25.1.9 An insulating lining or barrier of fiber or similar material, employed where spacings would otherwise be less than the required values, shall be no less than 0.028 inch (0.7 mm) in thickness and shall be so located or of such material that it will not be adversely affected by arcing.

Exception No. 1: Fiber no less than 0.013 inch (0.3 mm) thick may be used in conjunction with an air spacing of no less than 50 percent of the spacing required for air alone.

Exception No. 2: Material having a lesser thickness may be used if it has equivalent insulating, mechanical, and flammability properties when compared with material in thicknesses specified above.

25.1.9 revised May 15, 1996

25.1.10 The spacing between uninsulated live terminals of the components in an electric-discharge lamp circuit and a dead metal part or enclosure shall be not less than 1/2 inch (12.7 mm) if the potential is 600 volts or less and not less than 3/4 inch (19.1 mm) if the potential is 601 – 1000 volts.

25.1.10 added May 15, 1996

25.2.1 Deleted May 15, 1996

25.3 Patient-connected circuits

25.3.1 The spacings between uninsulated parts of patient-connected circuits and adjacent circuits derived from different sources shall be 1-1/2 times the spacings specified in 25.1.2 and Table 25.1. See 11.1.2.

25.4 Low-voltage circuits

25.4.1 A low-voltage circuit is one involving a potential of not more than 30 volts alternating current, 42.4 volts peak or direct current, and supplied by a standard Class 2 transformer or by a suitable combination of transformer and fixed impedance having output characteristics in compliance with those required for a Class 2 transformer.

25.4.1 added May 15, 1996

25.4.2 A circuit derived from a source of supply classified as a high-voltage circuit, by connecting resistance in series with the supply circuit as a means of limiting the voltage and current, is not considered to be a low-voltage circuit.

25.4.2 added May 15, 1996

25.4.3 The spacings for low-voltage electrical components which are installed in a circuit which includes a pressure-limiting device, motor overload protective device, or other protective device, where a short or grounded circuit may result in unsafe operation of the equipment shall comply with the following:

a) The spacing between an uninsulated live part and the wall of a metal enclosure, including fittings for the connection of conduit or metal-clad cable, shall be not less than 1/8 inch (3.2 mm).

b) The spacing between wiring terminals, regardless of polarity, and between the wiring terminal and a deal metal part, including the enclosure and fittings for the connection of conduit, which may be grounded when the device is installed, shall be not less than 1/4 inch (6.4 mm).

c) The spacing between uninsulated live parts, regardless of polarity, and between an uninsulated live part and a dead metal part, other than the enclosure, which may be grounded when the device in installed, shall be not less than 1/32 inch (0.8 mm) provided that the construction of the parts is such that spacings will be maintained.

25.4.3 added May 15, 1996

25.4.4 The spacings in low-voltage circuits which do not contain devices such as indicated in the previous paragraph are not specified.

25.4.4 added May 15, 1996

REFRIGERATION SYSTEM

26 Refrigerant

26.1 The kind of refrigerant employed in the system shall comply with the Standard for Refrigerants, UL 2182.

26.1 revised November 3, 1997

26.2 Deleted February 22, 1994

27 Refrigerant Tubing and Fittings

27.1 Copper or steel tubing used to connect refrigerant-containing components shall have a wall thickness not less than indicated in Table 27.1.

Exception: Capillary tubing which is protected against mechanical damage by the cabinet or assembly shall have a wall thickness not less than 0.020 inch (0.51 mm).

27.2 Tubing shall be constructed of corrosion resistant material, such as copper, or shall be plated, dipped, coated, or otherwise treated to resist external corrosion. Aluminum may be used where the material is not subject to galvanic corrosion.

27.3 Tubing forming part of components, such as evaporators or condensers, where protection is afforded by inherent construction shall be judged by the Strength Tests – Pressure Containing Components, Section 57.

27.3 revised February 22, 1994

27.4 Special alloys or constructions used in refrigerant-containing components, including tubing with a wall thickness less than indicated in 27.1, may be acceptable. Among the factors taken into consideration when judging the acceptability are its:

a) Resistance to mechanical abuse,

b) Strength against internal pressure,

c) Resistance to corrosion,

No Text on This Page

d) Protection against refrigerant contamination, and

e) Conformity with requirements of safety codes, such as the Safety Code for Mechanical Refrigeration, ANSI/ASHRAE 15-89, as compared to tubing of the minimum wall thickness indicated in Table 27.1.

Table 27.1
Minimum wall thickness for copper and steel tubing

Outside diameter		Copper				Steel	
		Protected within product		Unprotected			
inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)
1/4	(6.4)	0.0245	(0.622)	0.0265	(0.673)	0.025	(0.64)
5/16	(7.9)	0.0245	(0.622)	0.0285	(0.724)	0.025	(0.64)
3/8	(9.5)	0.0245	(0.622)	0.0285	(0.724)	0.025	(0.64)
1/2	(12.7)	0.0245	(0.800)	0.0285	(0.724)	0.025	(0.64)
5/8	(15.9)	0.0315	(0.800)	0.0315	(0.800)	0.032	(0.81)
3/4	(19.1)	0.0315	(0.799)	0.0385	(0.978)	0.032	(0.81)
7/8	(22.2)	0.0410	(1.041)	0.0410	(1.041)	0.046	(1.17)
1	(25.4)	0.0460	(1.168)	0.0460	(1.168)	–	–

NOTE – Nominal wall thickness of tubing will have to be greater than the thickness indicated to maintain the minimum wall thickness.

27.5 Tubing connections shall be made by means of flare-type fittings with steel or forged brass nuts, by soldering or brazing, or by equivalent means. Flare-type fittings shall conform to the Standard for Refrigeration Tube Fittings, ANSI/SAE J513F-JUN90.

28 Refrigerant-Containing Parts

28.1 The parts of a product subjected to refrigerant pressure shall withstand, without failure, the pressure indicated in the Strength Tests - Pressure Containing Components.

28.2 The parts of a product subjected to refrigerant pressure shall be constructed of corrosion resistant material, such as copper or stainless steel, or shall be plated, dipped, coated, to otherwise treated to resist external corrosion.

28.3 Pressure vessels, as referred to in this Standard, are any refrigerant-containing parts other than compressor; controls; evaporators, each separate section of which does not exceed 1/2 cubic foot (0.01 m^3) of refrigerant containing volume evaporator and condenser coils; headers; pipe; and pipe fittings.

28.4 Pressure vessels over 6 inches (152 mm) inside diameter shall be designed, tested, and stamped in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, for a working pressure in compliance with the performance requirements of this Standard.

28.5 Pressure vessels bearing the ASME Code ″U″ symbol complying with 28.4 are considered acceptable without tests.

28.6 Pressure vessels bearing the ASME Code ″UM″ symbol are to be tested to determine compliance with the Strength Tests - Pressure Containing Components requirements. The manufacturer is to submit evidence of compliance of these vessels with the ASME Boiler and Pressure Vessel Code, Section VIII.

29 Pressure Limiting Device

29.1 A pressure limiting device designed to automatically stop the operation of the compressor shall be installed on all products with a system containing more than 22 pounds-mass (10 kg) of refrigerant.

29.1 revised June 24, 1997

29.2 The adjustable cutout pressure setting of a pressure-limiting device shall not exceed one-third of the ultimate strength of high-side refrigerant-containing parts, provided this setting does not exceed 90 percent of the setting of the pressure-relief device.

29.2 revised June 24, 1997

29.3 Deleted June 24, 1997

29.4 There shall be no stop valves between the pressure-limiting device and the compressor.

29.4 revised June 24, 1997

30 Pressure Relief

30.1 General

30.1.1 A product shall be constructed so that pressure due to fire, or other abnormal conditions, will be relieved. Pressure relief devices, fusible plugs, soldered joints, or special terminals may be employed for this purpose. See 30.4.1.

30.1.1 revised June 24, 1997

30.1.2 A pressure relief device is a pressure-actuated valve or rupture member designed to relieve excessive pressures automatically.

30.1.3 A product with a pressure vessel over 3 inches (76.2 mm) inside diameter, but not exceeding 3 cubic feet (0.08 m^3) internal gross volume, shall be protected by a pressure relief device or fusible plug.

30.1.4 A product with a pressure vessel exceeding 3 cubic feet (0.08 m^3), but less than 10 cubic feet (0.28 m^3) internal gross volume, shall be protected by a pressure relief device.

30.1.5 There shall be no stop valve between the pressure relief means and the parts or section of the system protected.

30.1.5 revised June 24, 1997

30.1.6 All pressure relief devices shall be connected as close as practicable or directly to the pressure vessel or parts of the system protected. They shall be connected above the liquid refrigerant level, installed so that they are readily accessible for inspection and repair, and arranged so that they cannot readily be rendered inoperative.

30.1.6 revised June 24, 1997

30.1.7 Fusible plugs may be located above or below the liquid refrigerant level.

30.2 Required discharge capacity

30.2.1 Deleted June 24, 1997

30.3 Relief valves

30.3.1 Pressure relief valves shall comply with the requirements of the ASME Boiler and Pressure Vessel Code, Section VIII. Valves of 1/2 inch [0.840 inches (21.3 mm) outside diameter] iron pipe size (ips) and larger shall bear the authorized Code ″UV″ symbol together with the set pressure and capacity. Valves of less than 1/2 inch ips shall be similarly marked, except that where the size does not permit a nameplate, the code symbol may be omitted and the set pressure and capacity may be stamped on the valve or on a metal plate attached to it. Manufacturers of valves which do not bear the code symbol shall provide evidence of certification of the valve and its pressure and capacity rating by proper code authorities.

30.3.2 Pressure relief valves shall be sealed at a start-to-discharge pressure not exceeding the marked working pressure of the pressure vessel protected or not exceeding one-fifth of the ultimate strength of pressure vessels which do not have a marked working pressure.

30.3.3 The marked discharge capacity shall be not less than the minimum required discharge capacity as specified in 30.4.1.

30.3.3 revised June 24, 1997

30.4 Fusible plugs or rupture members

30.4.1 Calculation of the minimum required discharge capacity and the rated discharge capacity of a rupture member or fusible plug shall be in accordance with the Safety Code for Mechanical Refrigeration, ANSI/ASHRAE 15-1994.

Revised 30.4.1 effective June 24, 1998

30.4.2 Fusible plugs shall be stamped with the relief temperature.

30.4.3 Rupture members shall be stamped with the minimum and maximum bursting pressures.

30.4.4 Fusible plugs and rupture members, shall comply with performance requirements for such devices as contained in the Standard for Refrigerant-Containing Components and Accessories, Nonelectrical, UL 207.

30.4.4 revised March 16, 2010

PERFORMANCE

31 Instrumentation

31.1 Temperature measurements

31.1.1 Temperatures are to be measured by thermocouples, except that the change-in-resistance method may be used to measure the temperature of motor windings or of coils. See 36.4. The thermocouples are to consist of 24 – 30 AWG (0.21 – 0.05 mm^2) wires. The thermocouple wire is to conform to the requirements specified in the Tolerances on Initial Values of EMF versus Temperature tables in the Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples, ANSI/ASTM E230/E230M.

31.1.1 revised March 16, 2010

31.1.2 A thermocouple junction and adjacent thermocouple lead wire are to be securely held in positive thermal contact with the surface of the material whose temperature is being measured. In most cases thermal contact will result from securely taping or cementing the thermocouple in place, but where a metal surface is involved, brazing or soldering the thermocouple to the metal may be necessary.

31.1.3 Thermocouples consisting of 30 AWG (0.05 mm^2) iron and constantan wires and a potentiometer type of indicating instrument shall be used whenever referee temperature measurements by means of thermocouples are necessary.

31.1.3 revised March 16, 2010

31.2 Pressure measurements

31.2.1 Pressure gauges are to be attached in such a manner as to prevent leakage. Special fittings for direct connection to the system or minimum lengths of 1/8 inch (3.2 mm) outside diameter commercial capillary tubing may be employed for gauge connections. The volume of the pressure-measuring gauge and lines is to be held to a minimum. All joints in the gauge system are to be tested for leakage.

31.2.2 Opening of the gauge line valves shall not cause a significant change in the electrical input of the system. High-side gauges and lines may be heated above the saturation temperature corresponding to the expected pressure or may be precharged with a liquid refrigerant of the same type as used in the system to minimize the effect of opening the gauge line valves.

32 Test Voltage

32.1 Unless otherwise specified, products are to be tested at the following 60 hertz (Hz)[a] potentials maintained at the product supply connections:

Nameplate voltage rating	Test voltage[b]
110 to 120	120
208	208
220 to 240	240
254 to 277	277
440 to 480	480
550 to 600	600

[a] Products rated at frequencies other then 60 Hz are to be tested at their rated voltages and frequencies.

[b] These voltages are nominal for the condenser fan motor failure test, and condenser water failure test.

33 Leakage Current Test

33.1 General

32.1.1 All products shall be investigated for leakage current. Each product shall comply, depending upon its intended use, with 33.4.1 (patient care equipment) or 33.6.1 (nonpatient equipment).

33.2 Permanently connected equipment

33.2.1 Leakage current measurements in accordance with 33.7.1.1 – 33.7.3.2 normally are not made between the equipment frame and ground on equipment intended for permanent connection to the supply, provided all accessible metal parts that are likely to become energized (except electrodes, probes, and the like) are reliably connected to the equipment grounding means. However, measurements are to be made between accessible ungrounded parts (such as patient-connected electrodes, probes, and the like) and between such parts and ground in the manner described in 33.7.1.1 – 33.7.3.2.

Exception: The total impedance of capacitors and other electronic components connected from one or more sides of the line to the frame or enclosure of a permanently connected appliance shall be large enough to prevent the flow of more than 0.5 milliampere of leakage current measured through a 1000 ohm resistance in the grounding conductor for frequencies up to and including 1 kilohertz (kHz) and equivalent values at higher frequencies with a restriction of 10 milliamperes. Also see 33.5.1.

33.3 Cord-connected equipment

33.3.1 All accessible parts of a cord-connected product are to be tested for leakage current between the parts and between the parts and ground. The measurements are to be made in the manner described in 33.7.1.1 – 33.7.3.2.

33.4 Patient care equipment

33.4.1 When a patient care product is tested in the manner described in 33.7.1.1 – 33.7.3.2 the available leakage currents shall not exceed the values in Table 33.1.

Table 33.1
Patient care equipment maximum leakage current (microamperes)

Patient connection[a]				Enclosure or chassis[b,c,f]	
Isolated[d]		Ordinary[e]			
AC RMS	DC	AC RMS	DC	AC RMS	DC
10	14	50	70	100	140

[a] Measured between patient leads (applied part) or between patient leads and ground. Value indicated is acceptable for each particular body function or parameter measured or monitored.
[b] Metal enclosure or metal foil over insulating material, per 33.7.1.3.
[c] See 3.5.
[d,e] See 3.15.
[f] Measured with loss of ground per 33.7.1.2 (see 9.3.3 for appropriate plug cap).

33.4.2 The alternating current values in Table 33.1 are based on data obtained with 60 Hz sinusoidal voltages and apply for frequencies up to 1 kHz. For frequencies above 1 kHz the acceptable levels of leakage current are equal to the values indicated in Table 33.1 times the frequency in kHz up to a maximum multiplier of 100. See Figure 33.1.

33.5 Isolated patient connections

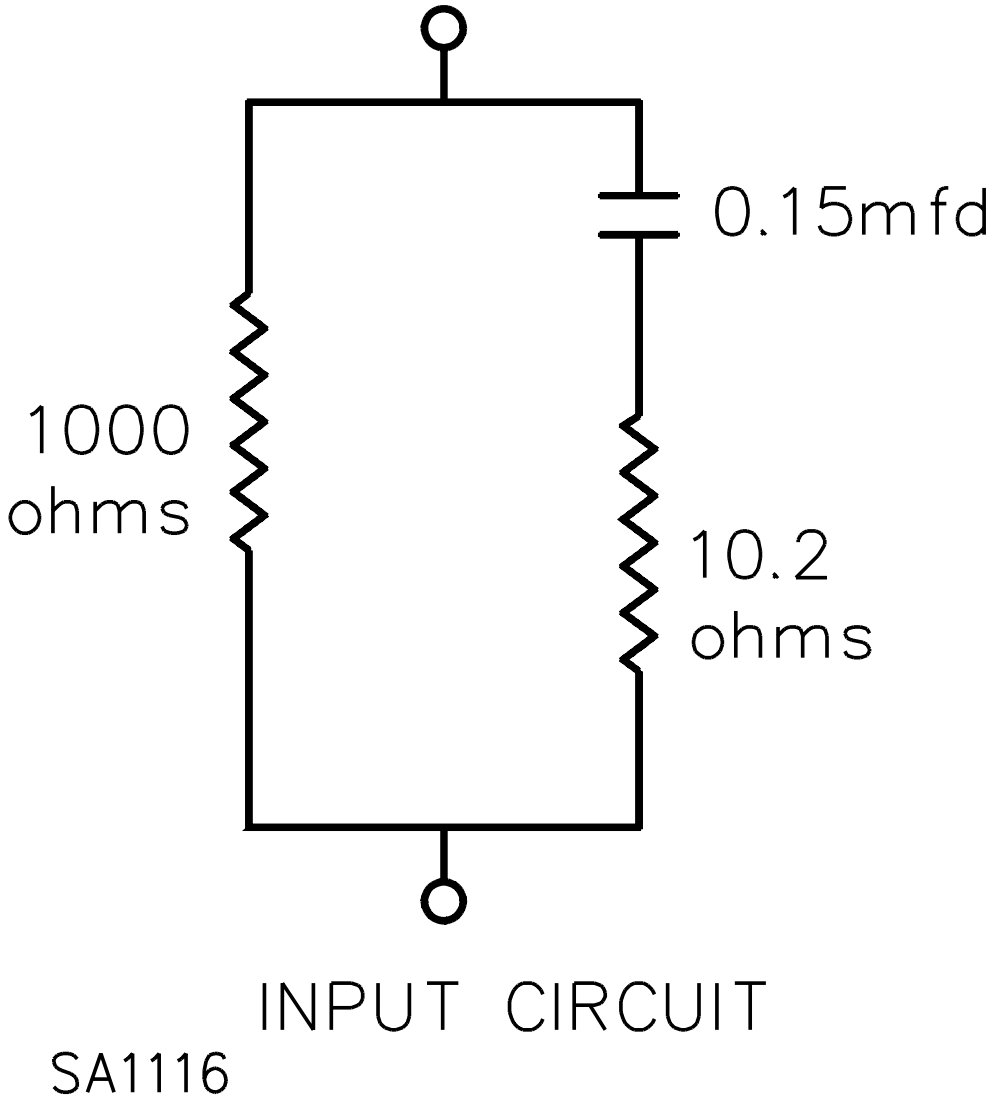
33.5.1 When equipment having an isolated patient connection is subjected to the outlined in 33.6.1, the available current shall not exceed 20 microamperes when measure at the patient end of the connecting cables.

Exception: When equipment having isolated patient connection terminals but no cables is subjected to the test outlined in 33.6.1, the available current shall not exceed 10 microamperes RMS when measured at the terminals.

33.5.2 A 120 volt, 60 Hz potential shall be applied between each isolated patient connection and ground in series with the measurement circuit (100 ohm resistor and meter) described in 33.7.2.1. This test shall be conducted with the appliance on and operating and also with the appliance off but connected to the supply circuit. The test shall be completed with the polarity of the supply connections reversed.

Figure 33.1
Input circuit

Figure 33.1 revised November 24, 1998



In the type testing of equipment, detailed measurements of leakage currents at all frequencies are necessary. However, to evaluated currents at frequencies over 1 kilohertz it is sometimes desirable to use an approximation during routine equipment testing.

The measurement circuit described in 33.7.2.1 would be employed in recording the actual leakage current determinations in 33.7.1.1 – 33.7.3.2. However, for a rapid approximate evaluation, an appropriate meter input circuit may be employed having an impedance-frequency characteristic that approximates the inverse of the allowable leakage current versus frequency relationships described in 33.4.2 and automatically provides the appropriate multiplying factor for frequencies greater than 1 kilohertz.

A sample input circuit is shown which would be applicable to measurements usually made. The 1000 ohm resistor shown is the same test load as noted in 33.7.2.1. A series resistor-capacitor combination is placed in parallel with the 1000 ohm resistor across the meter input terminals.