

# Public Review Draft

Proposed Addendum to Standard 189.1-2017

# Standard for the Design of High- Performance Green Buildings Except Low-Rise Residential Buildings

First Public Review (February 2020)  
(Draft Shows Proposed Changes to Current Standard)

This draft has been recommended for public review by the responsible project committee. To submit a comment on this proposed standard, go to the ASHRAE website at [www.ashrae.org/standards-research--technology/public-review-drafts](http://www.ashrae.org/standards-research--technology/public-review-drafts) and access the online comment database. The draft is subject to modification until it is approved for publication by the Board of Directors and ANSI. Until this time, the current edition of the standard (as modified by any published addenda on the ASHRAE website) remains in effect. The current edition of any standard may be purchased from the ASHRAE Online Store at [www.ashrae.org/bookstore](http://www.ashrae.org/bookstore) or by calling 404-636-8400 or 1-800-727-4723 (for orders in the U.S. or Canada).

This standard is under continuous maintenance. To propose a change to the current standard, use the change submittal form available on the ASHRAE website, [www.ashrae.org](http://www.ashrae.org).

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**(This foreword is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard 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.)**

## Foreword

This addendum updates normative references in Chapter 11 to their most recent, relevant version.

*[Note to Reviewers: This addendum makes proposed changes to the current standard. These changes are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) except where the reviewer instructions specifically describe some other means of showing the changes. Only these changes to the current standard are open for review and comment at this time. Additional material is provided for context only and is not open for comment except as it relates to the proposed changes.]*

## Addendum bd to 189.1-2017

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*Revise Section 11 as shown below:*

### 11. NORMATIVE REFERENCES

Section numbers indicate where the reference occurs in this document.

Reference	Title	Section
<b>Acoustical Society of America (ASA)</b> 1305 Walt Whitman Road, Suite 300 Melville, NY 11747-4300 (516) 576-2360; <a href="http://acousticalsociety.org">http://acousticalsociety.org</a>		
ANSI/ASA S12.60-2009/ <u>Part 2 (R 2014)</u>	Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 2: Relocatable Classroom Factors	8.3.3, 8.3.3.4
ANSI/ASA S12.60-2010/ <u>Part 1 (R2015)</u>	Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 1: Permanent Schools	8.3.3
<b>Air-Conditioning, Heating, and Refrigeration Institute (AHRI)</b> 2111 Wilson Blvd, Suite 500 Arlington, VA 22201, United States 1-703-524-8800; <a href="http://www.ahrinet.org">www.ahrinet.org</a>		
ANSI/AHRI 210/240- <del>2008</del> (with <del>Addenda 1 and 2</del> ) <u>2017</u>	Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment	Appendix B

BSR/ASHRAE/ICC/USGBC/IES Addendum bd to ANSI/ASHRAE/ICC/USGBC/IES Standard 189.1-2017, *Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings* First Public Review Draft.

ANSI/AHRI 310/380- <del>2014</del> 2017	Standard for Packaged Terminal Air-Conditioners and Heat Pumps (CSA-C744-14)	Appendix B
AHRI 340/360- <del>2015 (I-P)</del> 2019	Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment	Appendix B
ANSI/AHRI 1230- <del>2010</del> 2014 (with Addendum <del>21</del> )	Performance Rating of Variable Refrigerant Flow (VRF) Multi-Split Air-Conditioning and Heat Pump Equipment	Appendix B

**American Association of Radon Scientists and Technologists (AARST)**  
**~~475 South Church Street, Suite 600~~**  
**527 N. Justice Street**  
**Hendersonville, NC 28792 28739**  
**(800) 269-4174; ~~http://aarst-nrpp.com/wp~~ https://standards.aarst.org/**

ANSI/AARST RMS-LB- <del>2014</del> 2018	Radon Mitigation Standards for Schools and Large Buildings	10.3.1.9, 10.3.2.1.4.4
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**American National Standards Institute (ANSI)**  
**25 West 43rd Street**  
**New York, NY 20036, United States**  
**+1-212-642-4900; www.ansi.org**

ANSI Z21.10.3- <del>2015</del> 2017	Gas Water Heaters, Volume <del>III</del> 3, Storage Water Heaters with Input Ratings above 75,000 Btu/h, Circulating and Instantaneous	Appendix B
ANSI Z21.47- <del>2012</del> 2016	Gas-Fired Central Furnaces	Appendix B
ANSI Z83.8- <del>2013</del> 2016	Gas Unit Heaters, Gas Packaged Heaters, Gas Utility Heaters, and Gas-Fired Duct Furnaces	Appendix B

**American Society for Healthcare Engineering of the American Hospital Association (ASHE)**  
**155 N. Wacker Drive, Suite 400**  
**Chicago, IL 60606**  
**312-422-3800; www.ASHE.org**

<del>2014</del> 2018 FGI Guidelines: Hospitals and Outpatient Facilities	Guidelines for Design and Construction of Hospitals and Outpatient Facilities	8.3.3
<u>2018 FGI Guidelines: Hospitals and Outpatient Facilities</u>	<u>Guidelines for Design and Construction of Outpatient Facilities</u>	<u>8.3.3</u>
<del>2014</del> 2018 FGI Guidelines: Residential Health, Care and Support Facilities	Guidelines for Design and Construction of Residential Health, Care, and Support Facilities	8.3.3

**ASHRAE**  
**1791 Tullie Circle NE**  
**Atlanta, GA 30329, United States**  
**1-404-636-8400; www.ashrae.org**

ANSI/ASHRAE Standard 55-2017 <u>plus Addenda a and b to Standard 55-2017</u>	Thermal Environmental Conditions for Human Occupancy	8.3.2, 10.3.2.1.5
ANSI/ASHRAE Standard 62.1- <del>2016</del> 2019	Ventilation for Acceptable Indoor Air Quality	3.2, 7.4.3.2, 7.4.3.8, 8.3, 10.3.1.5, 10.3.2.1.4
ANSI/ASHRAE Standard 62.2- <del>2016</del> 2019	Ventilation and Acceptable Indoor Air Quality in Residential Buildings	
ANSI/ASHRAE/IES Standard 90.1- <del>2016</del> 2019	Energy Standard for Buildings Except Low-Rise Residential Buildings	

BSR/ASHRAE/ICC/USGBC/IES Addendum bd to ANSI/ASHRAE/ICC/USGBC/IES Standard 189.1-2017, *Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings* First Public Review Draft.

ANSI/ASHRAE Standard 111-2008 <u>(RA 2017)</u>	Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems	8.3.1.2.2, 10.3.2.1.4, 10.3.2.1.4.6
ANSI/ASHRAE Standard 154- <del>2014</del> <u>2016</u>	Ventilation for Commercial Cooking Operations	7.4.3.8.1
ANSI/ASHRAE/ASHE Standard 170- <del>2013</del> <u>2017</u>	Ventilation of Health Care Facilities	8.3.1
ANSI/ASHRAE/ACCA Standard 180- <del>2012</del> - <u>2018</u>	Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems	3.2, 10.3.2.2
ANSI/ASHRAE/IES Standard 202- <del>2013</del> <u>2018</u>	Commissioning Process for Buildings and Systems	10.3.1.2, 10.3.1.3

**Association of Home Appliance Manufacturers (AHAM)**

**1111 19th Street NW, Suite 402  
Washington, DC, 20036, United States  
1-202-872-5955; www.aham.org**

ANSI/AHAM RAC-1- <del>R</del> 2015	Room Air Conditioners	Appendix B
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**ASTM International**

**100 Barr Harbor Dr.  
West Conshohocken, PA 19428-2959, United States  
1-610-832-9585; www.astm.org**

ASTM C33/ <u>C33M-18</u>	Standard Specification for Concrete Aggregates	8.3.4.1.2
ASTM C919- <del>12</del> <u>19</u>	Standard Practice for Use of Sealants in Acoustical	8.3.3.1.1, 8.3.3.2.3.3
ASTM C920- <u>14</u> <u>18</u>	Standard Specification for Elastomeric Joint Sealants	8.3.4.1.1
ASTM C1549- <del>09</del> ( <del>2014</del> ) <u>16</u>	Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer	5.3.5.4
ASTM D1785-15 <u>e1</u>	Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120	8.3.4.1.3
ASTM D5197- <del>09</del> <u>e1</u> <u>16</u>	Standard Test Method for Determination of Formaldehyde and Other Carbonyl Compounds in Air (Active Sampler Methodology)	8.4.2, 10.3.1.5
ASTM E90-09( <u>2016</u> )	Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements	8.3.3.1.1
ASTM E336- <del>14</del> <u>19a</u>	Standard Test Method for Measurement of Airborne Sound Attenuation Between Rooms in Buildings	8.3.3.1.1, 10.3.1.1.5.1.2
ASTM E408-13( <u>2019</u> )	Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques	5.3.5.4
ASTM E492-09s( <u>2016</u> ) <u>e1</u>	Standard Test Method for Laboratory Measurement of Impact Sound Transmission through Floor-Ceiling Assemblies Using the Tapping Machine	8.3.3.1.1
ASTM E779- <del>10</del> <u>19</u>	Standard Test Method for Determining Air Leakage Rate by Fan Pressurization	10.3.1.3.5
ASTM E1007- <del>11</del> <u>19</u>	Standard Test Method for Field Measurement of Tapping Machine Impact Sound Transmission through Floor-Ceiling Assemblies and Associated Support Structures	8.3.3.1.1
ASTM E1643- <del>11</del> <u>18a</u>	Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs	8.3.4.1.1

BSR/ASHRAE/ICC/USGBC/IES Addendum bd to ANSI/ASHRAE/ICC/USGBC/IES Standard 189.1-2017, *Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings* First Public Review Draft.

ASTM E1745- <del>44</del> 17	Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs	8.3.4.1.1
ASTM E1827-11(2017)	Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door	10.3.1.3.5
ASTM E1918- <del>06(2015)</del> 16	Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field	5.3.5.4
ASTM E2399/ <del>E2399M-44</del> 19	Standard Test Method for Maximum Media Density for Dead Load Analysis of Vegetative (Green) Roof Systems	5.3.5.5

**Business and Institutional Furniture Manufacturer’s Association (BIFMA)**

678 Front Avenue NW, Suite 150  
 Grand Rapids, MI 49504-5368, United States  
 1-616-285-3963; [www.bifma.org](http://www.bifma.org); [email@bifma.org](mailto:email@bifma.org)

ANSI/BIFMA e3- <del>2014</del> 2019	Furniture Sustainability Standard	8.4.2.5, 9.4.1.4.3
ANSI/BIFMA X7.1-2011 (R2016) <u>FES Standard</u>	Standard for Formaldehyde and TVOC Emissions of Low-Emitting Office Furniture Systems and Seating	8.4.2.5

**California Air Resources Board (CARB)**

1001 “T” Street  
 P.O. Box 2815  
 Sacramento, CA 95812, United States  
 1-916-322-2990; [www.arb.ca.gov/homepage.htm](http://www.arb.ca.gov/homepage.htm)

CARB SCM for Architectural Coatings- <del>2007</del> 2019	California Air Resources Board (ARB) Suggested Control Measure for Architectural Coatings	8.4.2.2.2
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**California Department of Public Health (CDPH)**

Indoor Air Quality Section  
 850 Marina Bay Parkway  
 Richmond, CA 94804, United States  
 1-510-620-2802; [www.cdph.ca.gov/programs/IAQ](http://www.cdph.ca.gov/programs/IAQ) and [www.cal-iaq.org](http://www.cal-iaq.org)

CDPH/EHLB/Standard Method- <del>V1.1</del> ( <del>2010</del> ) <u>V1.2 (2017)</u>	Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers— Version <del>1-1.1</del> <u>1.2</u>	8.4.2, 8.5.2, Table 10.3.1.5, Appendix D
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**Canadian General Standards Board**

Place du Portage III, 6B1  
 11 Laurier Street  
 Gatineau, Quebec K1A 1G6 Canada  
 1-819-956-0425; [www.tpsgc-pwgsc.gc.ca/ongc-cgsb/index-eng.html](http://www.tpsgc-pwgsc.gc.ca/ongc-cgsb/index-eng.html)

CAN/CGSB 149.40- <del>M86</del> 2019	Determination of the Airtightness of Building Envelopes by the Fan Depressurization Method	10.3.1.3.5
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**Cooling Technology Institute (CTI)**

PO Box 681807  
 Houston, TX 77268  
 1-281-583-4087; [www.cti.org](http://www.cti.org)

CTI ATC-105 ( <del>00</del> )-(19)	Acceptance Test Code for Water Cooling Towers	Appendix B
CTI STD-201RS ( <del>45</del> )-(19)	Standard for the Certification of Water Cooling Tower Thermal Performance	Appendix B

**International Organization for Standardization (ISO)**

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**ISO Central Secretariat, 1 rue de Varembee, Case postale 56  
CH-1211, Geneva 20, Switzerland  
+41-22-749-01-11; www.iso.org**

<u>ISO 16890 (2016)</u>	<u>Air Filters for General Ventilation</u>	<u>8.3.1.3</u>
ISO 21930- <del>2007</del> <u>2017</u>	Sustainability in Buildings and Civil Engineering Works <del>Construction</del> — <u>Core Rules for Environmental Product Declarations of Construction Building Products and Services</u>	9.4.1.4
ISO/IEC-17025- <del>2005 (Reviewed 2010)</del> <u>2017</u>	General Requirements for the Competence of Testing and Calibration Laboratories	8.4.2
ISO/IEC Guide 59- <del>1994</del> <u>2019</u>	<u>ISO and IEC Recommended Code of Good Practices for Standardization by National Bodies</u>	9.4.1.3.1

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**National Electrical Manufacturers Association (NEMA)  
1300 North 17th Street, Suite 900  
Rosslyn, VA 22209, United States  
1-703-841-3200; www.nema.org**

ANSI/NEMA MG 1- <del>2009</del> <u>2016 (with 2018 supplements)</u>	Motors and Generators	7.4.3.1
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**National Fenestration Rating Council (NFRC)  
6305 Ivy Lane, Suite 140  
Greenbelt, MD 20770-6323  
1-301-589-1776; www.nfrc.org**

ANSI/NFRC 200- <del>2014</del> <u>2017</u>	Procedure for Determining Fenestration Product Solar Heat Gain Coefficients and Visible Transmittance at Normal Incidence	3.2
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**NSF International  
789 Dixboro Road  
Ann Arbor, MI 48105, United States  
1-734-769-8010; www.nsf.org; info@nsf.org**

NSF/ANSI 44- <del>2016</del> <u>2018</u>	Residential Cation Exchange Water Softeners	6.3.5
NSF/ANSI 58- <del>2016</del> <u>2018</u>	Reverse Osmosis Drinking Water Treatment Systems	6.3.6
NSF/ANSI 140- <del>2015</del> <u>2019</u>	Sustainability Assessment for Carpet	9.4.1.4.3
NSF/ANSI 332-2015	Sustainability Assessment for Resilient Floor Coverings	9.4.1.4.3
NSF/ANSI 336- <del>2014</del> <u>2018</u>	Sustainability Assessment for Commercial Furnishings Fabric	9.4.1.4.3
NSF/ANSI 342- <del>2014</del> <u>2019</u>	Sustainability Assessment for Wallcovering Products	9.4.1.4.3
NSF/ANSI 347- <del>2012</del> <u>2018</u>	Sustainability Assessment for Single Ply Roofing Membranes	9.4.1.4.3
NSF/ANSI 350- <del>2017</del> <u>2018</u>	On-Site Residential and Commercial Water Reuse Systems	6.3.7

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**Tile Council of North America  
100 Clemson Research Boulevard  
Anderson, SC 29625, United States  
864-646-8453; www.tcnatile.com; info@tileusa.com**

ANSI A138.1-2011	Standard Specifications for Sustainable Ceramic Tiles, Glass Tiles, and Tile Installation Materials	9.4.1.4.3
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**Underwriters Laboratories Inc. (UL)  
333 Pfingsten Road**

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**Northbrook, IL 60062, United States**

**1-847-272-8800; [www.ul.com](http://www.ul.com); [cec.us@us.ul.com](mailto:cec.us@us.ul.com)**

UL 100- <del>2012</del> <u>2016</u>	Standard for Sustainability for Gypsum Boards and Panels	9.4.1.4.3
UL 102-2012	Standard for Sustainability for Door Leafs	9.4.1.4.3
UL 727- <del>2006</del> <u>2018</u>	Standard for <u>Safety for</u> Oil-Fired Central Furnaces	Appendix B
UL 731- <del>2012</del> <u>2018</u>	Standard for <u>Safety for</u> Oil-Fired Unit Heaters	Appendix B

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**United States Congress**

**Washington, DC 20515, United States**

**1-202-224-3121; [http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=109\\_cong\\_bills&docid=f:h6enr.txt.pdf](http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=109_cong_bills&docid=f:h6enr.txt.pdf) and [www.govtrack.us/data/us/bills/text/110/h/h6.pdf](http://www.govtrack.us/data/us/bills/text/110/h/h6.pdf) <https://www.congress.gov/bill/110th-congress/house-bill/6/text>**

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**United States Department of Agriculture (USDA)**

**BioPreferred Program**

**1400 Independence Avenue, SW**

**Washington, DC 20250, United States**

**1-202-720-2791; [www.biopreferred.gov](http://www.biopreferred.gov)**

7 CFR Part 3201 <del>Subpart B, (Includes Rounds 1-7) August 29, 2011; Round 8, April 4, 2012; Round 9, November 19, 2012; Round 10, June 11, 2013</del>	Guidelines for Designating Biobased Products for Federal Procurement; <u>Designated Items</u>	9.4.1.3
<u>7 CFR Part 3202</u>	<u>Voluntary Labeling Program for Biobased Products</u>	<u>9.4.1.3</u>

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**United States Environmental Protection Agency (USEPA)**

**Ariel Rios Building**

**1200 Pennsylvania Avenue, NW**

**Washington, DC 20460, United States**

**1-919-541-0800; [www.epa.gov](http://www.epa.gov)**

**ENERGY STAR® +1-888-782-7937**

**WaterSense +1-866-987-7367 and +1-202-564-2660**

Version <del>1.0, August 1, 2012</del> <u>2.0, January 1, 2019</u>	ENERGY STAR Program Requirements for Uninterruptible Power Supplies	7.4.7
Version <del>1.0, March 4, 2010</del> <u>1.1, July 26, 2018</u>	WaterSense Specification for Showerheads	6.3.2.1
Version 1.0, October 1, 2007	WaterSense <del>Tank-Type</del> High-Efficiency Lavatory Faucet Specification	6.3.2.1
Version <del>1.2, July 1, 2004</del> <u>2.0, July 7, 2020</u>	ENERGY STAR Program Requirements for Room Air Cleaners	7.4.7
Version 1.2, June 2, 2014	WaterSense Tank-Type <del>High-Efficiency</del> Toilet Specification	6.3.2.1
Version 1.2, <del>May 8, 2009</del> <u>January 1, 2011</u>	ENERGY STAR Program Requirements for Commercial Griddles	7.4.7
Version <del>2.0, April 22, 2014</del> <u>3.0, October 1, 2016</u>	ENERGY STAR Program Requirements for Commercial Fryers	7.4.7
Version <del>2.0 December 31, 2015</del> <u>2.1 June 20, 2017</u>	ENERGY STAR Program Requirements for Lamps (Light Bulbs)	7.4.7
Version <del>2.0, February 1, 2013</del> <u>3.0, January 2, 2018</u>	ENERGY STAR Program Requirements for Commercial Ice Makers	6.3.2.5, 7.4.7
Version 2.0, <del>June 25, 2012</del> <u>February 1, 2013</u>	ENERGY STAR Program Requirements for Commercial Dishwashers	6.3.2.5, 7.4.7

BSR/ASHRAE/ICC/USGBC/IES Addendum bd to ANSI/ASHRAE/ICC/USGBC/IES Standard 189.1-2017, *Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings* First Public Review Draft.

<del>Version 2.0, June 26, 2013</del> <u>3.0, October 11, 2019</u>	ENERGY STAR Program Requirements for Imaging Equipment	7.4.7
<del>Version 2.0, May 9, 2013</del> <u>February 2, 2014</u>	ENERGY STAR Program Requirements for Water Coolers	7.4.7
<del>Version 2.0, May 29, 2015</del> <u>2.2, August 15, 2019</u>	ENERGY STAR Program Requirements for Luminaires	7.4.7.3
<del>Version 3.0, April 1, 2012</del> <u>4.0, June 15, 2018</u>	ENERGY STAR Program Requirements for Residential Ceiling Fans	7.4.7
<del>Version 3.0, December 20, 2013</del> <u>October 1, 2014</u>	ENERGY STAR Program Requirements for Boilers	7.4.7
<del>Version 3.0, July 18, 2014</del> <u>3.2, April 16, 2015</u>	ENERGY STAR Program Requirements for Residential Water Heaters	7.4.7
<del>Version 3.0, October 1, 2012</del> <u>5.0, October 31, 2019</u>	ENERGY STAR Program Requirements for Dehumidifiers	7.4.7
<del>Version 3.0, October 1, 2014</del> <u>4.0, March 27, 2017</u>	ENERGY STAR Program Requirements for Commercial Refrigerators and Freezers	7.4.7
<del>Version 3.1, January 1, 2012</del> <u>3.2, April 16, 2015</u>	ENERGY STAR Program Requirements for Geothermal Heat Pumps	7.4.7
<del>Version 3.1, March 1, 2013</del> <u>4, April 29, 2020</u>	ENERGY STAR Program Requirements for Refrigerated Beverage Vending Machines	7.4.7
<del>Version 3.2, April 1, 2012</del> <u>4.1, October 1, 2015</u>	ENERGY STAR Program Requirements for Residential Ventilating Fans	7.4.7
<del>Version 4.0, February 20, 2015</del> <u>4.1, October 26, 2015</u>	ENERGY STAR Program Requirements and Criteria for Room Air Conditioners	7.4.7
<del>Version 4.0, June 13, 2011</del> <u>4.1, February 1, 2013</u>	ENERGY STAR Program Requirements for Furnaces	7.4.7
<del>Version 5.0, May 13, 2016</del> <u>5.1, January 1, 2018</u>	ENERGY STAR Program Requirements for Set-Top Boxes	7.4.7
<del>Version 6.0, April 29, 2015,</del> <u>January 1, 2016</u>	ENERGY STAR Program Requirements Product Specification for Residential Dishwashers	6.3.2.2, 7.4.7
<del>Version 6.1, August 12, 2014</del> <u>Version 7.1, November 16, 2018</u>	ENERGY STAR Program Requirements for Computers	7.4.7
<del>Version 7.0, May 2016</del> <u>8.0, January 28, 2020</u>	ENERGY STAR Program Requirements for Displays	7.4.7
<del>Version 7.0, October 30, 2015</del> <u>8.0, March 1, 2019</u>	ENERGY STAR Program Requirements for Televisions	7.4.7
<del>Version 7.1, May 20, 2015</del> <u>8.0, February 5, 2018</u>	ENERGY STAR Program Requirements for Clothes Washers	6.3.2.2, 7.4.7