

EXECUTIVE SUMMARY

The HVACR and water heating industry annually manufactures and installs more than seven million pieces of equipment with an enviable record of safety, reliability, and performance, accomplishing that feat through a detailed, intertwined system of checks and balances related to design, fabrication, testing, and repair. As part of these efforts, the industry works closely with standards development organizations (SDOs) to continuously improve and update the relevant codes and standards for the benefit of all parties, including the public. Unfortunately, the HVACR and WH industry is currently facing unusual headwinds relative to pressure-containing equipment that has the potential to negatively impact both product availability and affordability.

The American Society of Mechanical Engineers (ASME) is considering a scope change to its Boiler and Pressure Vessel Code (BPVC) Section VIII, Rules for Construction of Pressure Vessels, Division I that would eliminate long-standing exemptions for certain equipment manufactured by AHRI's member companies. The change, if successfully implemented, removes key exemptions that the HVACR and water heating industry has successfully covered with its own codes and standards for decades, and would alter the way relevant standards and codes interact with, and are interpreted by, jurisdictions.

The Air-Conditioning, Heating, and Refrigeration Institute (AHRI), and many other stakeholder organizations, firmly believe existing codes and standards have served both the industry and the public well for many years, with an excellent, long-term safety record. Removing ASME's BPVC scope exemptions would place the BPVC in conflict with myriad codes and standards that currently occupy this space, such as those from nationally recognized testing laboratories (e.g., UL), SDOs (e.g., ASHRAE), and even other ASME codes.

The elimination of these long-standing, well-supported exemptions will create unnecessary confusion for local code inspectors, will increase equipment expenses and create production delays, and is likely to result in a shortage of trained ASME inspectors, repair issues for units in the field, and the potential for misapplication of codes.

Whether intentional or not, such code misapplication would not provide any enhancement in terms of safety or performance but would have a severe, detrimental impact on the industry's efforts to support decarbonization and address climate change.

AHRI joins other industry organizations in opposing the elimination of the ASME BPVC Section VIII key scope exemptions due to the lack of proper consideration of industry wide standards and technical justification, along with the resulting confusion on the jurisdictional level that will surely result. Such changes will negatively impact product choice, availability, and affordability of vital life- and health-affirming HVACR and water heating equipment, while doing nothing to



enhance its safety or performance. Please review the following whitepaper for additional details on this looming threat to stakeholders as well as consumers.

The Air-Conditioning, Heating, and Refrigeration Institute (AHRI) is the trade association representing manufacturers of heating, ventilation, air conditioning, refrigeration (HVACR) and water heating (WH) equipment within the global industry. AHRI represents more than 330 manufacturers of air conditioning, space heating, water heating, and commercial refrigeration equipment and components. It is an internationally recognized advocate for the HVACR and WH industry and certifies the performance of many of the products manufactured by its members. In North America, AHRI member companies represent more than 90 percent of the HVACR and WH residential and commercial equipment manufactured and sold. Through certification programs, standards, advocacy, and other activities, AHRI members save energy, improve productivity, and enable a better built environment, all with the highest safety standards.

Equipment produced by HVACR and WH manufacturers, particularly in the U.S., has a long and successful track record of reliability, performance, and most of all safety. This is especially important in today's world as we all strive for a safe, sustainable, affordable, and just environment for all. The HVACR and WH industry effectively utilizes standards and codes from AHRI, The



The American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE), The American Society of Mechanical Engineers (ASME), UL, The CSA Group (CSA), and other respected standards development organizations (SDOs) to design, fabricate, and certify equipment as both safe and efficient. Labeled and listed equipment is critical to the HVACR and WH industry.

The HVACR and WH Industry annually manufactures and installs more than seven million labeled and listed pieces of equipment, accomplishing that feat through a detailed, intertwined system of checks and balances which includes:

- 1) Equipment designed and developed to meet an extensive testing regimen per rigorous consensus safety and design standards;
- 2) Comprehensive labeling and listing via nationally recognized testing laboratories (NRTLs);
- 3) Comprehensive installation standards;

- 4) Uniform application of these standards by state and local jurisdictions through adoption of model building codes; and
- 5) Network of trained and qualified installation technicians who continually hone their expertise related to installation and servicing of this equipment.



The HVACR and WH industry works closely with SDOs to improve and update codes and standards on a regular basis for the benefit of all parties, including the public. Unfortunately, the HVACR and WH industry is currently facing some unusual headwinds relative to pressure-containing equipment that could upend the industry while also negatively impacting the affordability of equipment. One of the codes of great importance to the industry is the ASME Boiler Pressure Vessel Code (BPVC). ASME has been discussing a change in scope of Section VIII of the BPVC that would have the potential to now regulate HVACR and WH equipment already successfully covered under other codes and standards. This change would also alter how these standards and codes interact and are interpreted by jurisdictions.

The exact change being proposed is to eliminate many of the long-standing exemptions contained in the ASME BPVC Section VIII, *Rules for Construction of Pressure Vessels*, Division I, including the following exemptions that the HVACR and WH industry has been successfully employing for decades:

1. Pressure vessels with an inside diameter, width, height, or cross-section diagonal less than 6 inches;
2. Water side pressure vessels with a design pressure less than 300 psig and design temperature less than 210°F; and
3. Indirectly heated hot water storage tanks with an input rate less than 200 kBtu/hr, water temperature less than 210°F, and water-containing capacity less than 120 gallons.

The HVACR and WH industry does not see a need to expand the scope of the ASME BPVC. In fact, AHRI and many other stakeholder organizations firmly believe that the existing codes and standards in this space have served the industry and the public well for many years, with an excellent safety record. Removing the BPVC exemptions would place the ASME BPVC in conflict with the myriad of codes and standards that currently occupy this space, such as from UL, ASHRAE, and even other codes from ASME. The elimination of these ingrained and well-supported exemptions will add unnecessary confusion for local code inspectors, increase

expenses and production delays for equipment in numerous industries, lead to a shortage of trained ASME inspectors, lead to repair issues for units in the field, and create the potential for misapplication of codes, whether intentional or not, all without any enhancement in terms of either safety or performance. Note that HVACR and WH equipment that is outside of the exemptions shown above must be designed and built to the ASME BPVC, Section VIII and Section IV, *Rules for Construction of Heating Boilers*, respectively, as called for in industry codes.



Furthermore, equipment produced by the HVACR and WH industries, such as heat pumps and heat recovery chillers, help significantly in the effort to lower carbon emissions and reduce global warming. Creating additional barriers toward the accessibility of such equipment for no benefit in terms of safety, reliability, or performance would have a severe detrimental impact on the industry's decarbonization efforts.

Equipment produced under the current HVACR and WH standards has an excellent track record of safety and performance. For instance, the Occupational Safety and Health Administration's (OSHA) database contained 122 reports of injuries or deaths related to pressure vessels, none of which was linked to either HVACR or WH equipment. The Consumer Product Safety



Commission (CPSC) listed 2,757 reports of incidents related to pressure vessels and none were related to HVACR or WH equipment. The existing safety standards and codes that govern the HVACR and WH industry have established and maintained a robust commitment to safety. For these reasons, AHRI joins with many other industry organizations opposing the elimination of key exemptions in the scope of ASME BPVC Section VIII without proper consideration of relevant codes. Such changes will negatively impact product choice, availability, and affordability.¹

¹ AHRI, Central Air Conditioners and Air-Source Heat Pumps, <https://ahrinet.org/resources/statistics/historical-data/central-air-conditioners-and-air-source-heat-pumps> (showing the number of central air conditioners installed from 2001 to 2020).

AIR CONDITIONING AND REFRIGERATION SYSTEMS AND COMPONENTS

Much of the air conditioning equipment and heat pump water heaters produced by the industry during the past thirty years were listed to UL 1995, *Heating and Cooling Equipment*, or UL 484, *Room Air Conditioners*, and has now transitioned to the even more rigorous standard, UL 60335-2-40, *Household and Similar Electrical Appliances - Safety - Part 2-40: Particular Requirements for Electrical Heat Pumps, Air-Conditioners and Dehumidifiers*.



Similarly, refrigeration equipment which used to be listed to UL 412, *Standard for Refrigeration Unit Coolers*, UL 427, *Refrigerating Units*, UL 471, *Standard for Commercial Refrigerators and Freezers* and UL 1995 are transitioning to UL 60335-2-89, *Household and Similar Electrical Appliances - Safety - Part 2-89: Particular Requirements for Commercial Refrigerating Appliances and Ice-Makers with an Incorporated or Remote Refrigerant Unit or Motor-Compressor*. UL 60335-2-40 4th Edition and UL 60335-2-89 2nd edition are ANSI approved standards. Both are binational standards (U.S. and Canada) harmonized with their international counterpart IEC 60335-2-40 or IEC 60335-2-89. UL 60335-2-40 and UL 60335-2-89 have adopted more conservative safety requirements than the IEC standard to address the unique product usage of the North American market.²

It is no small feat to obtain equipment certification that meets an equipment standard such as UL 60335-2-40 or UL 60335-2-89. Product listing and labeling requires extensive testing at various steps along the way. Each piece of equipment contains no less than 20 or more integrated components each requiring safety testing. HVACR and WH equipment components and the completed product undergo rigorous testing at different stages of the design process. Equipment design standards emphasize testing of individual components and then final product testing. It is quite common for the various components in the final piece of equipment to carry a UL listing (e.g., compressors listed to UL 60335-2-34, *Standard for Household and Similar Electrical Appliances, Part 2: Particular Requirements for Motor-Compressors*).

A summary of the different UL standards that apply to refrigerant-containing equipment can be found in Appendix Table 1. Appendix Table 2 covers the UL standards that apply to water heating equipment. Both tables can be found in the Appendix at the end of this document. Besides pressure containing equipment and components, please note that many of these

² <https://www.ul.com/news/understanding-ul-60335-2-40-refrigerant-detector-requirements>

standards also address other areas such as electrical safety to ensure overall product reliability and safety.

After equipment has received certification or has been listed and labeled per the appropriate UL product safety standard, the equipment is ready for installation. Here the industry relies heavily on two ANSI/ASHRAE Standards; ANSI/ASHRAE Standard 15, *Safety Standard for Refrigeration Systems*, and ANSI/ASHRAE Standard 34, *Designation and Safety Classification of Refrigerants*. ANSI/ASHRAE 15 establishes installation guidelines for refrigeration equipment and systems and must be used in conjunction with ANSI/ASHRAE Standard 34. ANSI/ASHRAE 34 provides refrigerant safety classification and ensures that only refrigerant which has the proper safety classification is used as a heat transfer fluid in equipment. ANSI/ASHRAE 15 not only applies to the design, construction, test, installation, operation, and inspection of mechanical and absorption refrigeration systems including heat pump systems used in stationary refrigeration applications, but also provides necessary guidance needed due to modifications including replacement of parts or components to ensure that replacement components meet performance and safety requirements with the currently installed system. The installation information found in ANSI/ASHRAE 15 is then incorporated into the model codes using complementary language or by directly referencing sections in ANSI/ASHRAE 15.

Model Building Codes

ASHRAE and UL standards have been referenced in the model building codes such as the International Mechanical Code® (IMC) and the Uniform Mechanical Code® (UMC), which in turn are adopted either whole or in part by most state and local jurisdictions where they have the force of law. For instance, in the IMC and UMC, self-contained, factory-built refrigeration equipment and appliances are to be listed and labeled in accordance with UL 207, *Refrigerant-Containing Components and Accessories, Nonelectrical*, UL 412, UL 471, UL 1995, or UL 60335-2-89. Similarly, UL 474, *Dehumidifiers*, UL 484, UL 1995, and UL 60335-2-40, which provide construction and testing requirements for listed and labeled AC equipment are also referenced in the IMC and UMC. Equipment and appliances are deemed to meet the rigors of design, manufacture, and factory test requirements in the mechanical code if the equipment is listed and labeled per the key equipment standards.



Domestic electric water heaters are to comply with either UL 174, *Household Electric Storage Tank Water Heaters*, or UL 1453, *Electric Booster and Commercial Storage Tank Water*, while Commercial electric water heaters must comply with UL 1453 while oil-fired water heaters are

to comply with UL 732, *Standard for Safety for Oil-Fired Storage Tank Water Heaters*, and solid fuel-fired water heaters are to comply with UL 2523, *Solid Fuel-Fired Hydronic Heating Appliances, Water Heaters, and Boilers*.

Furthermore, either by directly incorporating the language or reference, the building codes follow the guidance provided by ANSI/ASHRAE 15. Refrigeration installation guidance is typically found in chapter 11 while chapter 10 covers water heaters in both the IMC and UMC. Both the IMC and UMC recognize the safety and reliability provided by these well-regarded, recognized industry standards and use them to their advantage as a foundational basis.

Personnel Training and Certification in the HVACR Industry

To properly implement the aforementioned safety standards, the domestic HVACR industry offers training and certification programs. Two of the most prominent are:

- **NORTH AMERICAN TECHNICIAN EXCELLENCE (NATE)**
 - The nation's largest nonprofit certification organization for heating, ventilation, air conditioning, and refrigeration (HVACR) technicians. NATE tests represent real-world working knowledge of HVACR systems and validate the professional competency of service and installation technicians. Contractors, manufacturers, distributors, and educators across the industry partner with NATE to develop knowledgeable and competent HVACR technicians.
 - For additional information, visit <https://www.natex.org/>
- **The Refrigerating Engineers & Technicians Association (RETA)**
 - The most recognized organization in the country dedicated to the professional development of industrial refrigeration operators and technicians. Founded in 1909, RETA is a non-profit membership and certification organization. RETA has many chapters throughout the United States to support the network of trained operators and technicians.
 - For additional information, visit <https://reta.com/>.



Most U.S. states also require technician licensing for HVAC and plumbing/heating professionals. In states that do not specifically require licensing and certification requirements, these requirements are typically the responsibility of the local municipalities.

For the relatively few HVACR and WH equipment and components that are within scope of the ASME BPVC Section VIII, Division 1 (2023), HVACR and WH codes call for design and fabrication



per the appropriate ASME BPVC. Note that an ASME-certified technician is required to perform repairs on these products and an authorized ASME Inspector must inspect and approve any required repairs. These requirements, which currently do not apply to most HVACR and WH equipment and components, can add substantial time and cost to the equipment repair process and would be prohibitive for many manufacturers.

Requirements for Pressure-Containing Components

HVACR equipment often contains heat exchangers that heat, cool, or process fluids and gases as well as other components that must withstand the operating pressures, such as filter dryers, thermostatic expansion valves, receivers, and accumulators. These components must handle the design pressure as well as cyclic pressures. Due to the extensive testing criteria for the components and final equipment, refrigerant-containing components are typically not required to comply with the ASME BPVC by UL 60335-2-40 and UL 60335-2-89 standards.



ANSI/ASHRAE 15 is also aligned with these exemptions. Under ANSI/ASHRAE 15, refrigerant-containing components having an inside diameter, width, height, or cross-sectional diagonal not exceeding 6 in. (152 mm), with no limitation on length of vessel may optionally comply with the ASME BPVC but are not required to do so. Also exempted are evaporator coils, compressors, condenser coils, controls, headers, pumps, piping, and evaporators where each separate evaporator section does not exceed 0.5 ft³ (0.014 m³) of refrigerant containing volume, regardless of the maximum inside dimension.



Typically, the UL standards and ANSI/ASHRAE 15 employ design criteria that refer to these refrigerant containing components as “pressure vessels” once certain criteria are met. Outside the stated criteria, the component and/or the equipment is “exempted” from additional testing. These exemptions are based on decades of sound engineering testing and validation and a long safety track

record.

The design criteria are colloquially referred to as the 6-inch exemption and the waterside exemption. If the component or equipment has an inside diameter greater than 152 mm (6 in)

and has an internal or external design pressure greater than 103.4 kPa gauge (15 psig), then the component or equipment is noted as a “pressure vessel.” Similarly, if the component or equipment contains water under pressure with a design pressure greater than 300 psi (2 MPa) or a design temperature greater than 210°F (99°C), then it also is designated as a pressure vessel.

Once refrigerating components or equipment are identified as being outside of the exemptions, they are designated as “pressure vessels” subject to additional design, fabrication, and testing requirements under the ASME BPVC.

For pressure vessel design, the ASME BPVC, Section VIII, Division 1 is utilized as the basis of design for vessels that are 6” or larger internal diameter and for vessels handling water, or solutions no more dangerous than water, that exceed 300 psi design pressure or temperature 210°F or higher, or where required by local law.

This part of the ASME BPVC has multiple scope exemptions, two of which are listed below:

- Six-inch exemption (U-1 c (-i))
 - vessels having an inside diameter, width, height, or cross section diagonal not exceeding 6 in. (152 mm), with no limitation on length of vessel or pressure.
- Waterside exemption (U-1 c (-f))
 - a vessel for containing water (or a fluid no more dangerous than water) under pressure, including those containing air, the compression of which serves only as a cushion, when none of the following limitations are exceeded:
 - a design pressure of 300 psi (2 MPa);
 - a design temperature of 210°F (99°C);



Another exemption to Section VIII impacts the water heater industry:

- Water heater exemption (U-1 c (-g))
 - when none of the following limitations is exceeded:
 - a heat input of 200,000 Btu/hr (58.6 kW)
 - a water temperature of 210°F (99°C)
 - a nominal water containing capacity of 120 gallons (450 L)

Note that the criteria for the water heater exemption matches the exemptions contained in a hot water supply storage tank heated by steam or any other indirect means ASME BPVC Section IV.

The six-inch exemption described above has existed in the ASME BPVC for over 75 years. The waterside exemption, which has been in the BPVC since December 1988, is based on sound, thorough technical data, testing, modeling, and analysis. These exemptions, along with the water heater exemption that defers to ASME BPVC Section IV, were incorporated with the approval of the ASME BPVC Committee.

Note that even when not required by local codes, users can always request that their vessels be fabricated, inspected, and stamped per the appropriate ASME BPVC, perhaps as a requirement from their insurance carrier. Such applications are usually for Industrial cooling or heating. Other ASME Codes, such as the ASME B31.5 Refrigeration Piping Code and Heat Transfer Components, can also be used to design and fabricate pressure-containing components such as evaporative condenser coils that are within their scope.



The industry has developed a set of robust codes and standards (see Tables 1-3 in the Appendix) to ensure the safety and reliability of HVACR and WH equipment and components that are subject to the above BPVC scope exemptions. These codes and standards contain requirements for pressure-containing components such as heat exchangers, filter dryers, suction filters, accumulators, and receivers. These design requirements for refrigerant containing components include one of the following:

- Burst pressure qualification method:
 - pressure proof testing at two times the higher of design, abnormal or rated pressure for water storage tanks.
 - pressure proof testing at three times the higher of design, abnormal, or rated pressure depending on piping or equipment (i.e., piping per UL 207 or equipment per UL 60335-2-40 or UL 60335-2-89).
- Fatigue qualification method:
 - Component subjected to a minimum of 500,000 cycles at the higher of the design, abnormal, or rated pressure, followed by an additional burst test two times the higher of design, abnormal, or rated pressure.

For water-containing components, a burst test is used to qualify the design at two times the higher of the design or rated pressure or 150 psi, whichever is higher.

For all components, UL 207, UL 60335-2-40, and UL 60335-2-89 require that each manufactured unit be tested at the design pressure to confirm structural integrity and leak tightness.

Boilers and Water Heating Systems and Components

The ASME BPVC, Section IV, Part HG, is utilized as the basis of design for boilers. The rules of Part HG apply to steam heating boilers, hot water heating boilers, hot water supply boilers, and to appurtenances thereto for the following:

- Hot water heating boilers and hot water supply boilers for operation at pressures not exceeding 160 psi (1100 kPa).
- Hot water heating boilers and hot water supply boilers for operation at temperatures not exceeding 250°F (120°C), at or near the boiler outlet, except that when some of the wrought materials permitted by Part HF are used, a lower temperature is specified.



Above these values, the rules of ASME BPVC Section VIII, Division 1 apply for boilers.

For potable water heaters, the industry follows ASME BPVC Section IV for units that are within its scope. These scope limitations include:

- heat input of 200,000 BTU/hr (kW) or higher;
- water temperature not exceeding 210°F;
- tank capacity of 120 gallons or more; and
- pressures not exceeding 160 psi.

For those water heaters *outside of the Scope of Section IV*, the industry has successfully relied on the UL standards summarized in Table 2 in the Appendix.

Pressure Vessel Requirements versus Building Codes

In North America, state and local governments adopt safety codes for the protection of the public. For pressure vessels, the ASME BPVC, Section VIII, Division 1, is typically adopted, sometimes with a few minor deviations to meet jurisdictional requirements or preferences. Enforcement and oversight of such pressure vessel installations is performed by the National

Board of Boiler and Pressure Vessel Inspectors, whose mission is “to reduce the risk to life and property by promoting safety in the construction, installation, inspection, operation, over-pressure protection, and repair and alteration of boilers, pressure vessels, and other pressure-retaining items.”

For pressure vessels and pressure-containing components that are outside of the scope of the ASME BPVC, local building code officials and inspectors oversee the use of such equipment in residential, commercial, and industrial applications. These code officials utilize the local building codes, often based on the model codes from ICC or IAPMO, to help ensure building safety as mentioned earlier. For example, a code official inspecting a building containing equipment that is within the scope of ASHRAE and/or UL codes and standards, must first determine if the pressure-containing component is within the scope of the ASME BPVC or the scope of other applicable codes and standards. In either case, the code official confirms that the pressure-containing parts comply with the appropriate design and testing requirements.

Both the National Board and local code officials help to ensure the safety and reliability of pressure-containing vessels. The National Board primarily works with enforcement of local pressure vessel codes based on the ASME BPVC. Building code officials primarily work with local building codes that are based on the Model Building Codes from ICC and IAPMO, such as the International Mechanical Code (IMC) and the Uniform Mechanical Code (UMC). Due to the nature of the affected equipment, these two “houses” of inspectors rarely cross paths in the field. Altering the scope of the ASME BPV Code would upset this balance between the two “houses” and create unnecessary confusion.

Global Codes

Many of these codes and standards are accepted around the world or there are local codes and standards that apply, such as:

- Europe’s Directive 2014/68/EU, *Pressure Equipment*
- China’s Guobiao 150-series of Standards (GB 150-1, *Pressure vessels – Part 1: General requirements*, GB 150-2, *Pressure vessels – Part 2: Materials* GB 150-3, *Pressure vessels – Part 3: Design*, and GB 150-4, *Pressure vessels - Part 4: Fabrication, inspection, and acceptance*)
- Canada’s CSA B51, *Boiler, pressure vessel, and pressure piping code*



These codes and standards are often quite similar to those used in North America and handle HVACR and water heating equipment in the same way, reinforcing the viability of this approach. This includes the 6” and waterside exemptions mentioned above as well as exclusions for HVACR and water heating equipment.

As an example, CSA B51 registration and inspection requirements for liquid service with liquids not more hazardous than water follow a path very similar to that required in the ASME BPVC. For this case, pressure vessels greater than 6 inches (152 mm) in diameter, operating under 150°F and 600 psig, must be registered as a pressure vessel and inspected by an authorized inspector. However, vessels less than 6" diameter are classified as a Category H fitting and can be inspected by the manufacturer.

A component classified as a Category H fitting that is used as part of a piping system must obtain a Canadian Registration Number. This process includes submitting calculations and the results of a proof test of the component witnessed by a licensed inspector. The shop that produces the fitting must inspect it per their quality control process. These requirements are very similar to those contained in the ASME BPVC where components less than 6" diameter are exempt. However, components under 6" are often produced per the requirements contained in ASME B31.5, *Refrigeration Piping and Heat Transfer Components*, or one of the other ASHRAE or UL codes mentioned earlier.



Summary

The HVACR industry in North America has earned a solid reputation for safety and excellence through its diligence in conforming to appropriate, widely accepted ANSI-approved codes and standards, proper training of personnel, and support for technician certification and licensing. Through the industry's efforts, many millions of safe and affordable systems are successfully installed and operated each year as part of a solid base of safe, safety- and life-sustaining equipment. The proposed BPVC change would needlessly raise the cost of manufacturing and installing vital life- and health-affirming HVACR and water heating equipment, while doing nothing to enhance its safety, which has for decades been proven to be extremely safe and reliable.

For further information on codes and standards in the HVACR and water heating industries and AHRI's efforts to ensure safety, performance, and sustainability, please visit ahrinet.org or contact Tom Deary at tdeary@ahrinet.org or 703-600-0338.

References

ANSI/ASHRAE Standard 15, *Safety Standard for Refrigeration Systems*, The American Society of Heating, Refrigeration, and Air-Conditioning Engineers, www.ashrae.org.

ANSI/ASHRAE Standard 34, *Designation and Safety Classification of Refrigerants*, The American Society of Heating, Refrigeration, and Air-Conditioning Engineers, www.ashrae.org.

ASME B31.5, *Refrigeration Piping and Heat Transfer Components*, The American Society of Mechanical Engineers, www.asme.org.

ASME Boiler and Pressure Vessel Code, Section IV, Rules for Construction of Heating Boilers, The American Society of Mechanical Engineers, www.asme.org.

ASME Boiler and Pressure Vessel Code, Section VIII, Rules for Construction of Pressure Vessels, The American Society of Mechanical Engineers, www.asme.org.

CSA B51, *Boiler, pressure vessel, and pressure piping code*, CSA Group, www.csagroup.org.

Directive 2014/68/EU, *Pressure Equipment*, European Agency for Safety and Health at Work, www.osha.europa.eu.

GB 150-1 *Pressure vessels – Part 1: General requirements*, China Special Equipment Inspection and Research Institution.

GB 150-2, *Pressure vessels – Part 2: Materials*, China Special Equipment Inspection and Research Institution.

GB 150-3, *Pressure vessels – Part 3: Design*, China Special Equipment Inspection and Research Institution.

GB 150-4, *Pressure vessels - Part 4: Fabrication, inspection, and acceptance*, China Special Equipment Inspection and Research Institution.

International Mechanical Code[®], International Code Council, www.iccsafe.org.

UL 174, *Household Electric Storage Tank Water Heaters*, UL, www.shopulstandards.com.

UL 207, *Refrigerant-Containing Components and Accessories, Nonelectrical*, UL, www.shopulstandards.com.

UL 427, *Refrigerating Units*, UL, www.shopulstandards.com.

UL 474, *Dehumidifiers*, UL, www.shopulstandards.com.

UL 471, *Standard for Commercial Refrigerators and Freezers*, UL, www.shopulstandards.com.

UL 484, *Room Air Conditioners*, UL, www.shopulstandards.com.

UL 732, *Standard for Safety for Oil-Fired Storage Tank Water Heaters*, UL, www.shopulstandards.com.

UL 1453, *Electric Booster and Commercial Storage Tank Water*, UL, www.shopulstandards.com.

UL 1995, *Heating and Cooling Equipment*, UL, www.shopulstandards.com.

UL 2523, *Solid Fuel-Fired Hydronic Heating Appliances, Water Heaters, and Boilers*, UL, www.shopulstandards.com.

UL 60335-2-40, *Household and Similar Electrical Appliances - Safety - Part 2-40: Particular Requirements for Electrical Heat Pumps, Air-Conditioners and Dehumidifiers*, UL, www.shopulstandards.com.

UL 60335-2-34, *Standard for Household and Similar Electrical Appliances, Part 2: Particular Requirements for Motor-Compressors*, UL, www.shopulstandards.com.

UL 60335-2-89, *Household and Similar Electrical Appliances - Safety - Part 2-89: Particular Requirements for Commercial Refrigerating Appliances and Ice-Makers with an Incorporated or Remote Refrigerant Unit or Motor-Compressor*, UL, www.shopulstandards.com.

Uniform Mechanical Code®, International Association of Plumbing and Mechanical Officials, www.iapmo.org.

Appendix

Table 1 UL Standards for Refrigerant Containing Systems and Components

STANDARD	PRODUCT COVERAGE	DESCRIPTION	COMMENTS
UL 60335-2-40	Air Conditioners / Heat Pumps, Liquid Chillers and Hydronic Fan Coil Units, Hot Water Heat Pumps, Dehumidifiers, and Supplemental Heaters	Specifies safety requirements for electric heat pumps, including sanitary hot water heat pumps, air conditioners, and dehumidifiers incorporating motor compressors and hydronic fan coils units, their maximum rated voltages being not more than 250 volts for single phase applications and 600 volts for all other appliances.	Binational standard for USA and Canada; based on international standard IEC 60335-2-40 used in Europe; replacing UL 1995.
UL 60335-2-89	Commercial Refrigerating Appliances	Specifies safety requirements for electrical commercial refrigerating appliances and icemakers with an incorporated or remote refrigerant unit or compressor.	Binational standard for USA and Canada; based on international standard IEC 60335-2-89 used in Europe; replacing UL 1995, UL412, UL427 and UL471.
UL 412	Refrigeration Unit Coolers	These requirements cover unit coolers intended for use in refrigerators, freezers, refrigerated warehouses, walk-in coolers, and the like.	Requirements for installation of unit coolers are included in the National Electrical Code, NFPA 70, and the Safety Standard for Refrigeration Systems, ASHRAE Standard 15.
UL 427	Refrigerating Units	These requirements cover refrigerating units intended for connection in accordance with the National Electrical Code, NFPA 70, to alternating-current (ac) circuits rated not greater than 600 volts.	This standard also covers component refrigeration systems (self-contained mechanical refrigeration systems), not already covered by a UL standard, that heat, cool or dehumidify as integral (not stand-alone) components of appliances.
UL 471	Commercial Refrigerators and Freezers	These requirements cover packaged commercial refrigerators and freezers intended for connection to alternating-current circuits rated not greater than 600 volts. These requirements also cover commercial refrigerators and freezers intended for installation within motor fuel dispensing facilities as defined by the Code for Motor Fuel Dispensing Facilities and Repair Garages, NFPA 30A.	Requirements for the installation of commercial refrigerators and freezers are included in the National Electrical Code, ANSI/NFPA 70, and the Safety Standard for Refrigeration Systems, ASHRAE 15
UL 1995	Heating and Cooling Equipment	These requirements apply to the following stationary equipment for use in nonhazardous locations rated 7200 V or less, single- or 3-phase, and remote-control assemblies for such equipment: a) Heat pumps, for heating and cooling with or without factory, or field-installed electric resistance heaters, or hot water or steam heating coils.	

		<p>b) Air conditioners for cooling with or without factory, or field-installed electric resistance heaters, or hot water or steam heating coils.</p> <p>c) Cooling portion and associated components of combination heating and cooling equipment employing gas-, oil-, or gas-oil-fired heating means. However, the requirements for the construction and performance of the gas-, oil-, or gas-oil-fired heating means, and their associated components, are to conform to the particular standards covering such heating equipment and components.</p> <p>d) Liquid chillers and compressor-evaporator or liquid chiller assemblies intended for use with remote condensers.</p> <p>e) Condensing units intended for connection to a remote nonspecified evaporator and compressor units intended for connection to a remote nonspecified evaporator and condenser.</p> <p>f) Add-on heat pumps for comfort heating or heating and cooling.</p>	
<p>UL 207</p>	<p>Refrigerant-Containing Components and Accessories, Nonelectrical</p>	<p>These requirements cover nonelectrical refrigerant-containing components and accessories, intended for field installation in accordance with the Safety Code for Mechanical Refrigeration, ASHRAE 15, in refrigeration systems, air conditioning equipment, or both, charged with the refrigerants identified for use in the component or accessory. The requirements also apply to components and accessories intended for use by manufacturers in factory-assembled systems or units, in which case the component or accessory is also judged under the requirements for the individual system or unit.</p>	<p>Note that UL 207 does not cover the following:</p> <ul style="list-style-type: none"> - Electric valves and electric refrigeration controllers, hermetic refrigerant motor-compressors, tubing fittings such as flare or compression type fittings, and the like, which are covered in or as part of separate, individual requirements. - Electrical components of assemblies incorporating these refrigerant-containing components or accessories, and - Pressure vessels bearing the ASME Code "U" symbol which are within the Scope of the ASME Boiler and Pressure Vessel Code, Section VIII.

Table 2 UL Standards for Boilers and Water Heating Equipment

STANDARD	PRODUCT COVERAGE	DESCRIPTION	COMMENTS
UL 174	Household Electric Storage Tank Water Heaters	This standard covers household electric storage tank and small capacity storage (>1 gal and < 120gal) tank water heaters rated no more than 600 volts and 12 kilowatts to be installed in accordance with the National Electrical Code, NFPA 70, and with model plumbing and mechanical codes.	
UL 732	Oil-Fired Storage Tank Water Heaters	These requirements cover oil-fired storage-tank water-heating appliances having a fuel input of not more than 200,000 Btu per hour (60 kW). These requirements do not apply to heaters that include storage vessels having a water capacity of more than 120 gallons (454.2 liters) or that are intended for heating water to a temperature of more than 200°F (93.3°C).	The oil-burning equipment covered by these requirements are intended for installation in accordance with the National Fire Protection Association Standard for the Installation of Oil Burning Equipment, NFPA 31, the International Mechanical Code and the Uniform Mechanical Code. (applies <120 gallons).
UL 1453	Electric Booster and Commercial Storage Tank Water Heaters	These requirements cover electric booster water heaters, electric commercial storage tank water heaters, and remote-control assemblies for such heaters, rated 600 volts or less, to be employed in ordinary locations in accordance with the National Electrical Code, NFPA 70.	Water Heaters: <ul style="list-style-type: none"> • >120 gal; • rated > 12 kW; or • equipped with one or more temperature-regulating controls that permit water temperature > 85°C.
UL 2523	Solid Fuel-Fired Hydronic Heating Appliances, Water Heaters, And Boilers	Requirements apply to factory built manually and/or automatically fueled solid fuel-fired hydronic heating appliances, water heaters, and boilers, as defined in Section 5, Glossary, intended to be fixed non-moveable appliances. The appliances are intended to burn solid fuels, such as wood, coal, or any other biomass fuel, as specified by the manufacturer.	Compliance with the Standard for Chimneys, Fireplaces, Vents, and Solid Fuel Burning Appliances, NFPA 211, and intended for installation in compliance with the National Electrical Code, ANSI/NFPA 70; and the International Mechanical Code (ICC), International Residential Code (ICC) and the Uniform Mechanical Code (IAPMO), as applicable.
UL 499	Electric Heating Appliances	These requirements cover heating appliances rated at 600 V or less for use in unclassified locations in accordance with the National Electrical Code (NEC), ANSI/NFPA 70. These requirements do not cover electric heating equipment or appliances that are covered by individual requirements that are separate from this Standard.	These requirements also cover electrically energized products that generate steam for other than space heating purposes and have an electrical power rating of 15 kW or less per steam generating vessel. Except as noted for steam-bath generators, steam generating products of the type described in 4 having an electrical input power rating of more than 15 kW per steam generating vessel are to be evaluated by the requirements in the Standard for Heating, Water Supply, and Power Boilers – Electric, UL 834.