the Code refers to the IMC®, as is fully compatible with the Family of ICC International Codes. In certain instances, the Standard references ASHRAE 62.1-2004. Resulting from final action to M44-06/07, the IMC® is technically consistent with ventilation rate procedures defined in ASHRAE Standard 62.1-2007 as indicative of the latest research on building indoor air and environmental quality. The improved procedures are such that ventilation systems designed using the IMC® will result in slightly lower outdoor rates for most occupancies compared to the former 2006 IMC®, thereby reducing first costs and energy costs. Standard 62.1 is not widely adopted by U.S. cities, counties, and states that adopt codes for mechanical and ventilation safety and health concerns.
6.4.3.1 Stair and Shaft Vents. **6.4.3.4.2 Gravity Hoods, Vents and Ventilators.** **6.4.3.4.3 Shutoff Damper Controls.** **6.4.3.4.4 Dampers.** **6.4.3.4.5 Ventilation Fan Controls.**	**502.4.5 Outdoor air intakes and exhaust openings** **502.4.5 Outdoor air intakes and exhaust openings** **503.2.4.4 Shutoff Damper Controls.** **502.4.5 Outdoor air intakes and exhaust openings** **6.4.3.4.5 Ventilation Fan Controls.**	Both Code and Standard address these topics. There are relatively insignificant differences here (not exhaustive). However: **Gravity Hoods, Vents and Ventilators.** The Code permits gravity dampers by exception for all buildings 2 stories or less in height. The Standard permits gravity dampers for buildings 2 stories or less in height and buildings of any height located in Zones 1-3. **Ventilation Fan Controls.** The Standard includes provisions specific to fans > ¾ hp (0.5 kW) having controls capable of shut-down when fan operation

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		is not required. It is unclear, but the Code's provisions for *system* "Automatic setback and shutdown capabilities," seem to address this concern using the ordinarily accepted meaning of the term, SYSTEM. The Code does not place a limit on the fan system hp for application of this requirement.
6.4.3.9 Ventilation Controls for High-Occupancy Areas.	**503.2.5.1 Demand controlled ventilation.**	Both Code and Standard address this topic. There are no differences here (not exhaustive).
6.4.4 HVAC System Construction and Insulation.	**503.2.7 Duct and plenum insulation and sealing.** **503.2.8 Piping insulation.**	Other than "Piping Insulation and Duct Insulation" discrepancies noted previously (see **6.3.2 Criteria**), both Code and Standard address these topics. There are relatively insignificant differences here (not exhaustive).
6.4.5 Completion Requirements. (see 6.7 Submittals)	**503.2.9 HVAC system completion.** (see 6.7 Submittals)	Both Code and Standard address these topics.
6.5 Prescriptive Path **6.5.1 Economizers.** **6.5.1.1 Air Economizers.** **6.5.1.1.1 Design Capacity.**	**503.2 Provisions applicable to all mechanical systems (Mandatory).** **503.3 Complex HVAC systems and equipment (Prescriptive).** **503.3.1, 503.4.1 Economizers.** **503.3.1, 503.4.1 Economizers.** **503.3.1, 503.4.1 Economizers.**	With respect to "Mandatory Provisions," both Code and Standard address these topics. There are some significant differences here, however, most have to be sought out and are "design-specific" (not exhaustive). Please note: **Economizer Thresholds.** The Code and Standard vary in this respect. For the Code, economizer control is not required for Zones 1A, 1B, 2A, 7 and 8 (i.e., Zones 1A, 1B, 2A, 3A and 4A for the Standard). For the Code, economizer control is then required on cooling systems ≥ 54,000 Btu/h (4½ tons) for all other Zones. From here on, the Standard requires economizer control for cooling systems ≥ 65,000 Btu/h (5.4 tons) in Zones 2B, 5A, 6A, 7 and 8; and for cooling systems ≥ 135,000 Btu/h (11¼ tons) in Zones 3B, 3C, 4B, 4C, 5B, 5C

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6.5.1.1.2 Control Signal.		and 6B.
	NR Control Signal.	**Control Signal.** The Standard could lead to improvements in energy efficiency in specifying that economizer dampers are *to be capable* of being sequenced and not be controlled solely by mixed air temperature. While this is a "capability" and not necessarily required to be utilized in operation (as worded), the Code does has no such provision.
6.5.1.1.3 High-Limit Shutoff.		
6.5.1.1.4 Dampers.	**NR High-Limit Shutoff.**	**High-Limit Shutoff Control Options & Settings.** The Standard improves energy efficiency in providing detailed requirements for economizer control types and settings. The Code has no such provision.
	502.4.5 Outdoor air intakes and exhaust openings	
6.5.1.1.5 Relief of Excess *Outdoor Air*.		
6.5.1.2 Water Economizers	**503.3.1, 503.4.1 Economizers.**	
6.5.1.2.1 Design Capacity.	**503.3.1, 503.4.1 Economizers.**	
6.5.1.2.2 Maximum Pressure Drop.	**503.3.1, 503.4.1 Economizers.**	
6.5.1.3 Integrated Economizer Control.	**NR Maximum Pressure Drop.**	**Maximum Pressure Drop.** The Standard specifies static pressure sensor locations for controlling VAV fans *[[For a Standard? A design choice?]].* The Code has no such provision.
	503.3.1, 503.4.1 Economizers.	
6.5.1.4 Economizer Heating System Impact.		
	NR Economizer Heating System Impact.	**Economizer Heating System Impact.** The Standard specifies system design and controls such that economizer operation does not increase the building heating energy use during normal operation. The Code has no such provision.
6.5.2 Simultaneous Heating & Cooling Limitation.	**503.4.5 Requirements for complex mechanical systems serving multiple zones.**	With respect to "Mandatory Provisions," both Code and Standard address these topics. There are some significant differences here, however, most have to be sought out and are "design-specific" (not exhaustive). Please note:
6.5.2.1 Zone Controls.	**503.4.5.1 Single duct variable air volume (VAV) systems, terminal devices.**	
	503.4.5.2 Dual duct mixing VAV systems, terminal	

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	devices. **503.3.5.3 Single fan dual duct and mixing VAV systems, economizers.**	
6.5.2.2 Hydronic System Controls.	**503.4.3 Hydronic systems controls.**	**Hydronic Systems Controls.** The Code improves energy efficiency as follows: (i) Multiple-packaged boiler operation shall be sequenced, (ii) Single boilers >500,000 Btu/h shall be equipped with multistage or modulating burners. The Standard has no such provision.
6.5.2.2.1 Three-Pipe System.	**503.4.3.1 Three-pipe system.**	
6.5.2.2.2 Two-Pipe Changeover System.	**503.4.3.2 Two-pipe changeover system.**	
6.5.2.2.3 Hydronic (Water Loop) Heat Pump Sys.	**503.4.3.3 Hydronic (water loop) heat pump sys.**	
6.5.2.3 Dehumidification.	**NR Dehumidification.**	**6.5.2.3 Dehumidification.** The Standard affords detailed specifications where humidistatic controls are utilized in order to prevent the reheating, mixing, or other means of simultaneous heating and cooling the same airstream. Several exceptions, including systems serving spaces where specific humidity levels are required to satisfy process needs, such as computer rooms, museums, surgical suites, and buildings with refrigerating systems, such as supermarkets, refrigerated warehouses, and ice arenas; and where desiccant systems are utilized to achieve humidistatic control. The Dehumidification-specific exceptions also apply to other applications for which fan volume controls in accordance with Code Section 503.4.5 may prove to be impractical to the *enforcement agency*. As to how this is deemed "impractical," and the burden of proof for which the applicant must offer in support of such "impracticality," is

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		unclear. The Code has no such provision.
6.5.2.4 Humidification.	**NR Humidification.**	**Humidification.** The Standard specifies water economizers for systems with hydronic cooling and humidification systems designed to maintain inside humidity at a dew-point temperature >35°F. The Code has no such provision.
6.5.3 Air System Design and Control.	**503.2.10 Air system design and control.**	With respect to "Air System Design and Control," both Code and Standard address these topics. There are some differences here, however, most have to be sought out and are "design-specific" (not exhaustive). Please note:
6.5.3.1 Fan System Power Limitation.	**503.2.10.1 Allowable fan floor horsepower.**	
6.5.3.1.1 (untitled).	**503.2.10.1 Allowable fan floor horsepower.**	
6.5.3.1.2 Motor Nameplate Horsepower.	**503.2.10.2 Motor nameplate horsepower.**	
6.5.3.2 VAV Fan Control (Including Systems Using Series Fan Power Boxes).	**503.4.2 Variable air volume (VAV) fan control.**	**Variable air volume (VAV) fan control.** The Standard permits the use of vane-axial fans with variable-pitch blades for VAV fan control. Centrifugal efficiencies range from 50-70% depending upon blade configuration and vane-axial efficiencies range from 80-90^{+}%. Depending on the style of fan being used and the flexibility desired, blade pitch adjustment or VFD control will be the most efficient. While variable pitch-in-motion vane-axial fans are less costly than mechanical or electrical variable speed drives, the Code does not recognize the approach at this time.
6.5.3.2.1 Part-Load Fan Power Limitation.	**503.4.2 Variable air volume (VAV) fan control.**	
6.5.3.2.2 Static Pressure Sensor Location.	**6.5.3.2.2 Static Pressure Sensor Location.**	**Static Pressure Sensor Location.** The Standard specifies static pressure sensor locations for controlling VAV fans. A design consideration. The Code has no such provision.
6.5.3.2.3 Set point Reset.	**503.4.5.4 Supply-air temperature reset controls.**	
6.5.4 Hydronic System Design and Control.	**503.3.2 & 503.4.3 Hydronic systems control.**	Both Code and Standard address these topics. There are relatively insignificant differences here (not exhaustive).
		Hydronic systems control. The Code triggers Hydronic systems control for all systems at 300,000 Btu/h [i.e., gpm = 300,000 / (500 x Δt)] ~

ASHRAE STANDARD 90.1-2007 *Section*	**INTERNATIONAL ENERGY CONSERVATION CODE** (IECC®) *Comparable Section(s)*	**COMMENTS** *This is opinion and not comprehensive.*
6.5.4.1 Hydronic Variable Flow Systems. **6.5.4.2 Pump Isolation.** **6.5.4.3 Chilled- and Hot-Water Temperature Reset Controls.** **6.5.4.4 Hydronic (Water Loop) Heat Pump Systems.**	**503.4.3.4 Part load controls.** **503.4.3.5 Pump Isolation.** **503.4.3.4 Part load controls.** **503.4.3.3 Hydronic (water loop) heat pump systems.**	40-60 gpm. Assuming water, and depending on system head (ft.) [i.e., Pump hp = (50gpm x (ft. head) / 3960 x η_p) x 0.99]. The Standard triggers Hydronic systems control for all systems at a *total pump system hp* of 10hp.
6.5.5 Heat Rejection Equipment. **6.5.5.1 General.** (Equipment Types) **6.5.5.2 Fan Speed Control.**	**503.4.4 Heat rejection equipment fan speed control.**	Both Code and Standard address these topics. There are relatively insignificant differences here (not exhaustive). **Heat rejection equipment fan speed control.** The Standard exempts condenser fans serving: (i) multiple refrigerant circuits, (ii) serving flooded condensers, (iii) serving air-cooled condensers, open and closed-circuit cooling towers, and evaporative condensers in Zones 1 and 2, and (iv) up to one-third of the fans on a condenser or tower with multiple fans, where the lead fans comply with the speed control requirement. The Code improves energy efficiency by exempting "factory-installed" heat rejection equipment in HVAC equipment meeting the NAECA efficiency for the applicable equipment category.
6.5.6 Energy Recovery. **6.5.6.1 Exhaust Air Energy Recovery.** **6.5.6.2 Heat Recovery for Service Water Heating.** **6.5.6.2.1 (untitled).** (Condenser Heat Recovery) **6.5.6.2.2 (untitled).** (Capacity)	**503.2.6 Energy Recovery ventilation systems.** **503.4.6 Heat Recovery for Service Water Heating.**	Both Code and Standard address these topics. There are relatively insignificant differences here (not exhaustive).
6.5.7 Exhaust Hoods. **6.5.7.1 Kitchen Hoods.** Individual kitchen exhaust hoods larger than 5,000 cfm shall be provided with	***IMC®* 501.3 Pressure equalization.** Mechanical exhaust systems shall be sized to remove the quantity of air required by this chapter to be	The *IMC®* and the Standard address these topics. There are significant differences here (not exhaustive). Primarily, that the Standard appears

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makeup air sized for at least 50% of exhaust air volume that is unheated or heated to no more than 60°F and un-cooled or cooled without the use of mechanical cooling. **Exceptions:** a. Where hoods are used to exhaust ventilation air that would otherwise exfiltrate or be exhausted by other fan systems. b. Certified grease extractor hoods that require a face velocity no greater than 60 fpm. **6.5.7.2 Fume Hoods.** Buildings with fume hood systems having a total exhaust rate greater than 15,000 cfm shall include one of the following: a. VAV hood exhaust and room supply systems *capable* of reducing exhaust and makeup air volume to 50% or less of design values. b. Direct makeup (auxiliary) air supply equal to at least 75% of the exhaust rate, heated no warmer than 2°F below room set point, cooled to no cooler than 3°F above room set point, no humidification added, and no simultaneous heating and cooling used for dehumidification control. c. Heat recovery systems to precondition makeup air from fume hood exhaust.	exhausted. The system shall operate when air is required to be exhausted. Where mechanical exhaust is required in a room or space in other than occupancies in R-3, such space shall be maintained with a neutral or negative pressure. If a greater quantity of air is supplied by a mechanical ventilating supply system than is removed by a mechanical exhaust for a room, adequate means shall be provided for the natural or mechanical exhaust of the excess air supplied. If only a mechanical exhaust system is installed for a room or if a greater quantity of air is removed by a mechanical exhaust system than is supplied by a mechanical ventilating supply system for a room, adequate make-up air consisting of supply air, transfer air or outdoor air shall be provided to satisfy the deficiency. The calculated building infiltration rate shall not be utilized to satisfy the requirements of this section. **SECTION 508 COMMERCIAL KITCHEN MAKEUP AIR** ***IMC®* 508.1.1 Makeup air temperature.** The temperature differential between makeup air and the air in the conditioned space shall not exceed 10ºF (6ºC). **Exceptions:** 1.Makeup air that is part of the air-conditioning system. 2.Makeup air that does not decrease the comfort conditions of the occupied space.	to conflict with mechanical and ventilation safety and health concerns of the *IMC®*. * **106.2 Conflicting requirements.** * **106.3Application of references.** * ((Wherever there exists conflict among the provisions of the Code and those of a referenced Standard, the provisions of the Code take precedence)) Standard 90.1 is not widely adopted by U.S. cities, counties, and states that adopt codes for mechanical and ventilation safety and health concerns.
6.5.8 Radiant Heating Systems. **6.5.8.1 Heating Unenclosed Spaces.** **6.5.8.2 Heating Enclosed Spaces.**	**503.2.11 Heating outside a building.**	Both Code and Standard address these topics. There are relatively insignificant differences here (not exhaustive).

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		The Code specifies occupant sensing or time-clock controls to turn-off the system when occupants are not present. The Standard does not include such provisions for controls.
6.5.9 Hot Gas Bypass Limitation.	**502.4.4 Hot gas bypass limitation.** (Err. 503.4.7)	Both Code and Standard address these topics. There are relatively insignificant differences here (not exhaustive).
6.6 Alternative Compliance Path. (Not Used)	N/A	The Code includes only those provisions necessary for Code enforcement and design.
6.7 Submittals. **6.7.2.1 Drawings.** **6.7.2.2 Manuals.** **6.7.2.3 System Balancing** **6.7.2.3.1 General.** (HVAC Systems) **6.7.2.3.2 Air System Balancing.** **6.7.2.3.3 Hydronic System Balancing.** **6.7.2.4 System Commissioning.** (Controls)	**SECTION 103 CONSTRUCTION DOCUMENTS** **503.2.9 HVAC system completion.** **503.2.9.3 Manuals.** **503.2.9.1 Air system balancing** **503.2.9.1 Air system balancing** **503.2.9.1 Air system balancing** **503.2.9.2 Hydronic system balancing.** **NR** (Controls)	Both Code and Standard address these topics. There are differences here (not exhaustive). **System Commissioning.** The standard requires HVAC control systems to be tested to ensure that control elements are calibrated, adjusted, and in proper working condition. The code does not include these provisions.
➔ **7. SERVICE WATER HEATING.** **7.1 General.** **7.2 Compliance paths.** **7.3 Simplified/Small Building Option (Not Used).** **7.4 Mandatory Provisions.**	➔ **504 SERVICE WATER HEATING (Mandatory).** **504.1 General.** N/A	Both Code and Standard address these topics. There are significant differences here (not exhaustive). The Code includes only those provisions necessary for Code enforcement and design.
7.4.1 Load Calculations.	NR	**Load Calculations.** The Standard requires calculation of service water heating system design loads for the purpose of sizing systems and equipment. Neither the Code, nor the ICC

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		International Plumbing Code (IPC®) include these provisions.
7.4.2 Equipment Efficiency.	**504.2 Service water-hearing equipment performance efficiency.**	Both Code and Standard address these topics. There are relatively insignificant differences here (not exhaustive).
7.4.3 Service Hot-Water Piping Insulation.	**504.5 Pipe Insulation.**	Both Code and Standard address these topics. There are differences here (not exhaustive). **Pipe Insulation.** The Code specifies 1-inch-thick, R-3.7 insulation. The Standard's specifications vary from ½- to 4-inch-thick and R-2.9 to R-4.5 insulation, based on system, fluid temperature, conductivity (k), and nominal pipe diameter (o.d.).
7.4.4 Service Water Heating System Controls. **7.4.4.1 Temperature Controls.** **7.4.4.2 Temperature Maintenance Controls.** **7.4.4.3 Outlet Temperature Controls.** **7.4.4.4 Circulating Pump Controls.**	 **504.3 Temperature controls.** **504.6 Hot water system controls.** **504.3 Temperature controls.** **504.6 Hot water system controls.**	Both Code and Standard address these topics. There are relatively insignificant differences here (not exhaustive).
7.4.5 Pools. **7.4.5.1 Pool Heaters.** **7.4.5.2 Pool Covers.** **7.4.5.3 Time Switches.**	**504.7 Pools.** **504.7.1 Pool Heaters.** **504.7.3 Pool covers.** **504.7.2 Time switches.**	Both Code and Standard address these topics. There are insignificant differences here (not exhaustive).
7.4.6 Heat Traps.	**504.4 Heat traps.**	Both Code and Standard address these topics. There are insignificant differences here (not exhaustive).
7.5 Prescriptive Path. **7.5.1 Space Heating and Water Heating.** **7.5.2 Service Water Heating Equipment.**	NR	The Standard provides for circumstances where space heating and service water heating functions are combined. The Code does not include such provisions.

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7.6 Alternative Compliance Path (Not Used).	N/A	The Code includes only those provisions necessary for Code enforcement and design.
7.7 Submittals. **7.7.1 General.** **7.8 Product Information.**	**SECTION 103 CONSTRUCTION DOCUMENTS** **103.1 General.** **103.2 Information on construction documents.** **103.3 Examination of documents.** **103.4 Amended construction documents.** **103.5 Retention of construction documents.** **SECTION 303 MATERIALS, SYSTEMS AND EQUIPMENT**	Both Code and Standard address these topics. There are insignificant differences here (not exhaustive).
➔ 8. POWER **8.1 General.** **8.2 Compliance Path(s).** **8.2.1 (untitled).** **8.3 Simplified/Small Building Option (Not Used).** **8.4 Mandatory Provisions.** **8.4.1 Voltage Drop** **8.4.1.1 Feeders.** *Feeder conductors* shall be sized for a maximum *voltage drop* of 2% at design load. **8.4.1.2 Branch Circuits.** *Branch circuit* conductors shall be sized for a maximum *voltage drop* of 3% at design load. **8.5 Prescriptive Path (Not Used).** **8.6 Alternative Compliance Path (Not Used).** **8.7 Submittals** **8.7.1 Drawings.** **8.7.2 Manuals.**	**➔ ELECTRICAL POWER AND LIGHTING SYSTEMS (Mandatory)** **505.7 Electrical energy consumption (Mandatory).** In buildings having individual dwelling units, provisions shall be made to determine the electrical energy consumed by each tenant by separately metering individual dwelling units. N/A N/A	The Standard addresses feeder sizing. The Code does not. The Code addresses *submetering*. The Standard does not. It is unclear whether the *National Electrical Code* (NFPA 70) addresses these topics in any more detail. *[[**Submetering** is a utility conservation and management solution that allows property owners and managers of multi-family and multi-tenant retail communities to reduce or eliminate water, gas and electricity costs by billing tenants for individual measured utility usage. Typical users of submetering are mobile home parks, apartment complexes, and multi-tenant commercial buildings. Submetering results in lower utility consumption and savings to the resident only to the extent that individual residents decide to reduce consumption.]]* The Code includes only those provisions necessary for Code enforcement and design.

ASHRAE STANDARD 90.1-2007 *Section*	**INTERNATIONAL ENERGY CONSERVATION CODE** (IECC®) *Comparable Section(s)*	**COMMENTS** *This is opinion and not comprehensive.*
8.8 Product Information (Not Used).		
➔ 9. LIGHTING. **9.1 General.**	**➔ ELECTRICAL POWER AND LIGHTING SYSTEMS (Mandatory)** **505.1 General (Mandatory).**	**Building Electrical Power and Lighting Systems.** Both Code and Standard account for daylighting control and provide limitations on interior and exterior lighting power and controls. Also known as photo-pollution or luminous pollution the code provides means to mitigate the adverse effects of artificial light including sky glow, glare, light trespass, light clutter, decreased visibility resulting from eye adaptation, and energy waste that interferes with astronomical observatories and disrupts ecosystems. The Standard does not include this provision. Unless specified otherwise, both afford identical requirements for electrical power and lighting systems:
9.1.1 Scope. This section shall apply to the following: a. interior spaces of buildings, b. exterior building features, including facades, illuminated roofs, architectural features, entrances, exits, loading docks, and illuminated canopies, and c. exterior building grounds lighting provided through the building's electrical service. **Exceptions:** a. emergency lighting that is automatically off during normal building operation, b. lighting within dwelling units, c. lighting that is specifically designated as required	**505.1 General (Mandatory).** This section covers lighting system controls, the connection of ballasts, the maximum lighting power for interior applications and minimum acceptable lighting equipment for exterior applications. **Exception:** Lighting within dwelling units where 50 percent or more of the permanently installed interior light fixtures are fitted with high-efficacy lamps.	With the exception of the Code's more specific dwelling unit exception, both Code and Standard address these topics. There are some significant differences, however, most have to be sought out and are "design-specific" (not exhaustive). Please note:

ASHRAE STANDARD 90.1-2007 *Section*	**INTERNATIONAL ENERGY CONSERVATION CODE** (IECC®) *Comparable Section(s)*	**COMMENTS** *This is opinion and not comprehensive.*
by a health or life safety statute, ordinance, or regulation, and d. decorative gas lighting systems		
9.1.3 Installed Interior Lighting Power.	**505.5 Interior lighting power requirements (Prescriptive).**	Both Code and Standard address these topics. There are insignificant differences here (not exhaustive). The Standard addresses the circumstance where two or more independently operating lighting systems in a space are capable of being controlled to prevent simultaneous user operation. The Code does not include this provision.
9.1.4 Luminaire Wattage.	**505.5.1.1 Screw lamp holders.** **505.5.1.2 Low-voltage lighting.** **505.5.1.3 Other luminaires.** **505.5.1.4 Line-voltage lighting track and plug-in busway.**	Both Code and Standard address these topics. There are insignificant differences here (not exhaustive). The Standard addresses the circumstance where low-voltage lighting track, cable conductors, rail conductors, and other flexible lighting systems allow for the addition/relocation of luminaires without altering system wiring. The Code does not include this provision.
9.2 Compliance Path(s). **9.2.1 Lighting Systems and Equipment.** **9.2.2 Prescriptive Requirements.**	**505 Interior lighting power requirements (Prescriptive).**	Both Code and Standard address these topics. There are insignificant differences here (not exhaustive).
9.3 (Not Used)	N/A	The Code includes only those provisions necessary for Code enforcement and design.
9.4 Mandatory Provisions. **9.4.1 Lighting Control.** **9.4.1.1 Automatic Lighting Shutoff.**	**505.2 Lighting controls (Mandatory).** **505.2.2.2 Automatic lighting shutoff.**	Both Code and Standard address these topics. There are insignificant differences here (not exhaustive).
9.4.1.2 Space Control.	**505.2.1 Interior lighting controls.** **502.2.2 Additional controls.**	Both Code and Standard address these topics. There are some subtle differences here (not

ASHRAE STANDARD 90.1-2007 *Section*	**INTERNATIONAL ENERGY CONSERVATION CODE** (IECC®) *Comparable Section(s)*	**COMMENTS** *This is opinion and not comprehensive.*
	502.2.2.2 Automatic lighting shutoff. **502.2.2.2.1 Occupant override.** **502.2.2.2.2 Holiday scheduling.**	exhaustive). Relative to "ready access," the Standard differentiates among manual and automatic controls. The Code does not. Accordingly, it could be perceived that automatic controls as required by the Standard are not to be *readily accessible*. As such, the implications to the psychosomatic tendencies of the occupant might be, "out of site – out of mind." The implications to energy efficiency might include the occupant overlooking an opportunity to directly intervene and switch off space lighting manually (via manual override) before the (max. 30-minute) timing cycle of the automatic control engages.
9.4.1.3 Exterior Lighting Control.	**505.2.4 Exterior lighting controls.**	Both Code and Standard address these topics. There are insignificant differences here (not exhaustive). The Standard provides an exemption for lighting at covered vehicle entrances or exits from buildings or parking structures as required for safety, security, or eye adaptation. The Code does not include this provision.
9.4.1.4 Additional Control.	**505.2 Lighting controls (Mandatory).**	Both Code and Standard address these topics. There are some subtle differences here (not exhaustive). Additional energy savings is achieved by the Standard as it identifies locations where task lighting controls can improve energy efficiency (i.e., display and accent lighting, case lighting, supplemental under-shelf or under-cabinet task lighting, lighting for plant growth and food warming, and demonstration lighting). The Code does not include a distinct task lighting control

ASHRAE STANDARD 90.1-2007 *Section*	**INTERNATIONAL ENERGY CONSERVATION CODE** (IECC®) *Comparable Section(s)*	**COMMENTS** *This is opinion and not comprehensive.*
		provision for these particular circumstances. Most often, the rational is that these locations and circumstances often do not involve permanent, hard-wired connections to the building electrical service. As such, the Code does not require a permit for portable and temporary equipment and appliances (i.e., here today – gone tomorrow).
NR	**505.2.2.1 Light reduction controls.**	**Light Reduction Controls.** The Code improves energy savings by requiring light reduction controls for all spaces not already controlled by occupant sensing or otherwise used as a whole. The Standard does not include this provision.
9.4.2 Tandem Wiring.	**505.3 Tandem wiring (Mandatory).**	Both Code and Standard address these topics. There are no differences here (not exhaustive).
9.4.3 Exit signs.	**505.4 Exit Signs (Mandatory).**	Both Code and Standard address these topics. There are no differences here (not exhaustive).
9.4.4 Exterior Building Grounds Lighting.	**505.6 Exterior lighting (Mandatory).** **505.6.1 Exterior building grounds lighting.**	Both Code and Standard address these topics. There are no differences here (not exhaustive).
9.4.5 Exterior Building Lighting Power. NR NR	**505.6 Exterior lighting (Mandatory).** **505.6.2 Exterior building lighting power.** **Table 505.6.2(1) Exterior Lighting Zones.** **Table 505.6.2(2) Individual Lighting Power Allowances for Building Exteriors.**	Both Code and Standard address these topics. There are some significant differences here (not exhaustive). The Code improves efficiency over the Standard by setting an "upper bound" on exterior building lighting power. The primary difference among the Code and Standard here is made apparent in noting that the building site exterior power allowances of the Code are rooted in tactics designed to mitigate photo-pollution or luminous pollution. As such, the site exterior power allowances have been specifically selected to lessen the adverse effects of artificial light including sky glow, glare, light trespass, light

ASHRAE STANDARD 90.1-2007 *Section*	**INTERNATIONAL ENERGY CONSERVATION CODE** (IECC®) *Comparable Section(s)*	**COMMENTS** *This is opinion and not comprehensive.*
		clutter, decreased visibility (at night) resulting from eye adaptation, and energy waste that interferes with astronomical observatories and disrupts ecosystems. The standard does not include this provision.
TABLE 9.4.5 Lighting Power Densities for Building Exteriors.	**TABLE 505.6.2 Lighting Power Densities for Building Exteriors.**	Both Tables, that of the Code and that of the Standard are identical. There are no differences here (not exhaustive).
9.5 Building Area Method Compliance Path. **9.5.1 Building Area Method of Calculating Interior Lighting Power Allowance.** **TABLE 9.5.1 Lighting Power Densities Using the Building Area Method.**	**505.5 Interior lighting power requirements (Prescriptive).** **505.5.1 Total connected interior lighting power.** **505.5.2 Interior lighting power.** **TABLE 505.5.2 INTERIOR LIGHTING POWER ALLOWANCES.**	Both Code and Standard address these topics. There are no significant differences here (not exhaustive). Both Tables, that of the Code and that of the Standard are identical. There are no differences here (not exhaustive).
9.6 Alternative Compliance Path: Space-by-Space Method. **9.6.1 Space-by-Space Method of Calculating Interior Lighting Power Allowance.** **9.6.2 Additional Interior Lighting Power.**	***(footnotes)* TABLE 505.5.2 INTERIOR LIGHTING POWER ALLOWANCES.**	There are significant differences here (not exhaustive). The Code provides a methodology for establishing interior lighting power by building area, while the Standard provides both a building area and space-by-space methodology. The Code's single method approach can be interpreted as establishing energy savings beyond that afforded to lighting designers (by choice) under the Standard's space-by-space method.
9.7 Submittals (Not Used).	N/A	The Code includes only those provisions necessary for Code enforcement and design.
➔ 10. OTHER EQUIPEMENT. **10.1 General.** **10.1.1 Scope.** This section applies only to the equipment described below.	NR	The Standard addresses "other equipment;" primarily motors/belt drives [i.e., as required by the Energy Policy Act of 1992 (as amended)] associated with vertical transportation and passenger conveyance systems. The Code does

ASHRAE STANDARD 90.1-2007 *Section*	**INTERNATIONAL ENERGY CONSERVATION CODE** (IECC®) *Comparable Section(s)*	**COMMENTS** *This is opinion and not comprehensive.*
10.1.1.1 New Buildings. **10.1.1.2 Additions to Existing Buildings.** **10.1.1.3 Alterations to Existing Buildings.** **10.1.1.3.1 (untitled).** **10.1.1.3.2 (untitled).** **10.2 Compliance Path(s)** **10.2.1 (untitled).**		not. It is unclear whether the *National Electrical Code* (NFPA 70) addresses these topics in any more detail.
10.3 Simplified/Small Building Option (Not Used). **10.4 Mandatory Provisions** **10.4.1 Electric Motors.**	N/A	The Code includes only those provisions necessary for Code enforcement and design.
10.5 Prescriptive Compliance Path (Not Used).	N/A	
10.6 Alternative Compliance Path (Not Used).	N/A	The Code includes only those provisions necessary for Code enforcement and design.
10.7 Submittals (Not Used).	N/A	
10.8 Product Information.		
11. ENERGY COST BUDGET METHOD **11.1 General.** **11.1.1 Energy Cost Budget Method Scope.** The building Energy Cost Budget Method is an alternative to the prescriptive provisions of this standard. It may be employed for evaluating the compliance of all proposed designs except designs with no mechanical system.	**SECTION 506 TOTAL BUILDING PERFORMANCE.** **506.1 Scope.** This section establishes criteria for compliance using total building performance. The following systems and loads shall be included in determining the total building performance: heating systems, cooling systems, service water heating, fan systems, lighting power, receptacle loads and process loads.	Both Code and Standard address these topics. There are no significant differences here (not exhaustive). A detailed comparison of the total building performance methodologies espoused by the Code and Standard is beyond the scope of this review, and will be undertaken separately.
➔ **FEDERAL LAWS – Residential Construction.**	The *IECC* is the only *I-Code* tied to federal law as bestowed by Congress and the U.S. DOE – 42 U.S.C. §6833(a) through EPAct (PL 102-486), and the only energy code that also serves as the basis for federal tax credits for energy efficient homes[i], energy efficiency standards for federal residential buildings[ii] and manufactured housing[iii], and state energy code determinations. Under federally insured energy improvement- and energy-efficient mortgage programs (FHA and VA) and the conventional secondary mortgage market (Fannie Mae and Freddie Mac), properties meeting the *IECC* are considered energy efficient and eligible for the two percentage point increase in the applicant's debt-to-income qualifying	

ASHRAE STANDARD 90.1-2007 *Section*	INTERNATIONAL ENERGY CONSERVATION CODE (IECC®) *Comparable Section(s)*	COMMENTS *This is opinion and not comprehensive.*
	ratio on loans, thereby allowing borrowers to qualify for a larger loan amount and a more energy-efficient home.[iv] Properties meeting solely the IRC Ch. 11 requirements for energy conservation are not.	
➔ **FEDERAL LAWS – Commercial (and high-rise Residential) Construction.**	On December 30, 2008, the DOE determined that the 2004 edition of ASHRAE/IESNA Standard 90.1 would achieve greater energy efficiency in commercial buildings, than the 1999 edition of the Standard.[v] Such a determination clears the way for establishing ICC's 2006 edition of the *International Energy Conservation Code®* (*IECC®*) a "safe harbor" for equivalence with Standard 90.1-2004 under the *Energy Conservation and Production Act (42 U.S.C. 6834(a))*, as amended. Put another way, states and municipalities enforcing the 2006 *IECC* currently recognize the 90.1-2004 Standard as a "deemed to comply" extension of the commercial provisions of the *IECC* by reference (§501).	
➔ **Discussion of the Particular Form of DOE's Determination Statement.**	From [Federal Register: December 30, 2008 (Volume 73, Number 250), Docket No. EERE-2006-BC-0132] http://edocket.access.gpo.gov/2008/E8-30975.htm, the Department's review and evaluation of Standard 90.1-2004 found that there are significant differences between the 1999 edition and the 2004 edition. Their overall conclusion is that the 2004 edition will improve the energy efficiency of commercial buildings. However, there are a number of changes in textual requirements and stringencies (i.e., 1999 – 2004 editions) that decrease energy efficiency. Overall, the Department concluded the changes in textual requirements and stringencies are "positive," in the sense that they will improve energy efficiency in commercial construction. DOE's quantitative analysis shows, nationally, new building efficiency should improve by almost 13.4%, looking at source energy, and by almost 11.1%, when considering site energy. While both the 1999 and 2004 edition cover existing buildings, the reduction in lighting power allowance and the relatively high frequency of lighting retrofits in commercial buildings should improve the efficiency of existing building stock. The Department has therefore concluded that Standard 90.1-2004 receive an affirmative determination under Section 304(b) of the Energy Conservation and Production Act (ECPA).	
➔ **Discussion of the Particular Form of DOE's Determination Statement and implications to the Commercial Provisions of the 2009 IECC.**	Given the Department's quantitative analysis (i.e., Commercial Buildings +13.4%, looking at source energy, and +11.1%, when considering site energy) and the International Code Council's qualitative analysis herein, it is probable that the 2009 IECC edition will at least equal, if not exceed the efficiency gains when compared to the 1999 edition of the Standard.	
➔ **ADOPTION STATUS.**	Collectively the ICC *International Codes®* are adopted at the state or local level in 50 states, Washington, D.C. and two U.S. territories, the U.S. Virgin Islands and Puerto Rico. Of those jurisdictions, the *IECC®* commercial provisions are administered state-wide in 30 states, Washington, D.C. and U.S. territories, and at the state and local level in 10 of the remaining 21 states and territories. The Standard is administered state-wide in six (6) states. In supporting testimony to the ICC 2007-08 Code Development Process (Nov 2008), the U.S. Department	

ASHRAE STANDARD 90.1-2007 *Section*	**INTERNATIONAL ENERGY CONSERVATION CODE** (IECC®) *Comparable Section(s)*	**COMMENTS** *This is opinion and not comprehensive.*
	of Energy (DOE) does believe that the level of specification provided in the Standard is adequate for systems designers, but the format and requirements are difficult to implement and enforce at the jurisdiction level. In total, the Code has a strong following and a well developed format that is simple to adopt and use and with which code officials have become familiar. For those seeking the sophistication of a systems designers' approach to commercial buildings, the Code continues to refer to the provisions of the Standard as an equivalent extension of the commercial provisions of the Code by reference. A Code adoption reflects the national renown of the *IECC®* as extension of the codes chosen by most U.S. cities, counties, and states that adopt codes.	
➔ **COSTS TO ADOPTING UNITS OF GOVERNMENT.**	The commercial provisions of the Code total 33 pp., and retails for $34 list price (Member Price: $26). Registration fees and workbook costs for a 2009 IECC instructor-led, FUNDAMENTAL SERIES course — Provides conceptual knowledge of the philosophy and technical aspects of each code — Member/Non-Member Price: $150 + 15 = $165. The Standard totals 183 pp., and retails for $99 (Member Price: $85). Registration fees and workbook costs for a 90.1-2007 Standard, One-Day Professional Development Seminar, Member Price: $360*, Non-Member Price: $460* (* includes User's Guide, $79).	

dbm – 04/17/2009

ATTACHMENT

TABLE 303.1.3(1) DEFAULT GLAZED FENESTRATION U-FACTOR *

FRAME TYPE	SINGLE PANE	DOUBLE PANE	SKYLIGHT	
			Single	Double
Metal	1.20 (1.25)	0.80 (0.90)	2.00 (1.98; 1/8 in. glass w/ curb)	1.30 (½ in. air glass w/ curb)
Metal w/ Thermal Break	1.10 (1.25)	0.65 (0.90)	1.90 (1.89; 1/8 in. glass w/ curb)	1.10 (½ in. air glass w/ curb)
Nonmetal or Metal-clad	0.95 (1.25)	0.55 (0.60)	1.75 (1/8 in. glass w/ curb)	1.05 (1.04; ½ in. air glass w/ curb)
Glazed Block	0.60			

* Code (Standard Tables A8.1A and A8.2 “where different.”) Inefficiencies highlighted.

TABLE 303.1.3(2) DEFAULT DOOR U-FACTORS *

DOOR TYPE	U-FACTOR
Uninsulated metal	1.20 (1.45, Uninsulated single-layer metal *swinging doors*)
Insulated metal	0.60 (0.50; Insulated metal *swinging doors*)
Wood	0.50
Insulated, nonmetal edge, max 45% glazing, any glazing is double pane	0.35 (No Requirement, NR)

* Code (Standard Table A8.1A “where different.”) Inefficiencies highlighted.

TABLE 303.1.3(3) DEFAULT GLAZED FENESTRATION SHGC *

SINGLE GLAZED		DOUBLE GLAZED		GLAZED BLOCK
Clear	**Tinted**	**Clear**	**Tinted**	
0.80 (0.82; All frame types)	0.70	0.70 (0.68; Metal and other types)	0.60 (0.50; Metal and other types)	0.60

* Code (Standard Table A8.2 “where different.”) Inefficiencies highlighted.

TABLE 502.1.2 BUILDING ENVELOPE REQUIREMENTS – OPAQUE ELEMENTS (MAXIMUM *U*-FACTORS) *

Zone	1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
Occupancy	**All other**	**Group R**	**All other**	**Group R**	**All other**	**Group R**	**All other**	**Group R**	**All other**	**Group R**	**All other**	**Group R**	**All other**	**Group R**	**All other**	**Group R**
ROOFS																
Insulation entire above deck	U0.063	U0.048	U0.048	U0.048	U0.048	U0.048	U0.048	U0.048	U0.048	U0.048	U0.048	U0.048	U0.039 (U0.048)	U0.039 (U0.048)	U0.039 (U0.048)	U0.039 (U0.048)
Metal buildings	U0.065	U0.065	U0.055 (U0.065)	U0.055 (U0.065)	U0.055 (U0.065)	U0.055 (U0.065)	U0.055 (U0.065)	U0.055 (U0.065)	U0.055 (U0.065)	U0.055 (U0.065)	U0.049 (U0.065)	U0.049 (U0.065)	U0.049 (U0.065)	U0.049 (U0.065)	U0.035 (U0.049)	U0.035 (U0.049)
Attic and other	U0.034	U0.027	U0.027	U0.027	U0.027	U0.027	U0.027	U0.027	U0.027	U0.027	U0.027	U0.027	U0.027	U0.027	U0.027 (U0.021)	U0.027 (U0.021)
WALLS ABOVE GRADE																
Mass	U0.058	U0.151	U0.151	U0.123	U0.123	U0.104	U0.104	U0.090	U0.090	U0.080	U0.080	U0.071	U0.071	U0.071	U0.071	U0.052
Metal building	U0.093 (U0.113)	U0.093 (U0.113)	U0.093 (U0.113)	U0.093 (U0.113)	U0.084 (U0.113)	U0.084 (U0.113)	U0.084 (U0.113)	U0.084 (U0.113)	U0.069 (U0.113)	U0.069 (U0.057)	U0.069 (U0.113)	U0.069 (U0.057)	U0.057	U0.057	U0.057	U0.057
Metal framed	U0.124	U0.124	U0.124	U0.064	U0.064	U0.064	U0.064	U0.064	U0.064	U0.064	U0.064	U0.057 (U0.064)	U0.064	U0.052 (U0.042)	U0.064	U0.037
Wood framed and other	U0.089	U0.089	U0.089	U0.089	U0.089	U0.089	U0.089	U0.064	U0.064	U0.051	U0.051	U0.051	U0.051	U0.051	U0.036	U0.036
WALLS BELOW GRADE																
Below-grade wall	C1.140	C1.140	C1.140	C1.140	C1.140	C1.140	C1.140	C0.119	C0.119	C0.119	C0.119	C0.119	C0.119	C0.092	C0.119	C0.075
FLOORS																
Mass	U0.322	U0.322	U0.107	U0.087	U0.107	U0.087	U0.087	U0.074	U0.074	U0.064	U0.064	U0.057	U0.064	U0.051	U0.057	U0.051
Steel Joist Standard only	(U0.350)	(U0.350)	(U0.052)	(U0.052)	(U0.052)	(U0.052)	(U0.038)	(U0.038)	(U0.038)	(U0.038)	(U0.038)	(U0.032)	(U0.038)	(U0.038)	(U0.032)	(U0.032)
Joist/Framing	U0.282	U0.282	U0.052 (U0.051)	U0.052 (U0.033)	U0.052 (U0.051)	U0.033	U0.033	U0.033	U0.033	U0.033	U0.033	U0.033	U0.033	U0.033	U0.033	U0.033
SLAB-ON-GRADE FLOORS																
Unheated slabs	F0.730	F0.730	F0.730	F0.730	F0.730	F0.730	F0.730	F0.540	F0.540	F0.540	F0.540	F0.520	F0.520	F0.520	F0.520	F0.510
Heated slabs	F1.020	F1.020	F1.020	F1.020	F0.900	F0.900	F0.860	F0.860	F0.860	F0.860	F0.860	F0.688	F0.830 (F0.843)	F0.688	F0.688	F0.688

* Code (Standard Tables 5.5-1 through 5.5-8 Building Envelope Requirements by Climate Zone “where different.”) Inefficiencies highlighted.

TABLE 502.2(1) BUILDING ENVELOPE REQUIREMENTS – OPAQUE ASSEMBLIES (MINIMUM *R*-VALUES) *

Zone	1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
Occupancy	**All other**	**Group R**	**All other**	**Group R**	**All other**	**Group R**	**All other**	**Group R**	**All other**	**Group R**	**All other**	**Group R**	**All other**	**Group R**	**All other**	**Group R**
ROOFS																
Insulation entire above deck	R15ci	R20ci	R20ci	R20ci	R20ci	R20ci	R20ci	R20ci	R20ci	R20ci	R20ci	R20ci	R25ci (R20ci)	R25ci (R20ci)	R25ci (R20ci)	R25ci (R20ci)
Metal building w/ R5 blocks	R19	R19	R13+13 (R19)	R13+13 (R19)	R13+13 (R19)	R19	R13+13 (R19)	R19	R13+13 (R19)	R19	R13+19 (R19)	R19	R13+19 (R19)	R19+10 (R19)	R11+19 (r13+19)	R19+10 (r13+19)
Attic and other	R30	R38	R38	R38	R38	R38	R38	R38	R38	R38	R38	R38	R38	R38	R49	R49
WALLS ABOVE GRADE																
Mass	NR	R5.7ci	R5.7ci	R7.6ci	R7.6ci	R9.5ci	R9.5ci	R11.4ci	R11.4ci	R13.3ci	R13.3ci	R15.2ci	R15.2ci	R15.2ci	R25ci	R25ci
Metal building	R16 (R13)	R16 (R13)	R16 (R13)	R16 (R13)	R19 (R13)	R19 (R13)	R19 (R13)	R19 (R13)	R13+5.6 (R13)	R13+5.6 (R13+13)	R13+5.6 (R13)	R13+5.6 (R13+13)	R19+5.6 (R13+13)	R19+5.6 (R13+13)	R19+5.6 (r13+13)	R19+5.6 (r13+13)
Metal framed	R13	R13	R13	R13+7.5	R13+3.8	R13+7.5	R13+7.5	R13+7.5	R13+7.5	R13+7.5	R13+7.5	R13+7.5	R13+7.5	r13+15.6	R13+7.5	r13+18.8
Wood framed and other	R13	R13	R13	R13	R13	R13	R13	R13+3.8	R13+3.8	R13+3.8	R13+7.5	R13+7.5	R13+7.5	R13+7.5	r13+15.6	r13+15.6
WALLS BELOW GRADE																
Below-grade wall	NR	NR	NR	NR	NR	NR	NR	R7.5ci	R7.5ci	R7.5ci	R7.5ci	R7.5ci	R7.5ci	R10ci	R7.5ci	R12.5ci
FLOORS																
Mass	NR	NR	R6.3ci	R8.3ci	R6.3ci	R8.3ci	R10ci (R8.3ci)	R10.4ci	R10ci (R10.4ci)	R12.5ci	R12.5ci	R14.6ci	R15ci (R12.5ci)	R16.7ci	R15ci (R14.6ci)	R16.7ci
Steel Joist Standard only	(NR)	(NR)	(R19)	(R19)	(R19)	(R19)	(R30)	(R30)	(R30)	(R30)	(R30)	(R30)	(R38)	(R30)	(R38)	(R38)
Joist/Framing	NR	NR	R19	R30	R19	R30	R30	R30	R30	R30	R30	R30	R30	R30	R30	R30
SLAB-ON-GRADE FLOORS																
Unheated slabs	NR	NR	NR	NR	NR	NR	NR	R10-24”	NR	R10-24”	R10-24”	R15-24”	R15-24”	R15-24”	R20-48”	R20-48”
Heated slabs	7.512	7.5-12	r7.5-12	r7.5-12	R10-24”	R10-24”	R15-24”	R15-24”	R15-24”	R15-24”	R15-24”	R20-48”	R20-24”	R20-48”	R20-48”	R20-48”
OPAQUE DOORS																
Swinging	U0.70	U0.70	U0.70	U0.70	U0.70	U0.70	U0.70	U0.70	U0.70	U0.70 (U0.50)	U0.70	U0.50	U0.50	U0.50	U0.50	U0.50
Roll-up or sliding	U1.45	U1.45	U1.45	U1.45 (0.50)	U1.45	U1.45 (0.50)	U0.50	U0.50	U0.50	U0.50	U0.50	U0.50	U0.50	U0.50	U0.50	U0.50

* Code (Standard Tables 5.5-1 through 5.5-8 Building Envelope Requirements by Climate Zone “where different.”) Inefficiencies highlighted.

TABLE 502.3 BUILDING ENVELOPE REQUIREMENTS – FENESTRATION (MAXIMUM *U*-FACTORS) *

ZONE	1	2	3	4 EXCEPT MARINE	5 AND MARINE 4	6	7	8
VERTICAL FENESTRATION (40% MAXIMUM OF ABOVE-GRADE WALL AREA)								
***U*-FACTORS**								
FRAMING MATERIALS OTHER THAN METAL WITH OR WITHOUT METAL REINFORCEMENT OR CLADDING								
U-factor	1.20	0.75	0.65	0.40	0.35	0.35	0.35	0.35
METAL FRAMING WITH OR WITHOUT THERMAL BREAK								
Curtain wall or storefront *U*-factor	1.20	0.70	0.60	0.50	0.45	0.45	0.40	0.40
Entrance door *U*-factor	1.20	1.10	0.90	0.85	0.80	0.80	0.80	0.80
All other *U*-factor	1.20	0.75	0.65	0.55	0.55	0.55	0.45	0.45
SHGC – ALL FRAME TYPES								
SHGC: PF < 0.25	0.25	0.25	0.25	0.40	0.40	0.40	0.45	0.45
SHGC: 0.25 ≤ PF < 0.5	0.33	0.33	0.33	NR	NR	NR	NR	NR
SHGC: PF > 0.50	0.40	0.40	0.40	NR	NR	NR	NR	NR
Code – SKYLIGHTS – 3% MAXIMUM **Standard – SKYLIGHTS – 5% MAXIMUM**								
U-factor (worst case)	0.75 (1.98)	0.75 (1.98)	0.65 (1.30)	0.60 (1.30)	0.60 (1.17)	0.60 (1.17)	0.60 (1.17)	0.60 (0.98)
SHGC (worst case)	0.35 (0.036)	0.35 (0.039)	0.35 (0.065)	0.40 (0.065)	0.40 (0.077)	0.40 (0.077)	NR (0.077)	NR

* Code (Standard Tables 5.5-1 through 5.5-8 Building Envelope Requirements by Climate Zone "where different.") Inefficiencies highlighted.

[i] Energy Policy Act (EPAct), Pub. L. 109-58 (2005)

[ii] Energy Conservation and Production Act (ECPA), Pub. L. 94-385 (1976)

[iii] Energy Independence and Security Act (EISA) Pub. L. 110-140 (2007) and HUD's Manufactured Home Construction & Safety Standards (24 CFR 3280)

[iv] http://www.energystar.gov/index.cfm?c=bldrs_lenders_raters.energy_efficient_mortgage

[v] FR: December 30, 2008 (Volume 73, Number 250), Notices (Pages 79868-79874) http://edocket.access.gpo.gov/2008/E8-30975.htm