UL 1995

STANDARD FOR SAFETY

Heating and Cooling Equipment

UL Standard for Safety for Heating and Cooling Equipment, UL 1995

Fifth Edition, Dated July 31, 2015

Summary of Topics

The revision of UL 1995 dated August 1, 2022 is being issued to remove the ANSI logo and approval from the title page. Other ANSI related notes for UL 1995 have been removed. No technical changes have been made.

As noted in the Commitment for Amendments statement located on the back side of the title page, UL and CSA are committed to updating this harmonized standard jointly. However, the revision pages dated August 1, 2022 will not be jointly issued by UL and CSA as these revisions only address the UL ANSI removal.

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

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CSA Group
CSA C22.2 No. 236-15
Fifth Edition

Underwriters Laboratories Inc.
UL 1995
Fifth Edition

Heating and Cooling Equipment

July 31, 2015

(Title Page Reprinted: August 1, 2022)

Commitment for Amendments

This standard is issued jointly by the Canadian Standards Association (operating as CSA Group) and Underwriters Laboratories Inc. (UL). Comments or proposals for revisions on any part of the standard may be submitted to CSA Group or UL at any time. Revisions to this standard will be made only after processing according to the standards development procedures of CSA Group and UL. CSA Group will not be issuing revisions dated August 1, 2022.

ISBN 978-1-77139-831-2 © 2015 Canadian Standards Association

This Standard is subject to review within five years from the date of publication, and suggestions for its improvement will be referred to the appropriate committee. To submit a proposal for change, please send the following information to inquiries@csagroup.org and include "Proposal for change" in the subject line: Standard designation (number); relevant clause, table, and/or figure number; wording of the proposed change; and rationale for the change.

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The Department of Defense (DoD) has adopted UL 1995 on March 9, 1992. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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Preface

This is the harmonized CSA Group and UL standard for Heating and Cooling Equipment. It is the fifth edition of CSA-C22.2 No. 236, and the fifth edition of UL 1995.

This harmonized standard was prepared by the CSA Group and Underwriters Laboratories Inc. (UL). The efforts and support of the heating and cooling equipment industry, the Air Conditioning and Refrigeration Institute (ARI), and the Heating, Refrigerating, and Air Conditioning Institute of Canada (HRAI) are gratefully acknowledged.

This standard is considered suitable for use for conformity assessment within the stated scope of the standard.

This Standard was reviewed by the CSA Subcommittee on Appliances for Air-Conditioning for Household and Similar Purposes, under the jurisdiction of the CSA Technical Committee on Consumer and Commercial Products and the CSA Strategic Steering Committee on the Requirements for Electrical Safety, and has been formally approved by the CSA Technical Committees. It was also reviewed by the UL Standards Technical Panel 1995 and processed according to the method of development, revision, and implementation of UL standards for safety.

Application of Standard

Where reference is made to a specific number of samples to be tested, the specified number is to be considered a minimum quantity.

Note: Although the intended primary application of this standard is stated in its scope, it is important to note that it remains the responsibility of the users of the standard to judge its suitability for their particular purpose.

Level of harmonization

This standard uses the IEC format but is not based on, nor is it considered equivalent to, an IEC standard. This standard is published as an equivalent standard for CSA Group and UL.

An equivalent standard is a standard that is substantially the same in technical content, except as follows: Technical national differences are allowed for codes and governmental regulations as well as those recognized as being in accordance with NAFTA Article 905, for example, because of fundamental climatic, geographical, technological, or infrastructural factors, scientific justification, or the level of protection that the country considers appropriate. Presentation is word for word except for editorial changes.

Reasons for differences from IEC

The THSC investigated and found no existing IEC standards or work programs covering the scope of the products in this standard.

Interpretations

The interpretation by the standards development organization of an identical or equivalent standard is based on the literal text to determine compliance with the standard in accordance with the procedural rules of the standards development organization. If more than one interpretation of the literal text has been identified, a revision is to be proposed as soon as possible to each of the standards development organizations to more accurately reflect the intent.

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Heating and cooling equipment

1 Scope

1.1 These requirements apply to the following stationary equipment for use in nonhazardous locations rated greater than 600 volts up to 7200 V, 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;

b) Air conditioners for cooling with or without factory, or field-installed electric resistance heaters, or hot water or steam heating coils;

c) Liquid chillers and compressor-evaporator or liquid chiller assemblies intended for use with remote condensers;

d) Add-on heat pumps for comfort heating or heating and cooling; and

e) Heat pump water heaters and refrigerant desuperheaters, and packaged heat pump water heaters consisting of a heat pump water heater and an associated storage tank;

Note: The above equipment rated 600 V or less are covered by the scope of ANCE/CSA/UL 60335-2-40.

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.

b) Air conditioners for cooling with or without factory, or field-installed electric resistance heaters, or hot water or steam heating coils.

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.

d) Liquid chillers and compressor-evaporator or liquid chiller assemblies intended for use with remote condensers.

e) Condensing units intended for connection to a remote nonspecified evaporator and compressor units intended for connection to a remote nonspecified evaporator and condenser.

f) Add-on heat pumps for comfort heating or heating and cooling.

g) Heat pump water heaters and refrigerant desuperheaters, and packaged heat pump water heaters consisting of a heat pump water heater and an associated storage tank.

h) Fan units and fan coil units for comfort heating and/or comfort cooling.

i) Room fan heater units, central heating furnaces, and similar fixed electric space heating for comfort heating.

1.2 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) 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, shall conform to the particular standards covering such heating equipment and components;

b) Condensing units intended for connection to a remote nonspecified evaporator and compressor units intended for connection to a remote nonspecified evaporator and condenser; and

c) Room fan heater units, central heating furnaces, and similar fixed electric space heating for comfort heating.

Note: The equipment mentioned in Clauses 1.3, 1.4, 1.5, 1.6, 1.7 and 1.13 are rated 7200 V or less, single or 3-phase. These products are not covered by the scope of ANCE/CSA/UL 60335-2-40.

The units referenced in Clause 1.1(g), self-contained heat pumps and air conditioners may be cord-connected if they

a) are for indoor use only;

b) are rated 250 V or less, single phase, with a marked rating of 24 A or less; and

c) comply with Clause 1.11.

1.3 A fan unit includes a motor-operated fan or blower and is intended to be connected to a duct system that supplies conditioned air for environmental heating and/or cooling. Such a unit may have air-controlled dampers, but does not include a factory-installed heat exchanger or any other integral heating or cooling means.

1.4 A fan coil unit includes a motor-operated fan or blower together with a cooling coil, a heating coil, or both. The fan or blower is intended to recirculate air, and can introduce air from outside of the heated or cooled space. The coil can be used for refrigerant cooling, for chilled water cooling, for hot water heating, for steam heating, or for combinations of these functions.

1.5 A fan coil unit is intended to be piped to a remote source of the heating and/or cooling mediums. A unit that includes an electric resistance heater is considered to be a fan coil unit if a water or refrigerant coil for comfort cooling and/or a water or steam coil for comfort heating is provided in the unit.

1.6 A room fan heater unit is intended for heating only, includes a motor-operated fan or blower, employs electric resistance heat as the only heat source, and is intended to serve only one room or space.

1.7 A fan coil unit or electric space heating equipment, as covered by these requirements, can be designed for free discharge of air to the room or can be provided with means for duct connection.

1.8 A central warm air furnace is a heating appliance that consists of an electric heating element or elements with an air-circulating fan or blower, is provided with appropriate integral operating and temperature-limiting controls, and is housed in an enclosure designed to be connected to ductwork for the distribution of the heated air remote from the unit.

1.9 The units referenced in Clause 1.1 and 1.2 can consist of one or more factory-made assemblies. If provided in more than one assembly, the separate assemblies are to be used together, and the requirements are based on the use of matched assemblies. These requirements apply to assemblies designed for free discharge of air into the conditioned space as well as those which may be provided with means for duct connection.

The units referenced in Clause 1.1 can consist of one or more factory-made assemblies. If provided in more than one assembly, the separate assemblies are to be used together, and the requirements are based on the use of matched assemblies. These requirements apply to assemblies designed for free discharge of air into the conditioned space as well as those which may be provided with means for duct connection.

1.10 These requirements do not apply to add-on heat pump systems designed to utilize the indoor fan motor assembly of an installed furnace where:

a) The heat pump and furnace are intended to operate simultaneously during heating operation except as noted in the Exception to Clause 26.17; or

b) The refrigerant coil is intended to be mounted upstream (return air side) of the furnace.

These requirements do not apply to add-on heat pump systems designed to utilize the indoor fan motor assembly of an installed furnace where

a) the heat pump and furnace are intended to operate simultaneously during heating operation except as noted in the Exception to Clause 26.17; or

b) the refrigerant coil is intended to be mounted upstream (return air side) of the furnace.

1.11 These requirements apply to equipment designed to be used in nonhazardous locations in accordance with the rules of CSA C22.1, ANSI/NFPA No. 70, CSA B52, ANSI/ASHRAE 15, NFPA 90A, and NFPA 90B.

Note 1: Requirements for the installation of units designed to be connected to air duct systems are also included in codes such as the BOCA Basic National Mechanical Code, the ICC's Standard Mechanical Code, and the ICC's Uniform Mechanical Code.

Note 2: Coolant distribution equipment are intended for use in an information technology room (ITE) that comples with NFPA 75.

These requirements apply to equipment designed to be used in nonhazardous locations in accordance with the rules of CSA C22.1, ANSI/NFPA No. 70, CSA B52, ANSI/ASHRAE 15, NFPA 90A, and NFPA 90B.
Note: Requirements for the installation of units designed to be connected to air duct systems are also included in codes such as the BOCA Basic National Mechanical Code, the ICC's Standard Mechanical Code, and the ICC's Uniform Mechanical Code.

1.12 The values given in SI (metric) units are normative. Any other values given are for informational purposes only.

The values given in SI (metric) units are normative. Any other values given are for informational purposes only.

1.13 Units intended for connection to telecommunication equipment are to have the appropriate assembly containing such circuitry meet CAN/CSA C22.2 No. 225 and UL 1459.

1.14 The general requirements of CSA C22.2 No. 0 apply, except as follows:

a) “General Requirements”, Clause 3, and “Construction Details”, Clause 4 (refer to Clauses 2 through 36 of this standard);

b) “Marking”, Clause 5 (refer to Clauses 43, 44, and 45 of this standard);

c) “Tests”, Clause 6 (refer to Clauses 46 through 79 of this standard).

The following Clauses of CAN/CSA-C22.2 No. 0 are superseded by the requirements of this Standard:

a) "General Requirements", Clause 3, and "Construction Details", Clause 4 (refer to Clauses 2 through 36 of this standard);

b) "Marking", Clause 5 (refer to Clauses 43, 44, and 45 of this standard);

c) "Tests", Clause 6 (refer to Clauses 46 through 79 of this standard).

1.15 These requirements do not cover panel or cable type radiant heating equipment, electric boilers, baseboard heaters, air heaters, duct heaters, and unit coolers for refrigeration purposes, nor any other electric heating equipment or appliances which are covered in or as a part of separate, individual standards.

2 Definitions

2.1 The following definitions apply in this Standard:

Absolute Irradiance – E, (W/cm^2), Radiant Flux incident on a surface. The quotient of radiant flux at that element of a surface to the area of that element.

Add-on heat pump – a pump that normally consists of an outdoor section, one or more indoor sections (without circulating fan), and related control devices.

Adjustable Speed Drive – A combination of the power converter, inverter, motor(s), motor-compressor(s) and motor-mounted auxiliary devices such as encoders, tachometers, thermal switches and detectors, air blowers, heaters, and vibration sensors.

Adjustable Speed Drive System – An interconnected combination of equipment that provides a means of adjusting the speed of a mechanical load coupled to motor(s) and/or motor-compressor(s). A drive system typically consists of an adjustable speed drive and auxiliary electrical apparatus.

Air-circulating blower – the complete blower or fan assembly, including the blower wheel or fan, the blower housing, and the motor used to provide the means for the circulation of air in a system.

Appliance Coupler – A single-outlet, female contact device for attachment to a flexible cord as part of a detachable power-supply cord to be connected to an appliance inlet (motor attachment plug). Note: Female contact device is defined as an electrical connector surrounded by an electrically isolated material such that the electrical contact cannot be accessed with the probe illustrated in Figure 7.1.

Appliance Inlet (Motor Attachment Plug) – A male contact device mounted on an end product appliance to provide an integral blade configuration for the connection of an appliance coupler or cord connector. Note: Male contact device is an electrical connector that is inserted into a corresponding female contact device to complete the electrical connection for the appliance.

Ballast – A current limiting device required to start and operate fluorescent lamps.

Barrier – A partition for the isolation (insulation) of hazardous voltage electrical circuits or isolation of electrical arcs, moving parts, or ultraviolet (UV) radiation from lamps.

Blocking diode – A diode used to block reverse flow of current into a photovoltaic source circuit.

Cabinet – That part of the unit that encloses insulated wiring, electrical enclosures, moving parts, motors or enclosed electrical parts.

Cascade system – A refrigeration system that incorporates two or more independent vapor-compressor refrigeration cycles in series. This is done to acquire low temperatures that might not be readily achieved with a single refrigeration cycle.

Charge controller – Equipment that controls dc voltage or dc current, or both, used to charge a battery.

Circuit, Class 2 – An extra-low voltage circuit with a power of 100 VA or less; or has 30 V dc supplied by a primary battery; or is supplied by a Class 2 transformer; or is supplied by a combination of a transformer and fixed impedance that, as a unit, complies with all the performance requirements for a Class 2 transformer, or is supplied by a power supply (such as a switching power supply) whose output meets the requirements of a Class 2 circuit. A circuit that is derived from a circuit that exceeds 30 V by connecting resistance or impedance, or both, in series with the supply circuit to limit the voltage and current, is not considered to be a class 2 circuit.

Circuit, extra-low-voltage – A circuit that has an ac potential of not more than 30 V rms (42.4 V peak or 30 V dc).

Circuit, hazardous voltage – A circuit of any voltage exceeding those of an extra-low-voltage circuit.

Combination temperature-regulating and -limiting thermostat – A thermostat that functions to regulate the temperature under normal conditions of use, and also serves to prevent a hazard that might result from conditions of abnormal operation of the heater.

Compressor unit – An assembly that includes one or more compressors with associated controls and wiring. A compressor unit may be intended for field connection to a remote evaporator, which may be an integral part of other refrigeration equipment, and to a remote condenser. Operation may include reverse cycle mode.

Compressor evaporator unit – An assembly that includes one or more compressors and evaporators, with associated controls and wiring, and which are intended for field connection to a remote condenser.

Computer room air conditoner (CRAC) – An air-cooled or water-cooled, special purpose air conditioner, factory assembled as a portable package, which is a self-contained combination of cooling and optional heating components. This equipment is intended to provide supplemental cooling only for Information Technology Equipment (ITE) and may contain network connections to ITE. It is intended to condition a single equipment room or space. It may contain condenser intake/exhaust grill(s) or separate ducts; and contain return air plenum with duct(s), filter, or grill(s) but is not designed for connection to an HVAC system.

In the US, this equipment is to be installed in accordance with Article 645 of NFPA 70 (National Electrical Code).

Condenser, forced-air cooled – An assembly that includes an air-cooled condenser and one or more electric motor-driven fans or blowers to circulate air through the condenser coil.

Condensing unit – An assembly that includes one or more compressors and condensers with interconnecting refrigerant piping and associated controls and wiring. A condensing unit may be intended for field connection to a remote evaporator, which may be an integral part of other refrigeration or air-conditioning equipment. Operation may include reverse cycle mode.

Control, auxiliary – A device or assembly of devices that provides a functional utility, is not relied upon as an operational or protective control, and therefore is not relied upon for safety. For example, an efficiency

control not relied upon to reduce the risk of electric shock, fire, or injury to persons during normal or abnormal operation of the end product is considered an auxiliary control.

Control, manual – A device that requires direct human interaction to activate or reset the control.

Control, operating – A device or assembly of devices, the operation of which starts or regulates the end product during normal operation. For example, an electronic motor on/off control, the failure of which another layer of protection (e,g, a warning marking on a motorized brush) would reduce the risk of electric shock, fire, or injury to persons, is considered an operating control.

Control, protective – A device or assembly of devices, the operation of which is intended to reduce the risk of electric shock, fire or injury to persons during normal and reasonably anticipated abnormal operation of the appliance. For example, a motor overload protector or a thermal cutout/limiter, or any other control/circuit relied upon for normal and abnormal conditions, is considered a protective control. During the evaluation of the protective control / circuit, the protective functions are verified under normal and single-fault conditions of the control.

Control, type 1 action – The actuation of an automatic control for which the manufacturing deviation and the drift (tolerance before and after certain conditions) of its operating value, operating time, or operating sequence has not been declared and tested under this standard.

Control, type 2 action – The actuation of an automatic control for which the manufacturing deviation and the drift (tolerance before and after certain conditions) of its operating value, operating time, or operating sequence have been declared and tested under this standard.

Converter – A device that accepts ac or dc power input and converts it to another form of ac or dc power.

Coolant distribution equipment – Air or water-cooled equipment that is factory assembled and consists of a coolant distribution (pumping) unit and separate evaporator (air conditioner) units intended to service a single ITE equipment rack. The pumping unit is intended for connection to a dedicated branch circuit. This equipment is not provided with a hermetic refrigerant motor-compressor and not designed for connection to an HVAC system that serves other occupancies. The equipment may contain network connections, condenser intake/exhaust grill(s) or separate ducts; and return air plenum with duct(s), filter, or grill(s).

In the US, this equipment is dedicated solely for Information Technology Equipment use and intended to be located only within a single ITE room that is separated from other areas of occupancy in accordance with NFPA 70, Article 645.

Design pressure – The maximum allowable working pressure for which a specific part of a system or the unit is designed.

Desuperheater – Factory-assembled equipment in which the flows of refrigerant vapour and water are maintained in such heat transfer relationship that the refrigerant vapour is desuperheated and the water is heated. Normally it consists of a heat exchanger, water pump, and associated controls, but without a self-contained refrigerating system.

Downflow unit – A forced air unit so designed that the air to be heated is forced vertically downward through the equipment heating compartment and discharged through the equipment base.

Enclosure – That part that houses electrical components, internal wiring, and uninsulated hazardous voltage live parts.

Flash gas bypass valve – Regulates the removal of gas from the flash gas tank for compression.

Flash gas tank – Supercritical gas after cooling in gas cooler is throttled to subcritical region and enters this device whose function is to separate the vapor and supply liquid to evaporators for further expansion.

Functional part – A part other than an enclosure, cabinet, or structural part but which is necessary for the intended operation of the unit (for example, fan blade, etc.)

Gas cooler – A heat exchanger designed to remove heat from a transcritical system.

Guard – That part of the cabinet, which, while permitting the passage of air, prevents contact with moving or electrical parts. Guards may also protect users from exposure to Ultraviolet (UV) radiation from lamps.

Heater assembly – A complete or partial assembly of the heating element, electrical insulation (for example, refractory or mica), metal sheath, thermal insulation, and frame or adaptor for holding the assembly together and fastening it in the heater enclosure; and leads and terminal connections, or both.

Heating element – The electrical conducting medium that is intended to be heated by an electric current.

Heat exchanger – A device specifically designed to transfer heat between two physically separated fluids.

Heat exchanger, double wall – A heat exchanger that has two distinct thicknesses of material separating any liquid or fluid from the heat transfer fluid.

Heat exchanger, single wall – A heat exchanger with only one distinct thickness of material separating any liquid or fluid from the heat transfer fluid.

Heat pump water heater – Factory-assembled equipment in which a self-contained refrigerating system is employed to transfer heat into water. The condenser provides the heat, while the evaporator is arranged to pick up heat from the air.

Heater guard – That part of the enclosure provided to prevent accidental contact with the heater assembly, or to prevent debris from falling on the heater assembly.

Heat recovery unit – A system used in conjunction with air conditioning or refrigeration equipment for the purpose of extracting heat from the refrigerant to heat potable water. These products include a heat exchanger, water temperature control components and may also include additional components such as hot water storage tanks, electric heaters and water circulating pumps. These products differ from heat pump water heaters in that they do not utilize a self-contained refrigeration system, but rather use heat from an external (remotely located) refrigeration or air conditioning system to heat the water by way of a heat exchanger.

High side – That part of a refrigerating system subject to condenser or gas cooler pressure.

Horizontal unit – A forced-air unit intended for installation in a horizontal position, and with the heater casing located in the same horizontal plane as the air-circulating blower compartment.

Interactive system – A solar photovoltaic system providing power to a utilization load and operating in parallel with, and may deliver power to, an electrical production and distribution network.

Intermediate Pressure Stage – An intermediate pressure stage on CO_2 transcritical systems that lays between the highside and lowside pressure stages. This intermediate pressure range may be regulated by a flash gas bypass valve and this stage may include a flash gas tank and gas cooler.

Lampholder – A wiring device intended for making connection to the electrical circuits of a lamp and, in some cases, providing support.

Low side – That part of a refrigerating system subject to evaporator pressure.

Maximum Operating Current (MOC) – MOC is marked instead of motor FLA on air-conditioning and refrigerating equipment having adjustable speed drives or drive systems. MOC is the current resulting when an electric motor and adjustable speed drive or drive system are operated under any conditions such as maximum speed/maximum load, maximum speed/minimum load, minimum speed/minimum load, minimum speed/maximum load, including locked-rotor such that current to the motor/adjustable speed drive or drive system is at a maximum. The MOC is the current at the input of the adjustable speed drive.

Maximum Rated Current (MRC) – MRC is marked instead of motor-compressor RLA and LRA on equipment having adjustable speed drives or drive systems. MRC is the current resulting when a hermetic refrigerant motor-compressor and adjustable speed drive or drive system are operated under any conditions such as maximum speed/maximum load, maximum speed/minimum load, minimum speed/minimum load, minimum speed/maximum load, including locked-rotor such that current to the motor-compressor/adjustable speed drive or drive system is at a maximum . The MRC is the current at the input of the adjustable speed drive. The test conditions to determine the MRC are found in Annex AA of UL 60335-2-34 or CAN/CSA C22.2 No. 60335-2-34.

Media wheel – Non metallic device that transfers energy from one air stream to another air stream.

Multi-circuit unit – An assembly intended primarily for refrigeration applications that includes multiple condensing units, compressor units, or compressors, with single or multiple condensers, with associated piping, controls, and wiring, mounted on a common frame or in a common housing. A multi-circuit unit may be intended for field connection to remote evaporators that form multiple refrigeration or air-conditioning systems.

Photovoltaic (PV) cell – The basic photovoltaic device that generates electricity when exposed to sunlight.

Photovoltaic (PV) inverter – Equipment that is used to change the voltage level or waveform, or both, of electrical energy. Typically changes dc input to an ac output.

Photovoltaic (PV) module – A complete, environmentally protected unit consisting of solar cells, optics, and other components, exclusive of a solar tracker mechanism, designed to generate dc power when exposed to sunlight.

Piping – The pipe or tube mains for interconnecting the various parts of a refrigerating system. Piping includes pipe, flanges, bolting, gaskets, valves, fittings, the pressure-containing parts of other components such as expansion joints, strainers, and devices that serve such purposes as mixing, separating, snubbing, distributing, metering, or controlling flow, pipe-supporting fixtures, and structural attachments.

Plenum – A chamber associated with air-handling apparatus, for distributing the processed air from the apparatus (outlet plenum) to the outlet ducts, or for receiving air to be processed by the apparatus (return plenum).

Potable water – Water intended for human consumption.

Pressure-limiting device – A mechanism that automatically responds to a predetermined pressure by stopping the operation of the pressure-imposing element.

Pressure relief device – A pressure (not temperature)-actuated valve or rupture member that functions to relieve excessive pressure automatically. A hermetic compressor's internal pressure relief valve is not considered a pressure relief device.

Pressure-regulating relief valve – Similar to a pressure-relief valve except specifically intended for use with refrigeration systems utilizing carbon dioxide (R744) as the refrigerant in a secondary loop or cascade system. The pressure-relief setting of this valve is always lower than the relief setting of a pressure-relief valve. This valve may open and re-close many times during the life of the system.

Pressure-relief valve – A pressure-actuated valve held closed by a spring or other means and designed to automatically relieve pressure in excess of its setting.

Pressure vessel – A closed vessel, used for containing, storing, distributing, transferring, distilling, processing, or otherwise handling any gas, vapour, or liquid under pressure and as further defined in CSA B52 and ANSI/ASHRAE 15.

Rooftop equipment – Horizontally-mounted, downflow or horizontal flow equipment, or similar equipment intended to be installed on rooftops; and equipped with means for attaching pipes or ducts for the distribution of the conditioned air.

Secondary loop – A piping circuit containing a fluid circulating within the circuit. The fluid transfers heat from a remote-type refrigerator to a colder heat exchanger located within the circuit. The circuit normally includes a circulating pump as well as other associated fittings. Such a circuit is considered to be equivalent to the low-side parts that are located in a refrigeration system.

Self-contained unit – A complete factory-made and factory-tested unit, in a suitable frame or enclosure, that is fabricated and shipped in one or more sections, and has no refrigerant-containing parts connected in the field other than by companion or block valves.

Solar photovoltaic (PV) system – The total components and subsystems that, in combination, convert solar energy into electric energy suitable for connection to a utilization load.

Stand-alone system – A solar photovoltaic system that supplies power independently of an electrical production and distribution network.

Start-to-discharge pressure – The pressure at which a relief valve begins to discharge, typically the pressure where the first bubbles can be seen when a valve is immersed in water.

Structural part – A part other than an enclosure or cabinet used in such a manner that failure of the part may present risk of electric shock or personal injury (for example, motor mount, etc).

Temperature-limiting thermostat – A thermostat that functions only under conditions that produce abnormal temperatures. The failure of such a thermostat might result in a hazard.

Temperature-regulating thermostat – A thermostat that functions only to regulate the temperature under normal conditions of use, the failure of which would not result in a hazard.

Transcritical system – A refrigeration system where evaporation occurs in the subcritical region and heat rejection may occur above the critical point of the refrigerant (e.g. R-744).

Ultimate strength – The highest stress level that the refrigeration component or vessel can tolerate without rupture.

Ultraviolet (UV) Lamp – Equipment that directly generates ultraviolet radiation typically used to supplement the normal unit air filters for enhanced air purification and surface cleaning. For the purpose of the standard, UV lamp systems are divided into 3 categories and are defined below:

a) **Factory Installed** – A UV lamp system that is located within the unit (integral) and installed at the factory. For the purpose of these requirements the term “within the unit” includes all space within the area between inlet and outlet air side of the heating and cooling unit including the area housing the evaporator coil if mounted directly on the unit.

b) **Field Installed** – A factory designated UV lamp system that is located within the unit (integral) and field installed per the manufactures procedures. For the purpose of these requirements the term “within the unit” includes all within the area between inlet and outlet side of the heating and cooling unit including the area housing the evaporator coil if mounted directly on the unit.

c) **Non Integral Field Installed** – A duct mounted UV lamp system that is not integral to the unit. For the purpose of these requirements, the term “non integral” refers to all areas of the ductwork that is outside of the heating and cooling unit inlet and outlet excluding the area housing the evaporator coil if mounted directly on the unit.

Unitary heat pump (or equipment) – A device for circulating, filtering, heating, or heating and cooling the air, that consists of one or more factory-made matched assemblies, which normally include an indoor coil, compressor(s), and an outdoor coil or chiller/condenser, and an electric resistance heater package with controls for automatic heating or cooling functions.

Upflow unit – A forced-air unit intended for installation in a vertical position; and with the heater casing located above the air-circulating blower compartment.

UV-C Irradiance – For the purpose of this standard UV-C irradiance is the effective irradiance (E_{eff} = $\mu W/cm^2$). Effective irradiance is the absolute irradiance that has been weighted against the spectral effectiveness curve (S_λ) for ultraviolet (UV) radiation as denoted in the current edition of the ACGIH TLVs and BEIs. For the purposes of this standard, UV-C lamps are limited to the low pressure florescent type construction with a predominate output of 254 nm.

3 Reference publications

3.1 Where reference is made to any Standards (see Clauses 90 and 92) such reference shall be considered to refer to the latest editions and revisions thereto available at the time of printing, unless otherwise specified. Also, except as indicated in Clause 3.2, a component of a product covered by this Standard shall comply with all the requirements for that component.

3.2 A component of a product covered by this standard shall comply with the following in (a) – (f). Specific components are accepted as being incomplete in construction features, or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as temperatures not exceeding specified limits, and shall be used only under those specified conditions for which they have been investigated.

a) Comply with the requirements for that component as indicated in Clauses 3.9 – 3.17;

b) Be used in accordance with its rating(s) established for the intended conditions of use;

c) Be used within its established use limitations or conditions of acceptability;

d) Comply with both the Underwriters Laboratories Inc. and the CSA Group standard for the component;

e) Additionally comply with the applicable requirements of this end product standard; and

f) Not contain mercury.

3.3 A component of a product covered by this standard is not required to comply with a specific component requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product,

b) Is superseded by a requirement in this end product standard, or

c) Is separately investigated when forming part of another component, provided the component is used within its established ratings and limitations.

3.4 A component that complies with a component standard other than those specified in Clauses 3.9 – 3.17 is acceptable if:

a) The component also complies with the applicable component standard of Clauses 3.9 – 3.17; or

b) The component standard:

1) Is compatible with the ampacity and overcurrent protection requirements of the Canadian Electrical Code, Part I, C22.1 in Canada, and the National Electric Code, NFPA 70 in the US, where appropriate;

2) Considers long-term thermal properties of polymeric insulating materials in accordance the Standard for Evaluations of Properties of Polymeric Materials, C22.2 No. 0.17 and the Standard for Polymeric Materials - Long Term Property Evaluations, UL 746B; and

3) Any use limitations of the other component standard are identified and appropriately accommodated in the end use application. For example, a component used in a household application, but intended for industrial use and complying with the relevant component standard may assume user expertise not common in household applications.

3.5 A component that is also intended to perform other functions, such as over current protection, ground-fault circuit-interruption, surge suppression, any other similar functions, or any combination thereof, shall comply additionally with the requirements of the applicable CSA Group and UL standard(s) that cover devices that provide those functions.

3.6 Where these other functions are not required for the application and not identified as part of markings, instructions, or packaging for the appliance, the additional component standard(s) need not be applied.

3.7 A component not anticipated by the requirements of this end product standard, not specifically covered by the component standards in Clauses 3.9 – 3.17, and that involves a risk of electric shock, fire, or personal injury, shall be additionally investigated in accordance with the applicable CSA Group and UL standard, and shall comply with Clause 3.2 (b) – (f).

3.8 With regard to a component being additionally investigated per Clause 3.7, reference to construction and performance requirements in another CSA Group and UL end product standard is appropriate where that standard anticipates normal and abnormal use conditions consistent with the application of this end product standard.

3.9 Attachment plugs, receptacles, connectors, and terminals

3.9.1 Attachment plugs, receptacles, shall comply with the Standard for General Use Receptacles, Attachment Plugs, and Similar Wiring Devices, C22.2 No. 42 and the Standard for Attachment Plugs and Receptacles, UL 498.

3.9.2 Attachment plugs integral to cord sets or power supply cords are investigated in accordance with the requirements of the Standard for Cord Sets and Power Supply Cords, C22.2 No. 21 and the Standard for Cord Sets and Power Supply Cords, UL 817, and need not comply with the Standard for General Use Receptacles, Attachment Plugs, and Similar Wiring Devices, C22.2 No. 42 and the Standard for Attachment Plugs and Receptacles, UL 498.

3.9.3 Quick-connect terminals, both connectors and tabs, for use with one or two 0.34 – 5.3 mm^2 (22 – 10 AWG) copper conductors, having nominal widths of 2.8, 3.2, 4.8, 5.2, and 6.3 mm (0.110, 0.125, 0.187, 0.205, and 0.250 in), intended for internal wiring connections in appliances, or for the field termination of conductors to the appliance, shall comply with the Standard for Quick-Connect Terminals, C22.2 No. 153 and the Standard for Electrical Quick-Connect Terminals, UL 310.

3.9.4 Other sizes of quick-connect terminals shall be investigated with respect to crimp pull out, insertion-withdrawal, temperature rise, and all tests shall be conducted in accordance with the Standard for Quick-Connect Terminals, C22.2 No. 153 and the Standard for Electrical Quick-Connect Terminals, UL 310.

3.9.5 Wire connectors shall comply with the Standard for Wire Connectors, C22.2 No. 65 and the Standard for Wire Connectors, UL 486A-486B.

3.9.6 Splicing wire connectors shall comply with the Standard for Splicing Wire Connectors, C22.2 No. 188 and the Standard for Splicing Wire Connectors, UL 486C.

3.9.7 Equipment wiring terminals for use with all alloys of copper, aluminum, or copper-clad aluminum conductors, shall comply with the Standard for Terminal Blocks, C22.2 No. 158 and the Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E.

3.9.8 Terminal blocks shall comply with the Standard for Terminal Blocks, C22.2 No. 158 and the Standard for Terminal Blocks, UL 1059, and if applicable, be suitably rated for field wiring.

3.10 Controls

3.10.1 General

3.10.1.1 Operating (regulating) controls, the failure of which would increase the risk of electric shock, fire, or personal injury, shall be evaluated using the applicable component standard requirements specified in Clauses 3.10.1 – 3.10.5, and if applicable, the requirements in Controls – End product Test Parameters, Clause 90, unless otherwise specified in this end product standard.

3.10.1.2 With reference to Clause 3.10.1.1, operating controls that rely upon software for the normal operation of the end product where deviation or drift of the operating parameters of the control may result in an increased risk of electric shock, fire, or injury to persons, shall comply with:

a) The Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991 and the Standard for Software in Programmable Components, UL 1998 and C22.2 No. 08 and CSA-ISO/IEC 16085; or

b) The Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, E60730-1 and the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1.

3.10.1.3 Solid-state protective (limiting) controls shall be evaluated using the applicable component standard requirements specified in Clauses 3.10.1 – 3.10.4, and if applicable, the parameters in Clause 90, unless otherwise specified in this end product standard.

3.10.1.4 With reference to Clause 3.10.1.3, protective controls that do not rely upon software as a protective component shall comply with:

a) The Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991 and C22.2 No. 08; or

b) The Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, E60730-1 and the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1, except Controls Using Software.

3.10.1.5 With reference to Clause 3.10.1.3, protective controls that rely upon software as a protective component shall comply with:

a) The Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991 and the Standard for Software in Programmable Components, UL 1998 and CSA22.2 No.08 and CSA-ISO/IEC 16085 or

b) The Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, E60730-1 and the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1.

3.10.2 Liquid level controls

3.10.2.1 A liquid level control shall comply with:

a) The Standard for Industrial Control Equipment, C22.2 No. 14 and the Standard for Solid-State Controls for Appliances, UL 244A;

b) The Standard for Temperature-Indicating and Regulating Equipment, C22.2 No. 24 and the Standard for Temperature-Indicating and -Regulating Equipment, UL 873;

c) The Standard for Industrial Control Equipment, C22.2 No. 14 and the Standard for Industrial Control Equipment, UL 508; or

d) The Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, E60730-1 and the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1, and:

1) The Standard for Automatic Electrical Controls for Household and Similar Use, Part 2: Particular Requirements for Automatic Electrical Air Flow, Water Flow, and Water Level Sensing, E60730-2-15 and the Standard for Automatic Electrical Controls for Household and Similar Use, Part 2: Particular Requirements for Automatic Electrical Water Level Controls of the Float Type for Household and Similar Applications, UL 60730-2-16A; or

2) The Standard for Automatic Electrical Controls for Household and Similar Use, Part 2: Particular Requirements for Automatic Electrical Air Flow, Water Flow, and Water Level Sensing, E60730-2-15 and the Standard for Automatic Electrical Controls for Household and Similar Use, Part 2: Particular Requirements for Automatic Electrical Water and Air Flow Sensing Controls, Including Mechanical Requirements, UL 60730-2-18.

3.10.3 Motor and speed controls

3.10.3.1 A control used to start, stop, regulate or control the speed of a motor shall comply with:

a) The Standard for Solid-State Speed Controls, C22.2 No. 156 and the Standard for Solid-State Controls for Appliances, UL 244A;

b) The Standard for Temperature-Indicating and Regulating Equipment, C22.2 No. 24 and the Standard for Temperature-Indicating and -Regulating Equipment, UL 873;

c) The Standard for Industrial Control Equipment, C22.2 No. 14 and the Standard for Industrial Control Equipment, UL 508;

d) The Standard for Industrial Control Equipment, C22.2 No. 14 and the Standard for Power Conversion Equipment, UL 508C; or

e) The Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, E60730-1 and the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1.

3.10.4 Pressure controls

3.10.4.1 A pressure control shall comply with:

a) The Standard for Temperature-Indicating and Regulating Equipment, C22.2 No. 24 and the Standard for Temperature-Indicating and -Regulating Equipment, UL 873;

b) The Standard for Industrial Control Equipment, C22.2 No. 14 and the Standard for Industrial Control Equipment, UL 508; or

c) The Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, E60730-1 and the Standard for Automatic Electrical Controls for Household and Similar Use, Part 2: Particular Requirements for Automatic Electrical Pressure Sensing Controls Including Mechanical Requirements, E730-2-6; and the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1 and the Standard for Automatic Electrical Controls for Household and Similar Use, Part 2: Particular Requirements for Automatic Electrical Pressure Sensing Controls Including Mechanical Requirements, UL 60730-2-6.

3.10.5 Temperature controls

3.10.5.1 A temperature control shall comply with:

a) The Standard for Temperature-Indicating and Regulating Equipment, C22.2 No. 24 and the Standard for Solid-State Controls for Appliances, UL 244A;

b) The Standard for Temperature-Indicating and Regulating Equipment, C22.2 No. 24 and the Standard for Temperature-Indicating and -Regulating Equipment, UL 873;

c) The Standard for Industrial Control Equipment, C22.2 No. 14 and the Standard for Industrial Control Equipment, UL 508; or

d) The Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, E60730-1 and the Standard for Automatic Electrical Controls for Household and Similar Use, Part 2: Particular Requirements for Temperature Sensing Controls, E60730-2-9; and the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General

Requirements, UL 60730-1 and the Standard for Automatic Electrical Controls for Household and Similar Use, Part 2: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9.

3.10.5.2 A temperature sensing positive temperature coefficient (PTC) or negative temperature coefficient (NTC) thermistor, that performs the same function as an operating or protective control shall comply with the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, E60730-1, the Annex for Requirements for Controls Using Thermistors, and the Standard for Thermistor-Type Devices, UL 1434.

3.10.5.3 A thermal cutoff shall comply with the Standard for Thermal-Links, Requirements and Application Guide, E60691 and the Standard for Thermal-Links, Requirements and Application Guide, UL 60691.

3.10.6 Timer controls

3.10.6.1 A timer control shall comply with:

a) The Standard for Industrial Control Equipment, C22.2 No. 14 and the Standard for Solid-State Controls for Appliances, UL 244A; or

b) The Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, E60730-1 and the Standard for Automatic Electrical Controls for Household and Similar Use, Part 2: Particular Requirements for Timers and Time Switches, E730-2-7; and the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1 and the Standard for Automatic Electrical Controls for Household and Similar Use, Part 2: Particular Requirements for Timers and Time Switches, UL 60730-2-7.

3.10.7 Electrically Operated valves

3.10.7.1 Electrically operated general purpose and safety valves intended for the control of fluids, such as air, gases, oils, refrigerants, steam, or water shall comply with the Standard for Electrically Operated Valves, UL 429 or Standard for Automatic Electrical Controls for Household and Similar Use, Part 2: Particular Requirements for Electrically Operated Water Valves, Including Mechanical Requirements, UL 60730-2-8 and Standard for Electrically Operated Valves, C22.2 No. 139 or Standard for Automatic Electrical Controls for Household and Similar Use, Part 2: Particular Requirements for Electrically Operated Water Valves, Including Mechanical Requirements, CSA E60730-2-8.

3.11 Cords, cables, and internal wiring

3.11.1 A cord set or power supply cord shall comply with the Standard for Cord Sets and Power Supply Cords, C22.2 No. 21, and the Standard for Cord Sets and Power Supply Cords, UL 817.

3.11.2 Flexible cords and cables shall comply with the Standard for Flexible Cords and Cables, C22.2 No. 49, and the Standard for Flexible Cord and Cables, UL 62. Flexible cord and cables are considered to comply with this requirement when preassembled in a cord set or power supply cord complying with the Standard for Cord Sets and Power Supply Cords, C22.2 No. 21 and the Standard for Cord Sets and Power Supply Cords, UL 817.

3.11.3 Internal wiring composed of insulated conductors shall comply with the Standard for Equipment and Lead Wires , C22.2 No. 127 or the Standard for Appliance Wiring Material Products, C22.2 No. 210 and the Standard for Appliance Wiring Material, UL 758.

3.11.4 Insulated conductors need not comply with the above reference standards if they comply with:

a) The Standard for Thermoset-Insulated Wires and Cables, C22.2 No. 38 and the Standard for Thermoset-Insulated Wires and Cables, UL 44; or

b) The Standard for Thermoplastic-Insulated Wires and Cables, C22.2 No. 75 and the Standard for Thermoplastic-Insulated Wires and Cables, UL 83; or

c) The Standard for Flexible Cords and Cables, C22.2 No. 49 and the Standard for Flexible Cords and Cables, UL 62; or

d) The applicable CSA Group and UL standard(s) for other insulated conductor types specified in the Canadian Electrical Code, Part I, C22.1 Wiring Methods, and the National Electric Code, NFPA 70, Wiring Methods and Materials.

3.11.5 Insulated conductors for specialty applications (e.g. data processing or communications) and located in a low-voltage circuit not involving the risk of fire or personal injury need not comply with the Standard for Equipment and Lead Wires, C22.2 No. 127 or the Standard for Standard for Appliance Wiring Material Products, C22.2 No. 210 and the Standard for Appliance Wiring Material, UL 758.

3.12 Light sources and associated components

3.12.1 Lampholders and indicating lamps shall comply with the Standard for Lampholders, C22.2 No. 43 and the Standard for Lampholders, UL 496.

3.12.2 Lampholders forming part of a luminaire that complies with the applicable CSA Group and UL luminaire standard are considered to comply with this requirement.

3.13 Marking and labeling systems

3.13.1 A marking and labeling system shall comply with the Standard for Adhesive Labels, C22.2 No. 0.15 and the Standard for Marking and Labelling Systems, UL 969 under the specified environmental conditions.

3.14 Power supplies

3.14.1 A Class 2 power supply shall comply with:

a) The Standard for Power Supplies with Extra-Low-Voltage Class 2 Outputs, C22.2 No. 223 and the Standard for Class 2 Power Units, UL 1310; or

b) The Standard for Information Technology Equipment, C22.2 No. 60950-1 and the Standard for Information Technology Equipment, UL 60950-1, with an output marked "Class 2", or that complies with the limited power source (LPS) requirements and is marked "LPS".

3.14.2 A non-Class 2 power supply shall comply with:

a) The Standard for General-Use Power Supplies, C22.2 No. 107.1, and the Standard for Power Units Other Than Class 2, UL 1012; or

b) The Standard for Information Technology Equipment, C22.2 No. 60950-1 and the Standard for Information Technology Equipment, UL 60950-1.

3.15 Printed wiring boards

3.15.1 Printed wiring boards, including the coatings, shall comply with the Standard for Evaluation of Properties of Polymeric Materials, C22.2 No. 0.17 and the Standard for Printed Wiring Boards, UL 796.

3.15.2 A printed-wiring board in an extra-low voltage, nonsafety circuit is not required to comply with the bonding requirements in the Standard for Evaluation of Properties of Polymeric Materials, C22.2 No. 0.17 and the Standard for Printed Wiring Boards, UL 796 if the board is separated from parts of other circuits such that loosening of the bond between the foil conductor and the base material will not result in the foil conductors or components coming in contact with parts of other circuits of the control or of the end-use product.

3.15.3 A printed-wiring board containing circuitry in a line-connected circuit or a safety circuit shall comply with the direct-support requirements for insulating materials in the Standard for Evaluation of Properties of Polymeric Materials, C22.2 No. 0.17 and the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

3.15.4 Unless otherwise specified, the flammability class and temperature rating shall be that specified for insulating materials in the Standard for Evaluation of Properties of Polymeric Materials, C22.2 No. 0.17 and the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

3.16 Switches

3.16.1 A clock-operated switch, in which the switching contacts are actuated by a clock-work, by a gear-train, by electrically-wound spring motors, by electric clock-type motors, or by equivalent arrangements shall comply with:

a) The Standard for Clock-Operated Switches, C22.2 No. 177 and the Standard for Clock-Operated Switches, UL 917; or

b) The Standard for Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, E60730-1 and the Standard for Automatic Electrical Controls for Household and Similar Use, Part 2: Particular Requirements for Timers and Time Switches, E730-2-7; and the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1 and the Standard for Automatic Electrical Controls for Household and Similar Use, Part 2: Particular Requirements for Timers and Time Switches, UL 60730-2-7.

3.16.2 Enclosed and dead-front switches shall comply with the Standard for Enclosed and Dead-Front Switches C22.2 No. 4-04 and the Standard Switches, Enclosed and Dead-Front UL 98.

3.17 Transformers

3.17.1 General-purpose transformers shall comply with the Standard for Low-Voltage Transformers – Part 1: General Requirements, C22.2 No. 66-1 and the Standard for Low-Voltage Transformers – Part 2: General Purpose Transformers, C22.2 No. 66-2, and the Standard for Low-Voltage Transformers – Part 1: General Requirements, UL 5085-1 and the Standard for Low-Voltage Transformers – Part 2: General Purpose Transformers, UL 5085-2.

3.17.2 Class 2 and Class 3 transformers shall comply with the Standard for Low-Voltage Transformers – Part 1: General Requirements, C22.2 No. 66-1 and the Standard for Low-Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, C22.2 No. 66-3, and the Standard for Low-Voltage Transformers – Part 1: General Requirements, UL 5085-1 and the Standard for Low-Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3.

3.17.3 Specialty transformers shall comply with the Standard for Transformers, Specialty UL 506 and CSA C22.2 No. 13 Transformers for oil-or gas-burner ignition equipment.

4 Installation and operating instructions

4.1 A copy of the installation and operating instructions intended to accompany each unit or component, or equivalent information, shall be included in the examination and test of the equipment. For this purpose, a draft, rather than a printed edition, is acceptable.

4.2 If a unit containing an indoor coil has no provision for connecting a return air duct, or if the instructions indicate that a return air duct need not be used, the instructions may indicate that applicable installation codes can limit this unit to installation only in a single story residence.

4.3 Applicable installation codes or CSA C22.1 or ANSI/NFPA No. 70 can limit the number of field wiring system connections. See Connection to Power Supply, Clause 17 of this Standard.

4.4 Equipment intended to utilize carbon dioxide (R744) in a secondary loop, cascade, or transcritial system and required to include pressure regulating relief valves per item (a) of Clause 34.32 shall provide instructions indicating that:

a) if the system is de-energized, venting of the R744 through the pressure-regulating relief valves on the equipment can occur. In such cases, the system might need to be recharged with R744, but in any case, the pressure-regulating relief valve(s) shall not be defeated or capped. The relief setting shall not be altered.

b) a sufficient number of pressure-relief and pressure-regulating relief valves may need to be provided based on the system capacity and located such that no stop valve is provided between the relief valves and the parts or section of the system being protected.

c) if the equipment contains a pressure vessel but the pressure-regulating and -relief valves are not installed as part of the equipment as permitted by Clauses 34.33 and 34.34, the instructions shall specify:

1) the method for installing the valves within the fittings, and

2) that the equipment must be provided with an adequate number of pressure regulating and relief valves based on the system capacity and located such that no stop valve(s) are provided between the relief valve(s) and the parts or section of the system being protected.

4.5 The instructions for heating and cooling equipment employing a solar PV system or subsystems thereof shall identify the major PV system components and shall describe the intended installation, including appropriate reference to installation requirements of Article 690 of NFPA 70 and Section 50 of the CEC C22.1.

4.6 The required markings specified in Clause 45.17 shall be repeated in the instructions.

4.7 Equipment intended to employ Ultraviolet (UV) radiation lamp systems shall provide instructions that:

a) Repeats the required markings of Clauses 44.3 (z1), 44.3 (z2) and 45.17.

b) Provides information for replacement of the lamps to include wattage, model and/or part number.

c) Provide instructions for the installation of field installed factory designated UV lamp systems that are integral to the system.

4.8 A heat recovery unit shall be provided with instructions indicating:

a) the types of air conditioning or refrigeration systems for which it is intended; and,

b) the method for interconnecting the heat recovery unit with the intended air conditioning or refrigeration equipment.

4.9 In reference to 4.7(b), the instructions shall include the method for interconnecting the water piping and hot water storage tank, if applicable, and for making electrical connections.

CONSTRUCTION

5 Enclosures

5.1 Enclosures for electrical equipment shall be so formed and assembled that, if abused during shipment, installation, or use, they will have the strength and rigidity to resist such abuses without increasing their fire and accident hazards due to a total or partial collapse that could result in a reduction of spacings, a loosening or displacement of parts, or any other defect.

5.2 Enclosures for individual electrical components and wiring, outer enclosures, and combinations of the two, shall be considered in determining compliance with the requirements of Clause 5.1.

5.3 Among the factors to be used in determining the acceptability of an enclosure are

a) physical strength;

b) resistance to impact;

c) moisture-absorptive properties;

d) flammability;

e) resistance to corrosion; and

f) resistance to distortion or melting caused by the temperatures that may be expected under conditions of anticipated use or by electrical disturbances within.

5.4 Polymeric enclosures shall be considered to comply with Clause 5.3, provided that

a) They comply with tests specified in CAN/CSA-C22.2 No. 0.17 and UL 746C, and

b) They have temperature ratings not less than the maximum temperatures to which they may be exposed during normal operation, and

c) They are suitable for exposure to UV-C radiation. The enclosure material must be suitable for the measured UV-C irradiance levels as stated in Clause 89.1.

Enclosures need not comply with Clause 5.10.

5.5 Polymeric materials not used as enclosures shall comply with Clause 5.10.

5.6 A sheet metal enclosure shall be evaluated with respect to its size, shape, metal thickness, and use in a particular application. Sheet steel having a thickness of less than 0.51 mm (0.020 in) if uncoated or 0.58 mm (0.023 in) if galvanized, or nonferrous sheet metal having a thickness of less than 0.58 mm (0.023 in) are not acceptable, except for relatively small areas or for surfaces that are curved or corrugated, or otherwise reinforced such as by angles, channels, flanges, or ribs.

5.7 The enclosure of a unit shall be provided with means for mounting in the intended manner. Any special fittings necessary for intended mounting shall be shipped with the unit. A free-standing, floor-

supported unit need not be provided with mounting means. A unit designed for installation in a manufactured (mobile) home shall have provision for permanent mounting.

5.8 An electrical part within the outer cabinet need not be individually enclosed if the assembly complies with all of the following:

a) The construction and location of the part do not permit the emission of flame or molten metal through openings in the outer cabinet, or it can be shown that malfunction of the component does not result in a risk of fire.

b) There are no openings in the bottom of the compartment in which the part is located that permit molten metal or the like to drop onto flammable material. See Clause 20.10 on units for outdoor installation.

c) The part is not near flammable material other than electrical insulation.

d) Sheet metal thickness of the outer cabinet is in compliance with Clause 6.

e) The part is not located in an air-handling compartment.

f) The part is not subject to unintended contact by persons, as specified in Clause 7.

g) There are no openings in the top surface of the outer cabinet that would permit objects to fall on or near uninsulated live parts.

Exception: Motors, electric resistance heating elements, metal-case capacitors, and other similar components that would not emit smoke or components protected to prevent emission of smoke into the air-handling compartment need not be individually enclosed.

5.9 To determine if a product complies with Clause 5.8, all of its intended mounting positions shall be considered. For this purpose an air filter is not considered to be part of the enclosure.

5.10 **Polymeric materials other than enclosures**

General

5.10.1 Polymeric materials or other nonmetallic materials are identified as follows:

a) 5VA,

b) 5VB,

c) V-0,

d) V-1,

e) V-2,

f) HF-1,

g) HF-2,

h) HB, and

i) HBF.

See Table 5.1 for determination of material classifications and uses.

5.10.2 This Clause covers polymeric materials used for cabinets and structural or functional parts.

5.10.3 These requirements do not apply to polymeric materials specified in items (a), (b), (c), and (d) of Clause 18.2.

5.10.4 See Table 46.3 for determination of properties to be evaluated for testing. Unit application shall determine properties to be evaluated.

Isolation From Ignition Sources

5.10.5 Ignition sources within the unit are considered to be insulated or uninsulated live parts such as:

a) hazardous voltage circuit wiring;

b) hazardous voltage electrical components (some examples are; switches, relays, transformer windings, motor windings etc).

5.10.6 Polymeric materials located below an ignition source and within Space A of Figure 5.1 shall be isolated by a barrier extending to the sides of Space A.

5.10.7 Polymeric materials located above an ignition source and within Space B of Figure 5.1 shall be isolated by a barrier and extending to the sides of Space B. This barrier shall be positioned so that a minimum distance of 51 mm (2 in) from hazardous voltage wiring and 102 mm (4 in) from hazardous voltage electrical components is maintained.

5.10.8 Polymeric materials located outside of Space A and/or B shall be isolated by a barrier from the ignition source.

Exception: This barrier may be deleted if the materials are positioned so that a minimum distance of 51 mm (2 in) from hazardous voltage wiring and 102 mm (4 in) from hazardous voltage electrical components is maintained.

5.10.9 Hazardous voltage wiring, in which the flame test, CSA FT-1 and UL VW-1, or the vertical flame test as described in CSA C22.2 No. 49 and UL 1581, is conducted, is considered to comply with Clauses 5.10.6 through 5.10.8 and need not be isolated by the barriers described.

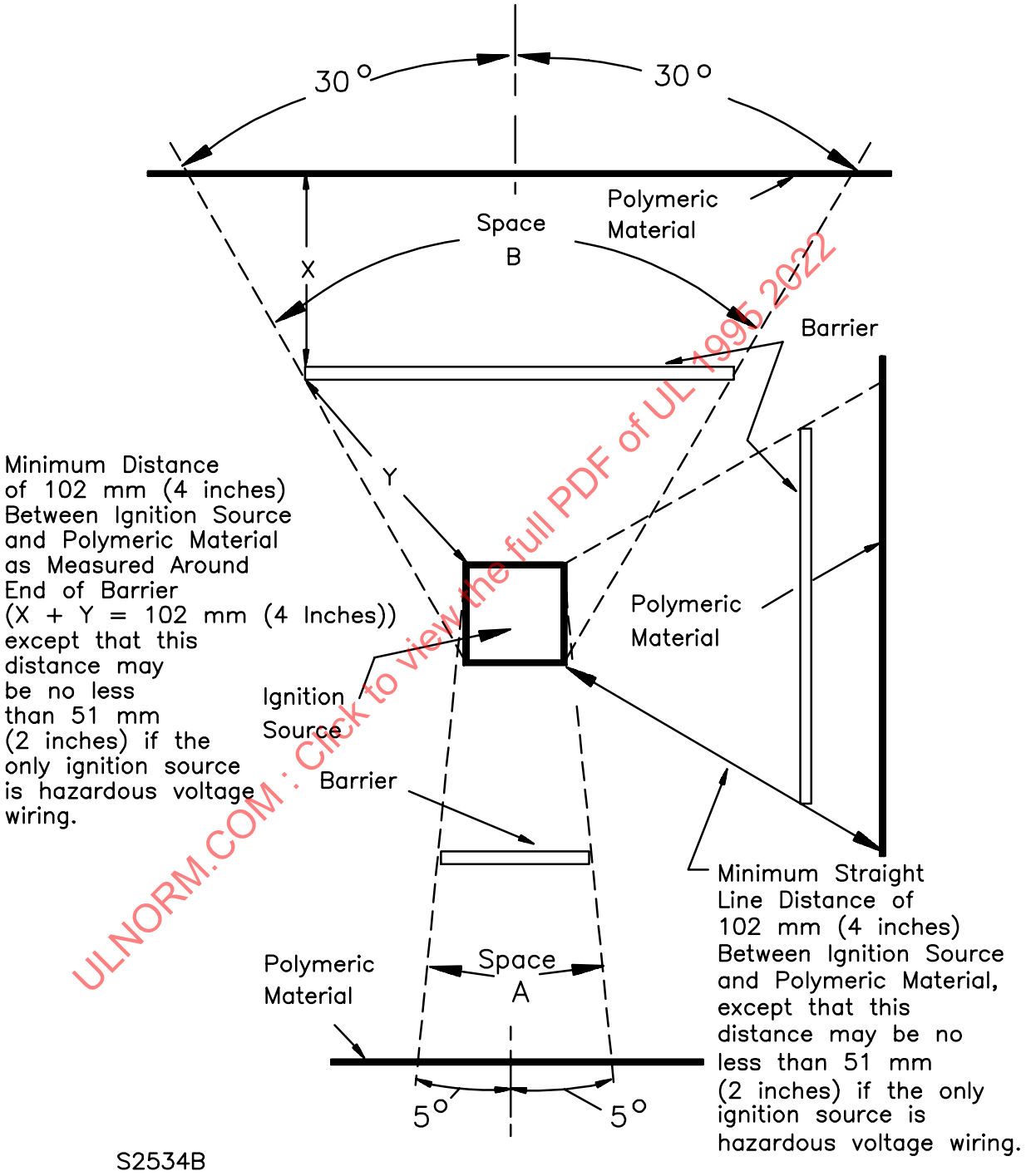
5.10.10 The barriers required in Clauses 5.10.6 through 5.10.8 shall be mechanically secured and:

a) be constructed of metal at least 0.25 mm (0.010 in) thick; or

b) be constructed of polymeric material rated 5VA.

Figure 5.1

Exposure to ignition



Space A represents the volume below the ignition source determined by a straight line that moves about the ignition source while remaining at an angle of 5° from the vertical and is always so oriented that the volume is a maximum.

Space B represents the volume above the ignition source determined in the same manner as Space A, except that the angle is 30° from the vertical.

Table 5.1
Uses of materials based on flammability classifications

Degree of exposure to ignition source	Material flammability rating					
	HB or HBF	HF-1	HF-2	V-2	V-0 or V-1	5VA, 5VB
Not exposed	Yes	Yes	Yes	Yes	Yes	Yes
Exposed, but isolated as shown in Figure 5.1[d]	No[d,e]	No[c,e]	No[a,c,e]	Yes[a]	Yes	Yes
Exposed	No[b]	No[b,c]	No[b,c]	No[b,c,e]	No[b,c,e]	Yes

[a] Shall not be used in Space A illustrated in Figure 5.1 if there are openings in the enclosure bottom in that space.

[b] Vertically oriented material when laminated between two metal surfaces each no less than 0.25 mm (0.010 in) thick can have an exposed vertical surface no more than 9.5 mm (0.75 in) wide.

[c] May be used if the ignition sources are appliance wiring material or flexible cord as listed in Table 20.2, Group B.

[d] *Exception: Materials with a minimum rating of HB or HBF may be used in the outdoor section outside of spaces A and B if the distance between an ignition source and polymeric materials or openings is not less than 102 mm (4 in) and no less than 50.8 mm (2 in) from wiring.*

[e] May be used if at a distance of not less than 610 mm (24 in) from the ignition source, except for directly below (5 deg, Space A) and above (30 deg, Space B).

6 Thickness of sheet metal enclosures for uninsulated live parts

6.1 Sheet metal used in making enclosures shall have a thickness of not less than that specified in Table 6.1 and Table 6.2, except as permitted by Clause 6.4.

Table 6.1
Minimum thickness of sheet metal for electrical enclosures carbon steel or stainless steel

Without supporting frame[a]		With supporting frame or equivalent reinforcing[a]			
Maximum width[b] mm (in)	Maximum length[c] mm (in)	Maximum width[b] mm (in)	Maximum length[c] mm (in)	Minimum thickness of metal uncoated mm (in)	Minimum thickness of metal coated mm (in)
102 (4.0)	Not limited	159 (6.25)	Not limited	0.51 (0.020[d])	0.58 (0.023[d])
121 (4.75)	146 (5.75)	171 (6.75)	210 (8.25)		
152 (6.0)	Not limited	241 (9.5)	Not limited	0.66 (0.026[d])	0.74 (0.029[d])
178 (7.0)	222 (8.75)	254 (10.0)	318 (12.5)		
203 (8.0)	Not limited	305 (12.0)	Not limited	0.81 (0.032)	0.86 (0.034)
229 (9.0)	292 (11.5)	330 (13.0)	406 (16.0)		
318 (12.5)	Not limited	495 (19.5)	Not limited	1.07 (0.042)	1.14 (0.045)
356 (14.0)	457 (18.0)	533 (21.0)	635 (25.0)		
457 (18.0)	Not limited	686 (27.0)	Not limited	1.35 (0.053)	1.42 (0.056)
508 (20.0)	635 (25.0)	737 (29.0)	914 (36.0)		
559 (22.0)	Not limited	838 (33.0)	Not limited	1.52 (0.060)	1.60 (0.063)
635 (25.0)	787 (31.0)	889 (35.0)	1092 (43.0)		
635 (25.0)	Not limited	991 (39.0)	Not limited	1.70 (0.067)	1.78 (0.070)
737 (29.0)	914 (36.0)	1041 (41.0)	1295 (51.0)		
838 (33.0)	Not limited	1295 (51.0)	Not limited	2.03 (0.080)	2.13 (0.084)

Table 6.1 Continued on Next Page

Table 6.1 Continued

Without supporting frame[a]		With supporting frame or equivalent reinforcing[a]			
Maximum width[b]	Maximum length[c]	Maximum width[b]	Maximum length[c]	Minimum thickness of metal	
				uncoated	coated
mm (in)	mm (in)	mm (in)	mm (in)	mm (in)	mm (in)
965 (38.0)	1194 (47.0)	1372 (54.0)	1676 (66.0)		
1067 (42.0)	Not limited	1626 (64.0)	Not limited	2.36 (0.093)	2.46 (0.097)
1194 (47.0)	1499 (59.0)	1727 (68.0)	2134 (84.0)		
1321 (52.0)	Not limited	2032 (80.0)	Not limited	2.74 (0.108)	2.82 (0.111)
1524 (60.0)	1880 (74.0)	2134 (84.0)	2616 (103.0)		
1600 (63.0)	Not limited	2464 (97.0)	Not limited	3.12 (0.123)	3.20 (0.126)
1854 (73.0)	2286 (90.0)	2616 (103.0)	3226 (127.0)		

[a] A supporting frame is a structure of angle or channel of a folded rigid section of sheet metal that is rigidly attached to and has essentially the same outside dimensions as the enclosure surface and that has sufficient torsional rigidity to resist the bending moments which may be applied via the enclosure surface when it is deflected. Construction considered to have equivalent reinforcing may be accomplished by designs that will produce a structure that is as rigid as one built with a frame of angles or channels. Construction considered to be without supporting frame includes

1) single sheet with single-formed flanges (formed edges);

2) a single sheet that is corrugated or ribbed; and

3) an enclosure surface loosely attached to a frame with, for example, spring clips.

[b] The width is the smaller dimension of a rectangular sheet metal piece that is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.

[c] For panels that are not supported along one side, for example, side panels of boxes, the length of the unsupported side shall be limited to the dimensions specified unless the side in question is provided with a flange at least 12.7 mm (1/2 in) wide.

[d] Sheet steel for an enclosure intended for outdoor use shall comply with the requirements for outdoor use equipment.

Table 6.2
Minimum thickness of sheet metal for electrical enclosures aluminum, copper, or brass

Without supporting frame[a]		With supporting frame or equivalent reinforcing[a]			
Maximum width[b]	Maximum length[c]	Maximum width[b]	Maximum length[c]	Minimum thickness	
mm (in)	mm (in)	mm (in)	mm (in)	mm	(in)
76 (3.0)	Not limited	178 (7.0)	Not limited	0.58[d]	(0.023)
89 (3.5)	102 (4.0)	216 (8.5)	241 (9.5)		
102 (4.0)	Not limited	254 (10.0)	Not limited	0.74	(0.029)
127 (5.0)	152 (6.0)	267 (10.5)	343 (13.5)		
152 (6.0)	Not limited	356 (14.0)	Not limited	0.91	(0.036)
165 (6.5)	203 (8.0)	381 (15.0)	457 (18.0)		
203 (8.0)	Not limited	483 (19.0)	Not limited	1.14	(0.045)
241 (9.5)	292 (11.5)	533 (21.0)	635 (25.0)		
305 (12.0)	Not limited	711 (28.0)	Not limited	1.47	(0.058)
356 (14.0)	406 (16.0)	762 (30.0)	940 (37.0)		
457 (18.0)	Not limited	1067 (42.0)	Not limited	1.91	(0.075)
508 (20.0)	634 (25.0)	1143 (45.0)	1397 (55.0)		
635 (25.0)	Not limited	1524 (60.0)	Not limited	2.41	(0.095)

Table 6.2 Continued on Next Page