



Underwriters Laboratories Inc.®

A not-for-profit organization dedicated to public safety
and committed to quality service

January 22, 1997

Revision pages for

Refrigerated Medical Equipment

UL 416, Fourth Edition

Attached to this distribution notice is a reprinted title page for the Fourth edition of UL 416.

As indicated on the title page (page 1), this UL Standard for Safety is an American National Standard. Attention is directed to the note on the title page of this Standard outlining the procedures to be followed to retain the text of this ANSI/UL Standard.

Revised and/or additional pages may be issued from time to time.

With the inclusion of the accompanying material, the standard consists of pages dated as shown in the following checklist:

Page	Date
1	August 30, 1993 (Reprinted January 22, 1997)
2, 3	May 15, 1996
4 – 22	August 30, 1993
23	February 22, 1994
24	August 30, 1993
25, 26, 26A, 27, 28, 28A	February 22, 1994
29 – 41	August 30, 1993
42 – 44, 44A	May 15, 1996
45	August 30, 1993
46	February 22, 1994
47 – 61	August 30, 1993
62 – 64	May 15, 1996
65	February 22, 1994
66 – 74	August 30, 1993
75	May 15, 1996
76	August 30, 1993
77	May 15, 1996
78, 79	August 30, 1993
80, 80A, 81, 82	February 22, 1994
83, 84, 84A, 84B	May 15, 1996
85, 86, 86A	February 22, 1994
87 – 92, A1	August 30, 1993

AUGUST 30, 1993
(Title Page Reprinted: January 22, 1997)



1

UL 416

Standard for
Refrigerated Medical Equipment

First Edition – August, 1956
Second Edition – May, 1973
Third Edition – July, 1978

The First and Second Editions were titled Standard for Oxygen Therapy Equipment, Refrigerated.

Fourth Edition

August 30, 1993

Approval as an American National Standard (ANSI) covers the numbered paragraphs on pages dated August 30, 1993 and February 22, 1994. These pages should not be discarded when revised or additional pages are issued if it is desired to retain the ANSI approved text.

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

Approved as ANSI/UL 416-1996, April 17, 1996

Revisions of this standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest published set of revision pages.

ISBN 1-55989-466-0

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CONTENTS**FOREWORD****INTRODUCTION**

1 Scope	5
2 General	5
3 Glossary	6
4 Installation and Operating Instructions	8

CONSTRUCTION

5 General	8
6 Assembly	9
7 Accessories	14
8 Enclosures	15
9 Field Supply Connections	20
10 Internal Wiring and Wiring Methods	25
11 Separation of Circuits	29
12 Bonding for Grounding	30

ELECTRICAL COMPONENTS

13 Capacitors	33
14 Current-Carrying Parts	33
15 Electric Heaters	34
16 Insulating Material	35
17 Lampholders and Lamps	35
18 Motors and Motor Overload Protection	35
19 Overcurrent Protection	38
20 Printed Wiring	38
21 Receptacles	38
22 Switches and Controllers	39
23 Transformers	40
24 Valves and Solenoids	41
25 Spacings	42

REFRIGERATION SYSTEM

26 Refrigerant	44A
27 Refrigerant Tubing and Fittings	44A
28 Refrigerant-Containing Parts	45
29 Pressure Limiting Device	46
30 Pressure Relief	46

PERFORMANCE

31 Instrumentation	48
32 Test Voltage	49
33 Leakage Current Test	49
34 Input Test	56
35 Starting Test	56

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Underwriters Laboratories Inc.®



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Subjects 2182 (207, 250, 303, 399, 412, 416, 427, 465, 471, 474, 484, 541, 559, 563, 621, 984, 1963, 1995, 2170, 2171, 2172, 2205)

333 Pfingsten Road
Northbrook, IL 60062
January 9, 1997

TO:

Casualty Council of Underwriters Laboratories Inc.,
Consumer Advisory Council of Underwriters Laboratories Inc.,
Electrical Council of Underwriters Laboratories Inc.,
Fire Council of Underwriters Laboratories Inc.,
Subscribers to UL's Standards Service for

Refrigerant Containing Components and Accessories, Nonelectrical, UL 207,
Household Refrigerators and Freezers, UL 250,
Refrigeration and Air-Conditioning Condensing, and Compressor Units, UL 303,
Drinking Water Coolers, UL 399
Refrigeration Unit Coolers, UL 412,
Refrigerated Medical Equipment, UL 416,
Refrigerating Units, UL 427,
Central Cooling Air Conditioners, UL 465,
Commercial Refrigerators and Freezers, UL 471,
Dehumidifiers, UL 474,
Room Air Conditioners, UL 484,
Refrigerated Vending Machines, UL 541,
Heat Pumps, UL 559
Ice Makers, UL 563,
Ice Cream Makers, UL 621,
Hermetic Refrigerant Motor Compressors, UL 984
Refrigerant Recovery/Recycling Equipment, UL 1963,
Heating and Cooling Equipment, UL 1995,
Field Conversion/Retrofit of Products to Change to an Alternative
Refrigerant – Construction and Operation, UL 2170,
Field Conversion/Retrofit of Products to Change to an Alternative
Refrigerant – Insulating Material and Refrigerant Compatibility, UL 2171,
Field Conversion/Retrofit of Products to Change to an Alternative
Refrigerant – Procedures and Methods, UL 2172
Refrigerants, UL 2182
Field Conversion/Retrofit of Alternative Refrigerants in Household Refrigerators and Freezers,
UL 2205

SUBJECT: Use of Classified Refrigerants

SUMMARY OF TOPICS

This bulletin proposes the following changes in requirements:

All of the UL refrigerant containing end-use standards would be revised to require the use of refrigerants that comply with the Standard for Refrigerants, UL 2182.

COMMENTS DUE: February 20, 1997

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Documents

Document Sharing Hub

Subjects 2182 (207, 250, 303, 399, 412,
416, 427, 465, 471, 474, 484, 541, 559, 563,
621, 998, 1963, 1995, 2170, 2171, 2172, 2205)

-2-

January 9, 1997

UL announces that as of July 1, 1996, refrigerants are now covered as Classified products in accordance with the Standard for Refrigerants, UL 2182. A tabulation of manufacturer's of Classified refrigerants are contained in the 1996 edition of UL's Electrical Appliance and Utilization Equipment Directory under the Category Control Number of SLGV.

Previous to July 1996 refrigerants were covered as Recognized components and a Recognition Report was developed for each Recognized refrigerant. This report contained information regarding the ignition temperature of the refrigerant. However, the new Classification Marking information does not contain the ignition temperature of the refrigerant.

UL uses this ignition temperature rating when evaluating the results of a refrigerant leak. The test requires the surface temperature to be below the ignition temperature of the refrigerant. Therefore, as part of the end-use investigations of refrigeration and air conditioning equipment, it will still be necessary to review the ignition temperature data. This data will be used to determine the results should a leak develop in proximity to a heat producing component. The Auto Ignition Test will continue to be conducted and the results will be contained in the Classification Report.

UL is proposing to revise its end-use standards covering refrigerant containing equipment to require the use of refrigerants investigated in accordance with UL 2182. These proposed revisions are included in Appendix A. In addition, all UL engineering reports for end-use refrigeration and air conditioning equipment will also be revised to reflect the use of Classified refrigerants.

The UL engineering reports will include the refrigerant manufacturer's name and the trade name of the refrigerant(s) used in testing the product. This information is needed since the trade name may differ from the ANSI/ASHRAE 34 designation and the refrigerant may not even have an ANSI/ASHRAE designation.

It is important for the end-use refrigeration and air conditioning equipment manufacturer's to:

- a) Check the specific refrigerant manufacturer's name when identifying Classified refrigerants, and
- b) Make sure the refrigerants are from a manufacturer and a location who has a UL Classification as indicated in the 1996 edition of the Electrical Appliance and Utilization Equipment Directory.

Please note that proposed requirements are of a tentative and early nature and are for review and comment only. Current requirements are to be used to judge a product until these requirements are published in final form.

PROPOSED EFFECTIVE DATE

These proposed requirements will not necessitate a review or additional testing of currently Listed or Recognized products. Therefore, UL proposes that these requirements become effective upon publication.

REQUEST FOR COMMENTS ON PROPOSALS

Please provide the following:

1. Your comments concerning the proposed requirements; and
2. Your comments concerning the proposed effective date, should the proposals be adopted.

Subjects 2182 (207, 250, 303, 399, 412,
416, 427, 465, 471, 474, 484, 541, 559, 563,
621, 998, 1963, 1995, 2170, 2171, 2172, 2205)

-3-

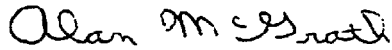
January 9, 1997

Written comments should be sent to the attention of Alan McGrath at UL's Northbrook office, 333 Pfingsten Road, Northbrook, IL 60062-2096. Please reference all correspondence to Subject 2182.

All comments should be sent by February 20, 1997.

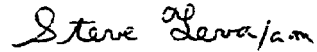
Unless specifically requested to do so, UL will not acknowledge comments indicating concurrence with these proposals.

UNDERWRITERS LABORATORIES INC.



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SR:JTM

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PROPOSED REQUIREMENTS ARE OF A TENTATIVE AND EARLY NATURE AND ARE FOR REVIEW AND COMMENT ONLY. CURRENT REQUIREMENTS ARE TO BE USED TO JUDGE A PRODUCT UNTIL THESE REQUIREMENTS ARE PUBLISHED IN FINAL FORM.

APPENDIX A

PROPOSED REQUIREMENTS AND PROPOSED EFFECTIVE DATES FOR

UL 207, UL 250, UL 303, UL 399, UL 412, UL 416, UL 427, UL 465, UL 471, UL 474, UL 484, UL 541, UL 559, UL 563, UL 621, UL 984, UL 1963, UL 1995, UL 2170, UL 2171, UL 2172, and UL 2205

For your convenience in review, proposed additions to existing requirements are shown underlined and proposed deletions are shown ~~lined-out~~. Proposed new requirements are identified by (NEW). In the case of extensively revised paragraphs, the original text is identified by (CURRENT) and is ~~lined-out~~, followed by the proposed text identified by (PROPOSED).

RATIONALE

UL is proposing to revise the following refrigerant containing end-use standards to require the use of refrigerants investigated in accordance with UL 2182. In addition, the reference to the Safety Code for Mechanical Refrigeration, ANSI/ASHRAE 15 is proposed to be deleted from the text of these standards since reference is already made to ASHRAE 15 in the Scope of these standards.

IMPACT

If the following proposals are adopted, they would not require a review, retest, or modifications to presently Listed equipment for the proposals are a clarification of present practice at UL.

PROPOSALS**1. UL 207**

(NEW)

2.5 Refrigerants

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

2.5.1 added (date of publication)

2. UL 250

Since the Standard for Refrigerators, UL 250/CSA No. 63 is a binational standard, this revision will be proposed concurrently with CSA at a later date.

3. UL 303

The Standard for Refrigeration and Air-Conditioning Condensing, and Compressor Units, UL 303, is being replaced by UL 1995 in January 1998. Therefore, please see item 18.

4. UL 399

(CURRENT)

REFRIGERATION SYSTEM**22 Refrigerant**

~~22.1 The refrigerant employed shall possess sufficient chemical stability to prevent disassociation or other changes which are likely to lead to the formation of hazardous substances, see 22.2, when subjected to the maximum range of temperatures and pressures encountered in the refrigerating cycle.~~

~~22.2 The refrigerants used in a water cooler employing the direct method of refrigeration shall be practically nonflammable and shall be of a degree of toxicity that will not produce death or serious injury to guinea pigs during a 2 hour exposure to the refrigerant at a concentration of 2 1/2 percent by volume in air. Refrigerants 12, 22, 500, and 502 are commonly used refrigerants which comply with this requirement.~~

(PROPOSED)

22.1 The kind of refrigerant intended for use with the unit cooler shall comply with the Standard for Refrigerants, UL 2182.

22.1 revised (date of publication)

22.2 *Clause 22.2 deleted (date of publication)*

5. UL 412

REFRIGERATION SYSTEM

23 Refrigerant

23.1 The kind of refrigerant intended for use with the unit cooler shall comply with the Standard for Refrigerants, UL 2182. ~~conform with the Safety Code for Mechanical Refrigeration, ANSI/ASHRAE 15-1978.~~

23.1 revised (date of publication)

6. UL 416

REFRIGERATION SYSTEM

26 Refrigerant

26.1 The kind ~~and quantity~~ of refrigerant employed in the system shall comply with the Standard for Refrigerants, UL 2182. ~~Safety Code for Mechanical Refrigeration, ANSI/ASHRAE 15-1989.~~

26.1 revised (date of publication)

7. UL 427

REFRIGERATION SYSTEM

22 General

22.1 Refrigerant

22.1.1 The kind ~~and quantity~~ of refrigerant employed in the system shall comply with the Standard for Refrigerants, UL 2182. ~~Safety Code for Mechanical Refrigeration, ANSI/ASHRAE 15-1992.~~

22.1 revised (date of publication)

8. UL 465

The Standard for Central Cooling Air Conditioners, UL 465, is being replaced by UL 1995 in January 1998. Therefore, please see item 18.

9. UL 471**REFRIGERATION SYSTEM****29 Refrigerants**

29.1 The kind and quantity of refrigerant employed in the system shall comply with the Standard for Refrigerants, UL 2182, Safety Code for Mechanical Refrigeration, ANSI/ASHRAE 15-1994.

29.1 revised (date of publication)

10. UL 474**REFRIGERATION SYSTEM****18 Refrigerants**

18.1 The kind and quantity of refrigerant employed in the system shall comply with the Standard for Refrigerants, UL 2182, Safety Code for Mechanical Refrigeration, ANSI/ASHRAE 15-1994.

18.1 revised (date of publication)

11. UL 484**REFRIGERATION SYSTEM****26 Refrigerant**

26.1 The kind and quantity of refrigerant employed in the system shall comply with the Standard for Refrigerants, UL 2182, Safety Code for Mechanical Refrigeration, ANSI/ASHRAE 15-1994.

26.1 revised (date of publication)

12. UL 541**REFRIGERATION SYSTEM****29 Refrigerant**

29.1 The kind and quantity of refrigerant employed in the system shall comply with the Standard for Refrigerants, UL 2182, Safety Code for Mechanical Refrigeration, ANSI/ASHRAE 15-1994.

29.1 revised (date of publication)

13. UL 559

The Standard for Heat Pumps, UL 559, is being replaced by UL 1995 in January 1998. Therefore, please see item 18.

14. UL 563**REFRIGERATION SYSTEM****24 Refrigerant**

24.1 The kind and quantity of refrigerant employed in the system shall comply with the Standard for Refrigerants, UL 2182, Safety Code for Mechanical Refrigeration, ANSI/ASHRAE 15-1994.

24.1 revised (date of publication)

15. UL 621**REFRIGERATION SYSTEM****28 Refrigerant**

28.1 The kind and quantity of refrigerant employed in the system shall comply with the Standard for Refrigerants, UL 2182. Safety Code for Mechanical Refrigeration, ANSI/ASHRAE 15-1994.

28.1 revised (date of publication)

16. UL 984

Since the Standard for Hermetic Refrigerant Motor Compressors, UL 984/CSA No. 140.2 is a binational standard, this revision will be proposed concurrently with CSA at a later date.

17. UL 1963**REFRIGERANT SYSTEM****25 Refrigerants**

25.1 The equipment shall operate with refrigerant that complies with the Standard for Refrigerants, UL 2182. Safety Code for Mechanical Refrigeration, ANSI/ASHRAE 15-1989.

25.1 revised (date of publication)

18. UL 1995

Since the Standard for Heating and Cooling Equipment, UL 1995/CSA No. 236 is a binational standard, this revision will be proposed concurrently with CSA at a later date.

19. UL 2170**5.2 Refrigerants**

5.2.1 The kind and quantity of refrigerant used in the system shall comply with the Standard for Refrigerants, UL 2182. Safety Code for Mechanical Refrigeration, ANSI/ASHRAE 15-1992.

5.2.1 revised (date of publication)

5.2.2 ~~The alternative refrigerants shall be nonflammable or practically nonflammable as determined by the ASTM E681-85 test method and the auto ignition temperature test method as adjusted to the methods outlined in ASHRAE 34-1992, Designation and Safety Classification of Refrigerants, at room ambient and at 100°C.~~

5.2.2 deleted (date of publication)

(Note: Clause 5.2.3 is shown for reference only. No changes are being proposed to it at this time.)

5.2.3 When a blended refrigerant with a flammable constituent is to be used as an alternative, fractionation that may occur as the result of a system leak shall be considered. This shall include consideration of both the fractionation of the blend remaining in the system and the composition of the blend leaking into the equipment or the equipment space that may involve a risk of fire or injury to persons.

20. UL 2171

Since UL 2170, 2171, and 2172 are a series of standards which are used together, the revision is covered by the revision in UL 2170.

21. UL 2172

Since UL 2170, 2171, and 2172 are a series of standards which are used together, the revision is covered by the revision in UL 2170.

22. UL 2205

Since the following clause is already contained in the proposed first edition of UL 2205, no revision will be proposed:

4.6 The alternative refrigerant shall comply with the Standard for Refrigerants, UL 2182.

**Underwriters Laboratories Inc.®**A not-for-profit organization dedicated to public safety
and committed to quality service**May 15, 1996****Revision pages for****Standard for****Refrigerated Medical Equipment****UL 416, Fourth Edition**

Attached to this transmittal notice is a revision of the Fourth edition of UL 416.

A CHANGE ON A PAGE DATED MAY 15, 1996 IS INDICATED BY A SMALL PRINT NOTE FOLLOWING THE
AFFECTED ITEM, PRECEDED AND FOLLOWED BY AN ASTERISK.

THESE NEW AND REVISED REQUIREMENTS ARE NOW IN EFFECT.

The new and revised requirements are substantially in accordance with UL's bulletins on this subject dated
August 14, 1995 and February 12, 1996. These bulletins are now obsolete and may be discarded.

Revised and/or additional pages may be issued from time to time.

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87 - 92, A1	August 30, 1993

AUGUST 30, 1993

(Title Page Reprinted: May 15, 1996)

1

UL 416

Standard for

Refrigerated Medical Equipment

First Edition – August, 1956

Second Edition – May, 1973

Third Edition – July, 1978

The First and Second Editions were titled Standard for Oxygen Therapy Equipment, Refrigerated.

Fourth Edition

August 30, 1993

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ISBN 1-55989-466-0

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CONTENTS**FOREWORD****INTRODUCTION**

1 Scope	5
2 General	5
3 Glossary	6
4 Installation and Operating Instructions	8

CONSTRUCTION

5 General	8
6 Assembly	9
7 Accessories	14
8 Enclosures	15
9 Field Supply Connections	20
10 Internal Wiring and Wiring Methods	25
11 Separation of Circuits	29
12 Bonding for Grounding	30

ELECTRICAL COMPONENTS

13 Capacitors	33
14 Current-Carrying Parts	33
15 Electric Heaters	34
16 Insulating Material	35
17 Lampholders and Lamps	35
18 Motors and Motor Overload Protection	35
19 Overcurrent Protection	38
20 Printed Wiring	38
21 Receptacles	38
22 Switches and Controllers	39
23 Transformers	40
24 Valves and Solenoids	41
25 Spacings	42

REFRIGERATION SYSTEM

26 Refrigerant	44A
27 Refrigerant Tubing and Fittings	44A
28 Refrigerant-Containing Parts	45
29 Pressure Limiting Device	46
30 Pressure Relief	46

PERFORMANCE

31 Instrumentation	48
32 Test Voltage	49
33 Leakage Current Test	49
34 Input Test	56
35 Starting Test	56

36	Temperature and Pressure Test	57
37	Heating Test	61
38	Dielectric Voltage Withstand Test	62
39	Condenser Fan Motor Failure Test	64
40	Condenser Water Failure Test	64
41	Overflow Test	65
42	Cleaning and Sterilization Test	65
43	Stability Test	66
44	Mechanical Abuse	67
45	Grounding Impedance Test	67
46	Endurance Test – Heater Control	67
47	Burnout Tests	68
48	Overvoltage and Undervoltage Tests	69
49	Current Overload Test – Bonding Conductors and Connections	70
50	Insulation Resistance Test	70
51	Limited Short-Circuit Test	71
52	Protective Devices – Maximum Continuous Current Test	72
53	Accelerated Aging Test – Electric Heaters	74
54	Reliability Test – Heater Termination	75
55	Abnormal Operation Test	75
56	Printed Wiring Assembly Tests	78
57	Strength Test – Pressure Containing Components	80
58	Marking Label Adhesion Tests	81
59	Additional Tests	82

MANUFACTURING AND PRODUCTION TESTS

60	Pressure Test	82
61	Production Line Dielectric Voltage Withstand Test	83
62	Production Line Grounding Continuity Test	84A

MARKING

63	General	84B
64	Permanently Connected Products	86A
65	Cord Connected Products	90
66	Caution and Warning Markings	90

APPENDIX A

Standards for Components	A1
--------------------------------	----

FOREWORD

A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.

D. A product employing materials or having forms of construction differing from those detailed in the requirements of this Standard may be examined and tested according to the intent of the requirements and, if found to be substantially equivalent, may be judged to comply with the Standard.

E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard.

F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

23.2 Patient care equipment

23.2.1 In determining compliance with 23.1.2, one or more of the following methods shall be used, and the product shall also comply with the tests outlined in 55.2.1 – 55.2.8.

- a) Windings wound on separate bobbins of functional insulating material on separate legs of the core of the transformer.
- b) Primary and secondary windings, or adjacent secondary windings, wound on one length of functionally insulated core (both coils on the core, not concentric) if the two windings are separated end to end by electrical insulating material (reinforced or double insulation is required if one winding is connected to a patient circuit).
- c) Concentrically wound primary and secondary windings, or adjacent secondary windings thermally protected and separated by a grounded copper shield at least 0.005 inch (0.127 mm) thick, or equivalent, which completely isolates the adjacent windings, adjacent splices, or both and crossover leads if present.
- d) Concentrically wound primary and secondary windings or adjacent secondary windings separated by either two layers of mica or other insulating material of equivalent resistance to ignition, 0.007 inch (0.178 mm) thick (total) or three layers of sheet insulating material, any two of which shall withstand the Dielectric Voltage Withstand Test, Section 38, for reinforced insulation and protected by means of a thermally sensitive device. The sheet insulating material should also provide protection for the splices and crossover leads if present.
- e) Other constructions that examination and tests show are equivalent to those specified in (a)-(d).

23.2.2 Thermal protection, where required in 23.2.1(c) or (d), is to be such that the temperature of the insulating material used to separate the primary and secondary or adjacent secondary windings from grounded metal or each other cannot exceed the values specified in 55.1.1 during performance of the overload and short circuit tests described in 55.2.1 – 55.2.8.

23.3 Nonpatient equipment

23.3.1 In determining compliance with 23.1.2, any of the methods described in 23.2.1 shall be used, and the product shall also comply with the tests outlined in 55.2.1 - 55.2.8 except that thermal protectors or double or reinforced insulation is not required.

24 Valves and Solenoids

24.1 The coil of an electrically operated valve or solenoid shall not overheat when the product is subjected to the Temperature and Pressure Test, Section 36, and the Heating Test, Section 37.

24.2 An electrically operated valve or solenoid shall comply with the requirements of the Burnout Tests – Components, Section 47.

24.3 If a valve must be cleaned periodically, the arrangement shall permit this operation to be performed without damage to the electrical parts of the valve or wiring.

23.4 Coil windings of electrically operated valves or solenoids shall be impregnated, dipped, varnished, or otherwise treated to resist absorption of moisture.

25 Spacings

25.1 High-voltage circuits

25.1.1 A high-voltage circuit is one involving a potential of not more than 600 volts and having circuit characteristics in excess of those of a low-voltage circuit as defined in 25.4.1.

25.1.1 revised May 15, 1996

25.1.2 Unless specifically noted otherwise, the spacings between uninsulated live parts of opposite polarity and between an uninsulated live part and a dead-metal part shall be not less than the values indicated in Table 25.1.

25.1.2 revised May 15, 1996

25.1.3 The spacings indicated in Table 25.2 are applicable to electrical components mounted in totally enclosed compartments that are nonrefrigerated, nonair-handling, or both, and that are free of moisture, including that caused by condensation. At wiring terminals and for circuits over 250 volts or over 2000 volt-amperes spacings in Table 25.1 apply.

25.1.3 revised May 15, 1996

Table 25.1
Electrical spacings in refrigerated and/or air-handling compartments

		Minimum spacing in Inches(mm)		
Ratings		Through air ^a	Over surface ^a	To enclosure ^c
Volt-amperes	Volts			
2000 or less	300 or less	1/8 ^b (3.2)	1/4 (6.4)	1/4 (6.4)
2000 or less	301 – 600	3/8 (9.5)	1/2 (12.7)	1/2 (12.7)
More than	150 or less	1/8 ^b (3.2)	1/4 (6.4)	1/2 (12.7)
2000	151 – 300	1/4 (6.4)	3/8 (9.5)	1/2 (12.7)
	301 – 600	3/8 (9.5)	1/2 (12.7)	1/2 (12.7)

^a At points other than field-wiring terminals, the spacings for heater elements only may be as indicated below provided the elements are not subject to moisture, such as may result from condensation on cooled surfaces:
 1/16 inch (1.6 mm) Through Air and Over Surface for heaters rated 0 – 300 volts.
 1/4 inch (6.4 mm) Through Air and Over Surface for heaters rated 301 – 600 volts.

^b The spacings between wiring terminals of opposite polarity or between a wiring terminal and ground shall be not less than 1/4 inch (6.4 mm), except that if short-circuiting or grounding of such terminals will not result from projecting strands of wire, spacing need not be greater than that given in the above Table. Wiring terminals are those connected in the field and not factory wired.

^c Includes fittings for conduit or metal-clad cable.

Table 25.1 revised May 15, 1996

25.1.4 The "Through Air" and "Over Surface" spacings given in Tables 25.1 and 25.2 at an individual component part are based on the total volt-ampere (VA) consumption of the load or loads which the component controls. For example, spacings at a component which controls only the compressor motor are based on the VA of the compressor motor.

The spacings at a component which controls loads in addition to the compressor motor are based on the sum of the volt-amperes of the loads so controlled, except that spacings at a component which independently controls separate loads are based on the volt-amperes of the larger load. The volt-ampere values for the loads referred to above are to be determined by the marked rating of the loads, except that for loads which are not required to have a marked rating, the measured inputs is to be used in determining the volt-ampere values.

25.1.4 revised May 15, 1996

Table 25.2
Spacings in nonrefrigerated and/or nonair handling compartments

Ratings		Minimum spacing in inches (mm)					
Volt-amperes	Volts	Through air		Over surface		To enclosure ^a	
0 – 2000	0 – 125	1/16	(1.6 mm)	1/16	(1.6 mm)	1/4	(6.4 mm)
	126 – 250	3/32	(2.4 mm)	3/32	(2.4 mm)	1/4	(6.4 mm)
NOTE – See 25.1.3.							
^a Includes fittings for conduit or metal-clad cable.							

Table 25.2 revised May 15, 1996

25.1.5 All uninsulated live parts connected to different circuits shall be spaced from one another as though they were parts of opposite polarity in accordance with the requirements indicated above and shall be based on the highest voltage involved.

25.1.5 revised May 15, 1996

25.1.6 With reference to 25.1.2 and 25.1.4, the To Enclosure spacings are not to be applied to an individual enclosure of a component part within an outer enclosure or cabinet.

25.1.6 revised May 15, 1996

25.1.7 The spacings requirements specified in 25.1.1 – 25.1.6 do not apply to the inherent spacings of a component part of the product, such as a hermetic motor-compressor, motor, snap switch, controller, attachment plug, or the like, for which spacing requirements are given in a standard for the component. See 2.1.1. However, the electrical clearance resulting from the assembly of the components into the complete product, including clearance to dead metal or enclosures, shall be those indicated.

25.1.7 revised May 15, 1996

25.1.8 If higher than rated potential is developed in a motor circuit through the use of capacitors, the rated voltage of the system shall be employed in applying the spacings indicated in this section.

Exception: If the developed steady-state potential as determined in the Temperature and Pressure Test, Section 36, and Heating Test, Section 37, exceeds 500 volts, the developed potential is to be used in determining the spacings for the parts affected.

25.1.8 revised May 15, 1996

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 *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 dead 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 is 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 and quantity of refrigerant employed in the system shall comply with the Safety Code for Mechanical Refrigeration, ANSI/ASHRAE 15-1989.

26.1 revised February 22, 1994

26.2 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,

Table 36.1
Maximum temperature rises (Cont'd)

Device or material	Degrees	
	C	F
E. Electrical Insulation — General		
1. Fiber used as electrical insulation or cord bushings	65	117
2. Phenolic composition used as electrical insulation or as parts where failure will result in a hazardous condition	125	225
3. Thermoplastic material. Rise based on temperature limits of material	—	—
^a Thermocouple applied directly to the integral insulation of the coil conductor. ^b Thermocouple applied as in (a) or applied to conventional coil wrap. ^c For an electrolytic capacitor which is physically integral with or attached to a motor, the temperature rise on insulating material integral with the capacitor enclosure may be not more than 65°C (117°F). ^d A capacitor which operates at a temperature higher than a 65°C (117°F) rise may be judged on the basis of its marked temperature rating. ^e Maximum — not rise.		

36.8 The product is placed within a room maintained at 40°C (104°F) and 26.7°C (80°F) wet bulb until the assembly reaches room temperature. Lights and/or other electrical loads which may operate concurrently with the condensing unit are to be energized during the test. The assembly is then started and operated until temperatures and pressures have stabilized. The potential is maintained as indicated in 32.1. The electrical input, the temperature of electrical components and surfaces, and high- and low-side pressures are recorded at intervals during the test.

36.9 For the test of a product of the water-cooled type, the condenser water flow is to be maintained at 80°F (26.7°C) inlet and 100°F (37.8°C) outlet temperatures. If 100°F (37.8°C) outlet water cannot be attained due to design, the product is to be tested at 80°F (26.7°C) inlet water and 35 psig (241 kPa) nominal pressure.

36.10 The product is to comply with the Dielectric Voltage Withstand Test following the Temperature and Pressure Test.

37 Heating Test

37.1 A hot gas, reverse cycle, bypass cycles, or electric heating cycle shall not result in overheating of flammable material, wiring insulation, motor windings, insulation of electric valves, or other electrical components, shall not cause excessive pressures in the refrigeration system, and shall not result in water draining on uninsulated live parts or collecting within enclosures for electrical parts or wiring.

37.2 Overheating of these materials is considered to occur if the temperature rises measured in this test exceed the permissible temperature rises for the insulating material as tabulated in Table 36.1.

37.3 Excessive pressures in the system occur if they exceed one-fifth of the ultimate strength of high- or low-side parts as determined by the Strength Tests.

37.4 Thermocouples are attached to flammable material, electrical components, and electrical insulation which may be affected by operation of the system.

37.5 The product is to be placed in a room ambient of 25°C (77°F) and the controls adjusted to cause maximum heating.

37.6 Temperatures and electrical input are to be measured at intervals during the heating cycle. When required by 37.1, the maximum high- and low-side pressures are to be recorded as reference values for the Strength Tests - Pressure Containing Components.

37.7 Upon completion of the heating cycle, the assembly is to be examined to determine if water contacts uninsulated live parts or collects within the enclosure of electrical parts or wiring.

37.8 The heating system is to comply with the Dielectric Voltage Withstand Test following the Heating Test.

38 Dielectric Voltage Withstand Test

38.1.1 **38.1.1 revised and combined with 38.1.2 and relocated as 38.1 May 15, 1996**

38.1.2 **38.1.2 revised and combined with 38.1.1 and relocated as 38.1 May 15, 1996**

38.1.3 **38.1.3 deleted May 15, 1996**

38.1.4 **38.1.4 deleted May 15, 1996**

38.1.5 **38.1.5 revised and relocated as 38.4 May 15, 1996**

38.2.1 **38.2.1 deleted May 15, 1996**

38.2.2 **38.2.2 revised and relocated as 38.3 May 15, 1996**

38.2.3 **38.2.3 deleted May 15, 1996**

38.2.4 **38.2.4 deleted May 15, 1996**

38.2.5 **38.2.5 deleted May 15, 1996**

38.3.1 **38.3.1 deleted May 15, 1996**

38.4.1 **38.4.1 deleted May 15, 1996**

38.4.2 **38.4.2 deleted May 15, 1996**

38.4.3 **38.4.3 deleted May 15, 1996**

38.1 A product shall withstand, without breakdown, a test potential applied for 1 minute between high-voltage live parts and dead metal parts and between live parts of high-voltage and low voltage circuits. The test potential shall be 1000 V plus twice rated voltage at any frequency between 40 and 70 hertz.

Exception No. 1: The test potential for units rated at not more than 1/2 horsepower (373 watts output) shall be 1000 V.

Exception No. 2: If the steady-state voltage developed in a motor circuit through the use of capacitors exceeds 500 V, as measured during the temperature and pressure test, the test potential for the parts affected shall be 1000 V plus twice the developed capacitor voltage.

38.1.1 and 38.1.2 revised, combined and relocated May 15, 1996

38.2 Equipment employing a low-voltage circuit shall withstand, without breakdown, a test potential of 500 volts applied for 1 minute between low-voltage live parts and dead metal parts. The test potential shall be at any frequency between 40 and 70 hertz. If components specified in paragraph 25.4.3 are employed in the low-voltage circuit, the dielectric voltage withstand test shall also be conducted between live parts of opposite polarity.

38.2 added May 15, 1996

38.3 With reference to the previous paragraph, the test between low-voltage parts of opposite polarity is to be conducted on magnet coil windings of the transformer after breaking the inner coil lead where it enters the layer. This opposite polarity test may be waived on the complete assembly provided that the components have been separately subjected to this test.

38.2.2 revised and relocated as 38.3 May 15, 1996

38.4 A 500 volt-ampere or larger transformer, the output voltage of which is essentially sinusoidal and can be varied, is to be used to determine compliance with the previous paragraphs. The applied potential is to be increased gradually from zero until the required test value is reached and is to be held at that value for 1 minute.

Exception: The requirement of a 500 volt-ampere or larger transformer can be waived if the high potential testing equipment maintains the specified high potential voltage at the equipment during the duration of the test.

38.1.5 revised and relocated as 38.4 May 15, 1996

38.5 If the charging current through a capacitor or capacitor-type filter connected across the line, or from line to earth ground, is large enough to make it impossible to maintain the required alternating-current test potential, the capacitors and capacitor-type filters may be tested as described in 38.6.

38.5 added May 15, 1996

38.6 The capacitors and capacitor-type filters mentioned in 38.5 are to be subjected to a direct-current test potential of 1414 volts for equipment rated 250 volts or less or 1414 volts plus 2.828 times the rated circuit voltage for equipment rated at more than 250 volts. The direct-current test potential is to be maintained for 1 minute without breakdown.

38.6 added May 15, 1996

38.7 Components providing a d.c. path in parallel with the insulation to be tested, such as discharge resistors for filter capacitors and voltage limiting devices (transient voltage suppressors), may be disconnected during the test.

38.7 added May 15, 1996

38.8 If the circuit is a patient connected circuit, then in addition to any applicable tests in 38.1 - 38.7, a 60 Hz essentially sinusoidal potential of 2500 volts is to be applied between primary circuits and the patient connected circuits. See 3.14.

38.8 added May 15, 1996

39 Condenser Fan Motor Failure Test

39.1 A product shall not be exposed to hazardous pressure or temperature or leak refrigerant if the condenser fan motor locks or fails to start.

39.2 The requirement in 39.1 will be complied with if:

a) The refrigeration system does not rupture or develop leaks during the test. The maximum high- and low-side pressures are to be recorded as reference values for the Strength Test requirement. An assembly employing a pressure-limiting device conforming with 29.1 or 29.2, as applicable, is considered to comply with the high-side pressure requirement.

b) The maximum temperature of the compressor enclosure, of the fan motor winding (open type), or of the fan motor enclosure (enclosed type) does not exceed 150°C. Compressors and condenser fan motors equipped with thermal protective devices as specified in 18.7 and 18.8 are considered to comply with this requirement.

39.3 A sample of the assembly is to be fitted with a pressure gauge on the high-pressure side of the refrigeration system and provided with thermocouples on the compressor enclosure and condenser fan motor winding (open type) or condenser fan motor enclosure (enclosed type). When evaluating low-side components for compliance with the strength requirement of 57.10, a pressure-gauge is to be fitted on the low-side of the system. The low-side pressure is to be recorded while the compressor is operating and after shutdown. The controls are to be set for maximum cooling and the product is operated with the condenser fan motor locked until stabilized temperatures and pressures are reached. The compressor motor overload device and/or the fan motor overload device may operate during this test. The test ambient temperature is approximately 25°C (77°F). The potential is maintained as indicated in 32.1. If two or more condenser fan motors are employed, the test is to be conducted with one motor locked.

40 Condenser Water Failure Test

40.1 A water-cooled product shall not be exposed to hazardous pressure or leak refrigerant during water failure.

40.2 The requirement of 40.1 will be complied with if:

a) The refrigeration system does not rupture or develop leaks during the test. The maximum high- and low-side pressures are to be recorded as reference values for the Strength Tests - Pressure Containing Components requirements.

b) The maximum temperature of the compressor enclosure does not exceed 150°C. If the compressor is equipped with a thermal protective device(s) as specified in 18.7, this temperature test may be waived.

40.3 A sample of the assembly is to be fitted with a pressure gauge on the high-pressure side of the refrigeration system and provided with thermocouples on the compressor enclosure. When evaluating low-side components for compliance with the strength requirement of 57.10, a pressure gauge is to be fitted on the low side of the system. The low-side pressure is to be recorded as specified in 39.3. The product is to be operated with the condensing water shut off and also with the condensing water restricted until maximum stabilized temperatures are reached or until representative maximum temperatures are attained under cycling

Table 53.1
Accelerated aging test criteria

Measured temperature rise degrees		Material	Test program
C	(F)		
35	(63)	Neoprene	Air oven aging for 70 hours at $100 \pm 2^{\circ}\text{C}$ ($212 \pm 3.6^{\circ}\text{F}$)
35	(63)	Thermoplastic	7 days in an air circulating oven at 100°C (212°F)
50	(90)	Neoprene	Air oven aging for 168 hours at $100 \pm 2^{\circ}\text{C}$ ($212 \pm 3.6^{\circ}\text{F}$)
50	(90)	Thermoplastic	10 days in an air circulating oven at 100°C (212°F)
55	(99)	Neoprene or thermoplastic	7 days in an air circulating oven at 113°C (235.4°F)
65	(117)	Neoprene	10 days in an air circulating oven at 121°C (249.8°F)
65	(117)	Thermoplastic	7 days at 121°C (249.8°F) or 60 days at 97°C (206.6°F) in an air-circulating oven
80	(144)	Neoprene or thermoplastic	7 days in an air circulating oven at 136°C (276.8°F)
100	(180)	Neoprene or thermoplastic	60 days in an air circulating oven at 136°C (276.8°F)
125	(225)	Neoprene or thermoplastic	60 days in an air circulating oven at 158°C (316.4°F)
175	(315)	Neoprene or thermoplastic	60 days in an air circulating oven at 210°C (410°F)

Table 53.1 revised May 15, 1996

54 Reliability Test — Heater Termination

54.1 Electric heaters employing integrally molded leads or molded terminal assemblies shall withstand a test load of 20 pounds-mass (9.1 kg) applied for a 1 minute. The load is to be applied in the same direction at which the lead exits the heater case or molded connection and shall not result in displacement of insulation or separation of the connection between the lead and the heater.

55 Abnormal Operation Test

55.1 General

55.1.1 If the conditions of normal operation are not representative of abnormal conditions that can occur in actual service, a product shall not result in a risk of electrical shock or fire when operated under abnormal conditions and a transformer shall not experience temperature rises greater than indicated in Table 55.1.

Table 55.1
Acceptable temperature rises

Type of protection	Degrees C maximum		Degrees C average	
	Class 105 or A Insulation	Class 130 or B Insulation	Class 105 or A Insulation	Class 130 or B Insulation
Impedance	135	160	—	—
Thermal Cut-Out				
Automatic Reset				
1. During first hour of operation	175	200	—	—
2. After first hour of operation	150	175	125	150
Manual Reset				
1. During first hour of operation, or during the first 10 cycles of operation mentioned in 55.2.8 whichever is the shorter interval.	175	200	—	—
2. After first hour of operation, if the first 10 cycles of operation mentioned in 55.2.8 require more than 1 hour for completion	150	175	—	—
Fusible and Nonresettable Devices				
1. Before opening during first hour of operation	175	200	—	—
2. Opening after first hour of operation	150	175	—	—

55.1.2 To determine if an electrical shock or risk of fire actually exists, separate tests are to be conducted with the product or specific portion thereof operating until the ultimate results have been observed. Unless otherwise indicated, each test is to be conducted in accordance with the Temperature and Pressure Test and the Heating Test. The product is to be connected in series with a nontime-delay fuse of the maximum current rating that can be accommodated by the fuseholder of the branch circuit to which the product can be connected. For each test of cord connected products, the grounding means shall be interrupted, and a separate connection which includes a 1 ampere fuse shall be made between the enclosure and ground. For permanently connected products, the normal grounding means shall be employed. In most cases, continuous operation for 7 hours will be necessary to assure that the ultimate result has been observed. A cord connected product is to be placed on white tissue paper on a softwood surface.

55.1.3 Extractor type fuses that are accessible for operator (user) servicing shall be effectively defeated during each test. However, fuses which are soldered in place or are located to be accessible only to qualified service personnel and marked in accordance with 66.3.1 may be left in the circuit under test. Similarly, other overcurrent (overload) protective devices not subject to user-replacement may be left in the circuit.

55.1.4 When operated under such abnormal conditions, a risk of fire is considered to exist if there is any emission of flame or molten metal, other than drops of melted solder, or if the operation of the product results in the glowing or flaming of flammable material upon which the product may be placed or which may be placed around it, or, in the case of a permanently installed product, which may be in proximity to the installed product.

55.1.5 An electrical shock is considered to exist if:

- a) The ground fuse opens during the test (cord connected products only); or
- b) The product is, or appears to be, usable and it fails the Dielectric Voltage Withstand Test specified in 38.1.1 – 38.4.2 or the Leakage Current Test specified in 33.7.1.1 – 33.7.3.2.

55.1.5 revised May 15, 1996

55.1.6 A product which is obviously not usable or which involves exposure of current-carrying parts is considered to involve an electrical shock if the leakage current at an accessible part is more than 0.5 milliamperes when measured in accordance with 33.7.1.1 – 33.7.3.2.

55.1.7 Opening of the branch circuit fuse noted in 55.1.2, or the product protective device noted in 55.1.3 before any of the conditions described in 55.1.4 – 55.1.6 result, is considered to be an acceptable conclusion of a test.

55.1.8 Some specific abnormal test conditions are described in 55.2.1 – 55.3.4. However, products having features not contemplated in these test procedures may be tested as necessary to meet the intent of these requirements.

55.2 Transformers

55.2.1 A transformer as noted in 23.2.1 is to be subjected to continuous operation under applicable overload conditions, including short-circuiting of the secondary (or patient) circuit winding or windings.

55.2.2 If a transformer has more than one secondary winding, or a tapped secondary winding, separate test are to be performed for each winding or each section of the tapped winding, with the other windings loaded and unloaded, unless it can be determined that one condition will produce the most unfavorable result.

55.2.3 In conducting the tests noted in 55.2.1, a transformer with inherent temperature-limiting characteristics is to be operated continuously with the secondary winding, or sections of a tapped winding, short-circuited and the primary connected to a supply circuit in accordance with 32.1. Temperature is to be determined by the resistance method.

55.2.4 If a transformer is not inherently temperature limited but is used with thermal or overcurrent protection, the tests are to be made with the secondary winding or windings loaded to result in the maximum current input to the transformer without causing the protective device to open and also with the secondary winding or windings short-circuited.

55.2.5 For transformers with thermal or overcurrent protection, temperatures are to be measured by thermocouples consisting of wires not larger than No. 30 AWG (0.05 mm²) placed on the surfaces of coils of all windings. A thermocouple for measuring a coil temperature is to be applied to the conductor metal, or it is to be separated from the metal material by the integral conductor insulation.

55.2.6 In conducting the short-circuit test on a transformer with an automatic-reset protector, the transformer is to be energized for 360 hours (15 days) with the secondary winding short-circuited. The transformer is to be at room temperature at the beginning of the test.

55.2.7 The average temperature rise noted in Table 55.1 is to be determined as follows:

- a) The curve or graph of temperature plotted against time is to be obtained for the 2nd hour and also for the 360th hour.
- b) During each of these periods, the average temperature is to be determined by taking the arithmetic mean:
 - 1) Of the maximum temperatures and
 - 2) Of the minimum temperatures.

55.2.8 In conducting the short-circuit test on a transformer with a manual-reset protector, it is to be operated for 50 cycles under secondary short-circuit conditions with the protector being reclosed as quickly as possible after it has opened the circuit. The test is to be started with the transformer at room temperature.

55.3 Electrolytic capacitor and rectifier short-circuit tests

55.3.1 If an electrolytic capacitor, a rectifier (vacuum-tube or solid state), and a resistance are connected in series across a supply circuit, tests are to be performed involving short-circuiting singly of either the capacitor or the rectifier.

55.3.2 A single layer of cheesecloth is to be loosely draped over the product as a whole with the cloth within 1/8 inch (3.2 mm) of openings in the overall enclosure. The supply-circuit connection is to be such that the maximum potential exists between the series resistor and the chassis.

55.3.3 If a vacuum-tube rectifier is employed, the plate and cathode terminals of the rectifier are to be connected together. The test is to be repeated with only the cathode and heater terminals connected together if this condition was not represented by the first test. If a solid state rectifier is employed, tests are to be conducted with the rectifier terminals connected together. Three complete tests are to be made under each of the conditions described.

55.3.4 Three additional tests are to be conducted with the terminals of the electrolytic capacitor connected together.

56 Printed Wiring Assembly Tests

56.1 Dielectric voltage withstand

56.1.1 If electrical breakdown would result in an electrical shock, a printed wiring assembly shall be capable of withstanding for a period of 1 minute, without breakdown, the application of a direct potential of $2E \pm 1000$ volts between printed wiring parts, and between printed wiring parts and other parts.

56.1.2 E is the maximum peak potential between parts measured with the product connected to a supply circuit operated under the conditions described in 38.4.1 and 38.4.2.

Table 60.1
Leakage test pressure

Deleted Table 60.1 effective August 25, 1995

60.2 If the final assembly is completed with flare-type fittings or telescoped tubing joints which are sealed with silver solder, brazing, or equivalent means, the pressure test on the complete system may be at the low-side design pressure provided the high-side parts are individually tested either by the product manufacturer or by the manufacturer of the part at not less than the high-side design pressure.

Exception: The following high-side components need not be pressure tested at the high-side design pressure:

- a) *Components that are formed by spinning down the ends of a single piece of copper tubing meeting the minimum wall thickness requirements; and*
- b) *Components constructed of continuous tubing meeting the minimum wall thickness requirements.*

Revised 60.2 effective August 25, 1995

60.3 *60.3 deleted February 22, 1994*

60.4 *60.4 deleted February 22, 1994*

60.5 At least once each year, the manufacturer shall conduct a strength test on refrigerant-containing parts of the shell type, including compressor shells which have an inside diameter greater than 3 inches (76.2 mm), except that ASME Code vessels bearing the Code "U" symbol need not be retested. The tests shall be conducted on at least one sample of each size and type. The sample shall not fail when subjected to pressures indicated under the Strength Tests, Section 57.

61 Production Line Dielectric Voltage Withstand Test

61.1 Each product shall withstand without electrical breakdown, as a routine production-line test, the application of a potential at a frequency within the range of 40 – 70 hertz, or a dc potential:

- a) Between the primary wiring, including connected components, and accessible dead metal parts that are likely to become energized; and
- b) Between primary wiring and accessible low-voltage, 42.4 volts peak or less, metal parts, including terminals.

61.1 revised May 15, 1996

61.1.1 The production-line test shall be conducted in the time and at the potential specified in either Condition A or Condition B of Table 61.1.

61.1.1 added May 15, 1996

Table 61.1
Production-line test conditions

Product rating	Condition A			Condition B		
	Potential, volts ac ^c volts dc		Time, seconds	Potential, volts ac ^c volts dc		Time, seconds
250 volts or less with no motor rated more than 1/2 horsepower (373 watts output)	1000	1400	60	1200	1700	1
250 volts or less with a motor rated more than 1/2 horsepower (373 watts output)	$1000 + 2V^a$	$1400 + 2.8V^a$	60	$1200 + 2.4V^a$	$1700 + 3.4V^a$	1
251 – 600 volts	$1000 + 2V^b$	$1400 + 2.8V^b$	60	$1200 + 2.4V^b$	$1700 + 3.4V^b$	1
^a Maximum marked voltage but not less than 120 volts if the maximum marked voltage is within the range 105 – 120 volts, and not less than 240 volts if the maximum marked voltage is within the range 210 – 240 volts. ^b Maximum marked voltage. ^c Where there are capacitors across the insulation under test (e.g. radio-frequency filter capacitors), it is recommended that d.c. test voltages are used.						

Table 61.1 added May 15, 1996

61.2 For equipment employing low-voltage circuits, the test is to be conducted with the low-voltage circuit connected to the cabinet, chassis, or other dead metal part so that the potential applied between the high-voltage live parts and dead metal parts will simultaneously be applied between high-voltage live parts and low-voltage circuits.

61.2 revised May 15, 1996

61.2.1 The test shall be conducted when the product is fully assembled. It is not intended that the product be unwired, modified, or disassembled for the test.

Exception No. 1: A part, such as a snap cover or friction-fit knob, that would interfere with the performance of the test need not be in place.

Exception No. 2: The test may be performed before final assembly if the test represents that for the completed product. Any component not included shall not affect the results with respect to determination of possible risk of electric shock resulting from miswiring, defective component, insufficient spacings, and the like.

61.2.1 added May 15, 1996

61.3 Solid-state and similar components that might be damaged by a secondary effect (induced voltage surge, excessive heating, and the like), of the test may be short-circuited by means of a temporary electrical jumper or the test may be conducted without the component electrically connected, providing the wiring and terminal spacings are maintained. Additionally, components providing a d.c. path in parallel with the insulation to be tested (primary to dead-metal) may be disconnected during the test. Examples of such components are discharge resistors for filter capacitors and voltage limiting devices such as transient voltage suppressors (other than capacitors).

61.3 revised May 15, 1996

61.4 If the output of the test-equipment transformer is less than 500 volt-amperes, the equipment shall include a voltmeter in the output circuit to directly indicate the test potential.

61.4 revised May 15, 1996

61.5 The test equipment shall have a means of indicating the test potential, an audible or visual indicator of electrical breakdown, and either a manually reset device to restore the equipment after electrical breakdown or an automatic reject feature of any unacceptable unit. When an ac test potential is applied, the test equipment shall include a transformer having an essentially sinusoidal output.

61.5 revised May 15, 1996

61.6 If the output of the test-equipment transformer is 500 volt-amperes or more, the test potential may be indicated:

- a) By a voltmeter in the primary circuit or in a tertiary-winding circuit,
- b) By a selector switch marked to indicate the test potential, or
- c) For equipment having a single test-potential output, by a marking in a readily visible location to indicate the test potential. If marking is used without an indicating voltmeter, the equipment shall include a positive means, such as an indicator lamp, to indicate that the manually reset switch has been reset following a dielectric breakdown.

61.6 added May 15, 1996

61.7 Test equipment other than that described in the preceding paragraphs may be used if found to accomplish the intended factory control.

61.7 added May 15, 1996

61.8 During the test, the primary switch is to be in the on position, both sides of the primary circuit of the product are to be connected together and to one terminal of the test equipment, and the second test-equipment terminal is to be connected to the accessible dead metal.

Exception: A product having circuitry – resistive, high-impedance winding, or the like – not subject to excessive secondary-voltage build-up in case of electrical breakdown during the test may be tested:

- a) *With a single-pole primary switch, if used, in the off position, or*
- b) *With only one side of the primary circuit connected to the test equipment when the primary switch is in the on position, or when a primary switch is not used.*

61.8 added May 15, 1996

62 Production Line Grounding Continuity Test

62.1 The manufacturer shall test each product which has a power supply cord to assure electrical continuity between the device and the grounding blade of the attachment plug as required by 12.1.

62.2 An indicating device such as an ohmmeter, low-voltage battery- and buzzer-combination, or the like may be employed in the test mentioned in 62.1.

62.3 Where internal parts as referred to in 12.1 are determined in the investigation of the device to be bonded to the frame and enclosure of the product, a test which determines the electrical continuity between the grounding blade and the frame or enclosure is sufficient for establishing compliance with 62.1.

MARKING

63 General

63.1 Unless specifically indicated otherwise, every marking required in 63.3 – 66.5.1 and elsewhere in this Standard shall be permanent.

63.2 A marking that is required to be permanent shall be molded, die-stamped, paint-stenciled, stamped, or etched metal that is permanently secured, or stamped on pressure-sensitive labels which comply with the Marking Label Adhesion Tests, Section 58. Ordinary usage, handling, and storage of the product is considered in the determination of the permanence of the marking.

63.3 Each product shall be marked with:

- a) The manufacturer's or private labeler's name or identifying symbol.
- b) A distinctive type or model designation.
- c) The electrical rating.
- d) The kind and amount of refrigerant in pounds (kg x 2.2) and/or ounces (kg x 35.4).
- e) The high- and low-side design pressures.
- f) The date of manufacture of the product.

Revised 63.3 effective August 25, 1995

63.4 With reference to the requirements of 63.3 (f), the date of manufacture may be by month and year, or quarter and year, or equivalent. This information, which may be in code, shall be located on or near the nameplate.

**Underwriters Laboratories Inc.®**A not-for-profit organization dedicated to public safety
and committed to quality service**February 22, 1994****Revision pages for****Standard for****Refrigerated Medical Equipment****UL 416, Fourth Edition**

Attached to this transmittal notice is a revision of the Fourth edition of UL 416.

A CHANGE ON A PAGE DATED FEBRUARY 22, 1994 IS INDICATED BY A SMALL PRINT NOTE FOLLOWING THE AFFECTED ITEM, PRECEDED AND FOLLOWED BY AN ASTERISK.

THESE NEW AND REVISED REQUIREMENTS ARE NOW IN EFFECT EXCEPT FOR 29.2, 40.5, 57.1 – 57.12, 60.1, 60.2, 63.3, 63.21, AND TABLE 60.1, WHICH BECOME EFFECTIVE AUGUST 25, 1995 AS INDICATED IN THE SMALL PRINT NOTE FOLLOWING THE AFFECTED ITEM. TO RETAIN THE REQUIREMENTS IN EFFECT UNTIL AUGUST 25, 1995, DO NOT DISCARD THE PREVIOUS PAGES CONTAINING THE REQUIREMENTS SPECIFIED ABOVE UNTIL THIS FUTURE EFFECTIVE DATE.

New product submittals made prior to a specified future effective date will be judged under all of the requirements in this standard unless the applicant specifically requests that the product be judged under the current requirements. However, should the applicant elect this option, it should be noted that compliance with all the requirements in this standard will be required as a condition of continued Listing and Follow-Up Services after the effective date and understanding of this should be signified in writing.

The new and revised requirements are substantially in accordance with UL's bulletin on this subject dated September 13, 1993. The bulletin is now obsolete and may be discarded.

Revised and/or additional pages may be issued from time to time.

With the inclusion of the accompanying material, the standard consists of pages dated as shown in the following checklist:

Page	Date
1	August 30, 1993 (Reprinted: February 22, 1994)
2	August 30, 1993
3	February 22, 1994
4 – 22	August 30, 1994

**Documents**

Document Sharing Hub

February 22, 1994 – UL 416

Page	Date
23	February 22, 1994
24	August 30, 1993
25 – 26A, 27 – 28A	February 22, 1994
29 – 43	August 30, 1993
44	February 22, 1994
45	August 30, 1993
46	February 22, 1994
47 – 64	August 30, 1993
65	February 22, 1994
66 – 79	August 30, 1993
80, 80A, 81 – 86A	February 22, 1994
87 – 92, A1	August 30, 1993

AUGUST 30, 1993

(Title Page Reprinted: February 22, 1994)

1

UL 416

Standard for

Refrigerated Medical Equipment

First Edition – August, 1956

Second Edition – May, 1973

Third Edition – July, 1978

The First and Second Editions were titled Standard for Oxygen Therapy Equipment, Refrigerated.

Fourth Edition

August 30, 1993

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

Revisions of this standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest published set of revision pages.

ISBN 1-55989-466-0

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(1 – 08/30/93 – 02/22/94)

CONTENTS**FOREWORD****INTRODUCTION**

1 Scope	5
2 General	5
3 Glossary	6
4 Installation and Operating Instructions	8

CONSTRUCTION

5 General	8
6 Assembly	9
7 Accessories	14
8 Enclosures	15
9 Field Supply Connections	20
10 Internal Wiring and Wiring Methods	25
11 Separation of Circuits	29
12 Bonding for Grounding	30

ELECTRICAL COMPONENTS

13 Capacitors	33
14 Current-Carrying Parts	33
15 Electric Heaters	34
16 Insulating Material	35
17 Lampholders and Lamps	35
18 Motors and Motor Overload Protection	35
19 Overcurrent Protection	38
20 Printed Wiring	38
21 Receptacles	38
22 Switches and Controllers	39
23 Transformers	40
24 Valves and Solenoids	41
25 Spacings	42

REFRIGERATION SYSTEM

26 Refrigerant	44
27 Refrigerant Tubing and Fittings	44
28 Refrigerant-Containing Parts	45
29 Pressure Limiting Device	46
30 Pressure Relief	46

PERFORMANCE

31 Instrumentation	48
32 Test Voltage	49
33 Leakage Current Test	49
34 Input Test	56
35 Starting Test	56

36	Temperature and Pressure Test	57
37	Heating Test	61
38	Dielectric Voltage Withstand Test	62
39	Condenser Fan Motor Failure Test	64
40	Condenser Water Failure Test	64
41	Overflow Test	65
42	Cleaning and Sterilization Test	65
43	Stability Test	66
44	Mechanical Abuse	67
45	Grounding Impedance Test	67
46	Endurance Test – Heater Control	67
47	Burnout Tests	68
48	Overvoltage and Undervoltage Tests	69
49	Current Overload Test – Bonding Conductors and Connections	70
50	Insulation Resistance Test	70
51	Limited Short-Circuit Test	71
52	Protective Devices – Maximum Continuous Current Test	72
53	Accelerated Aging Test – Electric Heaters	74
54	Reliability Test – Heater Termination	75
55	Abnormal Operation Test	75
56	Printed Wiring Assembly Tests	78
57	Strength Test – Pressure Containing Components	80
58	Marking Label Adhesion Tests	81
59	Additional Tests	82

MANUFACTURING AND PRODUCTION TESTS

60	Pressure Test	82
61	Production Line Dielectric Voltage Withstand Test	83
62	Production Line Grounding Continuity Test	84

MARKING

63	General	84
64	Permanently Connected Products	86A
65	Cord Connected Products	90
66	Caution and Warning Markings	90

APPENDIX A

Standards for Components	A1
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FOREWORD

A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.

D. A product employing materials or having forms of construction differing from those detailed in the requirements of this Standard may be examined and tested according to the intent of the requirements and, if found to be substantially equivalent, may be judged to comply with the Standard.

E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard.

F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

9.2.15 Upturned lugs or a cupped washer shall be capable of retaining a conductor of the size mentioned in 9.2.8 and 64.11, but no smaller than No. 14 AWG (2.1 mm²), under the head of the screw or the washer.

9.2.16 A wire binding screw shall thread into metal.

9.2.17 A field-wiring terminal intended for the connection of a grounded conductor shall be of a metal or plated with a metal substantially white in color and shall be readily distinguishable from the other terminals, or proper identification of that terminal shall be shown in some other manner, such as on an attached wiring diagram. A lead intended for the connection of a grounded conductor shall be finished to show a white or natural gray color, shall be readily distinguishable from other leads, and no other lead shall be so identified.

9.2.18 The length of a lead inside an outlet box or wiring compartment shall be 6 inches (152 mm) or more if the lead is intended for field connection to an external circuit.

Exception: The lead may be less than 6 inches (152 mm) in length if it is evident that the use of a longer lead may result in damage to the lead insulation.

9.2.19 Leads intended for connection to an external circuit shall be provided with strain relief if a strain on the lead may be transmitted to terminals, splices, or internal wiring.

9.2.20 Leads provided for spliced connections to an external high-voltage circuit shall not be connected to wire binding screws or pressure wire connectors located in the same compartment as the splice unless the screws or connectors are rendered unusable for field-wiring connections or the leads are insulated at the unconnected ends.

9.3 Cord connected products

9.3.1 A product intended for cord connection to the power supply shall be provided with a flexible cord of proper type, length, and ampacity and with an attachment-plug or proper type and rating.

9.3.2 Cord-connected products shall employ grounding-type attachment plugs.

Exception: Patient care equipment may employ either the locking type attachment plug designated "Hospital Only," or a conventional two-blade with grounding pin attachment plug designated "Hospital Grade," and shall be marked in accordance with 65.3.

9.3.2 revised February 22, 1994

9.3.3 The marked rating of a cord connected product, see 65.1, shall not exceed 80 percent of the rating of the attachment plug.

9.3.4 A cord-connected product may employ Type SO, ST, STO, SJO, SJT, or SJTO power-supply cord rated for use at a voltage not less than the rated voltage of the product. The ampacity of the cord as given in the National Electrical Code, ANSI/NFPA 70-1990 shall not be less than that required by the ampere input measured in the Temperature and Pressure Test, Section 36, the Heating Test, Section 37, or both. The ampere input value shall include the loads for convenience outlets and the current drawn by accessories intended for use with the product. See 63.9.

9.3.5 The supply cord shall be permanently attached to the product.

Exception: A separate cord set with means for connection to the product may be employed if it can be shown that unintentional disconnection is unlikely or that unintentional disconnection or the additional impedance of the ground circuit contacts will not constitute a potential risk to the patient or operator.

9.3.6 The power supply cord for a product shall be no less than 6 feet (1.8 m) nor more than 15 feet (4.6 m) in length. The length is measured between the attachment plug and:

- a) Any point at which the cord exits the product cabinet or
- b) The last strain relief, whichever is shorter.

9.3.7 The power supply cord shall be provided with strain relief means so that strain on the cord will not be transmitted to terminals, splices, or internal wiring. If a metallic strain relief means is provided, it shall not contact uninsulated live parts or reduce spacings within the enclosure if the cord is moved inward. The cord shall not be subject to damage by moving parts if it can be moved inward.

9.3.8 To determine the adequacy of the strain relief means, a 35 pound (15.9 kg) weight is to be suspended on the cord and supported by the product so that the strain relief means will be stressed from any angle which the design of the product permits. The load is to be applied for 1 minute. The strain relief is not acceptable if there is such movement of the cord as to indicate that stress would have resulted on the cord connections.

9.3.9 The edges of the entry hole for the power supply cord, including the cord entry hole in a bushing, shall be smooth and rounded without burrs, fins, or sharp edges which might damage the cord insulation. The power supply cord shall be routed to reduce the risk of damage to the cord insulation.

9.4 Grounding

9.4.1 A product shall have provision for grounding as follows:

- a) In a permanently connected product, an equipment grounding terminal or lead.
- b) In a cord connected product, an equipment grounding conductor in the cord terminating in an identified grounding terminal as specified in 9.3.7.

9.4.2 On a permanently connected product, a terminal solely for connection of an equipment-grounding conductor shall be capable of securing a conductor of the size acceptable in accordance with the National Electrical Code, ANSI/NFPA 70-1990.

9.4.3 A soldering lug, a push-in, a screwless connector, or a quick connect or similar friction fit connector shall not be used for the grounding terminal.

9.4.4 On permanently connected products, a wire binding screw intended for the connection of an equipment grounding conductor shall have a green colored head that is hexagonal, slotted, or both. Except as indicated in 9.4.5, a pressure wire connector intended for connection of such a conductor shall be plainly identified such as by being marked G, GR, GROUND, or GROUNDING, or by a marking on a wiring diagram provided on the product. The wire binding screw or pressure wire connector shall be secured to the frame or enclosure of the product and shall be located so that it is unlikely to be removed during service operations such as replacing fuses, resetting manual-reset devices, or oiling motors.

9.4.5 If a pressure wire connector intended for grounding is located where it could be mistaken for the neutral conductor of a grounded supply, it shall be identified by a marking EQUIPMENT GROUND, with a green color identification, or both.

9.4.6 On a permanently connected product, the surface of an insulated lead intended solely for the connection of an equipment grounding conductor shall be finished in a continuous green color or a continuous green color with one or more yellow stripes, and no other lead shall be so identified.

9.4.7 On cord connected products, the grounding conductor of the flexible cord shall be finished with a continuous green color or with a continuous green color with one or more yellow stripes, and no other conductor shall be so identified. The grounding conductor shall be secured to the frame or enclosure of the product by a positive means, see 12.5, that is not likely to be removed during any servicing operation not involving the power supply cord. The grounding conductor shall be connected to the grounding blade of the attachment plug.

10 Internal Wiring and Wiring Methods

10.1 General

10.1.1 All wires and cords used in a product shall be routed and supported to prevent damage due to:

- a) Sharp edges,
- b) Surfaces and parts which operate at temperatures in excess of that for which the wire insulation is rated,
- c) Moving parts, and
- d) Parts which can be expected to vibrate such as motors, motor-compressors, refrigerant lines, and the like. Clamping means are to have smooth, rounded surfaces.

10.1.2 With reference to 10.1.1, wires and cords may contact a vibrating part provided:

- a) The wiring is securely fastened to the part at the point of contact so as to restrict movement,
- b) The part does not have burrs, fins, or sharp edges which might abrade the insulation, and
- c) Vibration does not place a strain on the wiring or wiring connections.

10.1.3 Wiring shall have insulation rated for the potential involved and the temperatures to which it may be subjected. Compliance is to be judged on the basis of the temperatures measured during the applicable temperature tests specified in Sections 36 and 37.

Exception: If it can be determined that the wiring shall not be exposed to heat from radiating sources or heated components, and if the ampacity of the conductors is in accordance with Table 10.2 and 10.1.5, the temperature tests on the wiring may be waived.

10.1.3 revised February 22, 1994

10.1.4 Wiring which is color coded green or green with one or more yellow stripes shall be used only for grounding conductors. Wiring used for other purposes shall not be identified with the above color codes.

10.1.5 With reference to the Exception to 10.1.3 high voltage circuit conductors supplying one motor shall have an ampacity not less than 125 percent of the full-load current rating of the motor. Conductors supplying more than one motor shall have an ampacity not less than 125 percent of the full-load current rating of the largest motor plus the full-load current rating of any other motors supplied. Conductors supplying a motor load and other loads shall have an ampacity not less than 125 percent of the full-load current rating of the motor plus the marked current ratings or measured inputs of the additional loads supplied.

10.1.5 revised February 22, 1994

10.1.6 All wires and cords shall be routed and supported so that they will not be immersed in water unless the insulation is specifically intended for this purpose. The wiring arrangement shall be such as to prevent water from entering wiring enclosures and electrical enclosures.

Exception: Water may enter an enclosure providing:

- a) *the point of entrance is not in proximity to live electrical parts and*
- b) *the live parts are not wetted.*

10.1.7 Parallel conductor appliance wiring material of the integral type is not to be ripped more than 3 inches (76.2 mm) unless the minimum wall thickness of the conductor insulation after ripping is at least 0.058 inch (1.47 mm) in thickness. If the material has conductor insulation not less than 0.028 inch (0.71 mm) after ripping and is within a separate metal enclosure, conduit, electrical metallic tubing, or metal raceway, the length of rip is not limited.

10.1.8 If wiring extends from the cabinet to a hinged door or other parts which are moved in use, stranded conductors shall be employed, and the arrangement shall prevent twisting or stressing of conductors as a result of the movement. The wiring shall be routed or protected to prevent damage to the insulation. The conductors shall be of a jacketed type such as Type SJO or SJT and shall be provided with strain relief so that stress will not be transmitted to terminals or splices.

10.1.9 With reference to 10.1.8, wiring which is subjected to movement is to be tested by cycling the moving part through the maximum travel permitted by the design. The duration of the test is to be 100,000 cycles. Following this, the unit is to be subjected to the Dielectric Voltage Withstand Test, and the wiring is to be examined for damage to determine if any conductors are broken or if individual strands have penetrated the insulation.

10.1.10 No. 14 AWG (2.1 mm²) conductors supplying 15 ampere general purpose receptacles and No. 12 AWG (3.3 mm²) conductors supplying 20 ampere general purpose receptacles are considered as complying with the temperature requirement of 10.1.5. See 36.6.

10.1.11 The insulation of wires or cords connected to fan motors and other auxiliary motors shall be of an oil resistant type, such as Type SJO, SJT, SPT-3, or appliance wiring materials having oil resistant insulation.

10.1.12 If any failure of low-voltage wiring may cause malfunctioning of a pressure-limiting device, motor overload protective device, or other protective device which may result in unsafe operation of the product, such wiring shall be enclosed wire as indicated in 10.2.1 or shall be Type SPT-2 cord or one of the types indicated in Group B of Table 10.1. Wires of types indicated in Group A of Table 10.1, or low-energy safety control wire may be used if such wiring is located in a cavity or compartment of the product and is shielded from damage.

10.1.13 All splices and connections shall be mechanically secured and electrically bonded. A soldered connection shall be made mechanically secure before being soldered.

10.1.14 Splices shall be located within the product enclosure. They shall be secured in position or located in a separate enclosure so that they are not subject to flexing, motion or vibration due to air movement, or the like. Strain relief shall be provided on the conductors if the wiring is liable to be moved during service operations, such as replacing fuses, resetting manual-reset devices, or oiling motors.

10.1.15 A splice shall be provided with insulation equivalent to that of the wires involved if permanence of spacing between the splice and other metal parts is not assured.

Table 10.1
Typical wiring materials

Group	Type of wire, cord, or cable ^a	Wire size		Insulation thickness	
		No. AWG	mm ²	Inch	mm
A	TF, TFF, TFN, TFFN, THW, XHHW, MTW, THW-MTW, THWN, PF, PGF, PFF, PGFF, TW, or thermoplastic appliance wiring material	10 and smaller	5.3	2/64	0.8
		8	8.4	3/64	1.2
B	SO, ST, SPT-3, SJO, SJT, or appliance wiring material ^a with thermoplastic or neoprene insulation	18	0.82	4/64	1.6
		16	1.3	4/64	1.6
		14	2.1	5/64	2.0
		12	3.3	5/64	2.0
		10	5.3	5/64	2.0
		8	8.4	6/64	2.4

^a Appliance wiring recognized for refrigeration use.

Table 10.2
Wiring materials ampacities^a

Wire size		Ampacity
mm ²	AWG	
0.41	22	4
0.66	20	7
0.82	18	10
1.3	16	13
2.1	14	18
3.3	12	25
5.3	10	30
8.4	8	40
13.3	6	55
21.2	4	70
33.6	2	95
42.4	1	110

^aThe ampacities shown apply to appliance wiring materials with insulation rated not less than 90°C (194°F). For types of wires other than appliance wiring materials, the ampacity shall be determined from Tables 310-16 and 310-17 in the National Electrical Code, ANSI/NFPA No. 70-1993 for the type of wire employed. The correction factors of the referenced tables need not be applied.

Table 10.2 added February 22, 1994

10.1.16 Splicing devices, such as fixture-type splicing connectors and pressure wire connectors, may be employed if they provide mechanical security and employ insulation rated for the voltage to which they are subjected. In determining if splice insulation consisting of coated fabric, thermoplastic, or other type of tubing is acceptable, consideration is to be given to such factors as its electrical, mechanical, and flammability properties. Thermoplastic tape wrapped over a sharp edge is not acceptable.

10.1.17 Quick-connecting assemblies are to form a secure electrical connection, such as by detents in the mating parts, and are to be capable of carrying the current involved.

10.1.18 Wire binding screws shall thread into metal. At terminals, stranded conductors shall be secured by soldered or pressure-type terminal connectors or the conductors shall be soldered or otherwise assembled to prevent loose strands after assembly. Soldered connections shall be made mechanically secure before being soldered. Open-slot type connectors shall not be used unless they are constructed to prevent disconnection resulting from loosening of the clamping means. The shanks of terminal connectors shall be protected by electrical insulation if the spacings may be reduced below the minimum acceptable values by slight loosening of the clamping means. The insulating material shall be secured in position. The thickness of the insulation on the shanks shall be not less than 0.028 inch (0.71 mm) except as permitted by 25.1.9.

10.1.19 Holes in walls, panels, or barriers through which insulated wires or cords pass and on which they may bear shall be provided with smoothly rounded bushings or shall have smooth, rounded surfaces upon which the wires or cords may bear to prevent abrasion of the insulation. Bushings shall be fabricated from materials such as ceramic, phenolic, cold-molded composition, or fiber.

10.2 Permanently connected products

10.2.1 Wiring shall be of the type indicated in Table 10.1, Group A, and enclosed by means such as conduit, electrical metallic tubing, metal raceways, or control boxes. Fittings shall be constructed for use with the type of wiring enclosure employed.

Exception: Cords or appliance wiring material of a type indicated in Table 10.1, Group B, may be employed in lieu of the enclosed wiring provided the wiring is enclosed by the cabinet to prevent damage to wiring, ignition of flammable material, or emission of flame or molten metal through openings in the cabinet.

10.2.2 With reference to 10.2.1, the wiring is considered to be enclosed when the cabinet or compartment enclosing the wiring complies with the following:

- a) There are no openings in the top of the compartment unless barriers or baffles are placed between the wiring and the openings.
- b) There are no openings in the bottom unless a U-shaped channel or trough is located under the wiring, and the wires do not project through the plane of the top of the trough or channel.
- c) Louvers or openings, other than in the bottom, will not permit entrance of a rod having a diameter of 1/2-inch (12.7-mm).

d) Openings are not closer than 6 inches (152 mm) to the wiring unless barriers or baffles are placed between the wiring and the openings. A nonmetallic material employed as a barrier or baffle shall be investigated for use as an enclosure. See 8.1.6.

e) Where flammable material, other than electrical insulation, is located within the compartment, the wiring is to be separated from such material or the material shall not introduce a risk of fire.

Exception: Wiring need not be isolated as indicated above if it complies with the VW-1 flame test or the vertical flame test described in the reference Standard for Electrical Wires, Cables, and Flexible Cords, UL 1581.

10.2.3 Conductors of motor circuits having two or more thermal- or overcurrent-protected motors wired for connection to one supply line shall withstand the conditions of the Limited Short-Circuit Test, Section 51.

Exception: A conductor that complies with one or more of the following is acceptable without test:

- a) A conductor that has an ampacity of not less than one-third of ampacity of the branch circuit conductors as determined in 9.2.8, or
- b) A conductor that is No. 18 AWG (0.82 mm²) or larger and not more than 4 feet (1.2 m) in length, provided that the circuit will be protected by a fuse or "HACR Type" circuit breaker rated not more than 60 amperes, or
- c) A conductor that serves as a jumper lead between controls, provided that either the length of the lead does not exceed 3 inches (76.2 mm), or the conductor is located in an electrical control enclosure.

10.3 Cord-connected products

10.3.1 A cord-connected product shall be wired by either of the following means or combinations of the two:

- a) Cords or appliance wiring material as referenced in Table 10.1, Group B.
- b) Wiring material as referenced in Table 10.1, Group A, enclosed in conduit, electrical metallic tubing, metal raceways, control boxes, or cabinet walls.

Exception: Neoprene or thermoplastic insulated wiring material in Group A of Table 10.1 need not be enclosed as indicated above, if all of the following conditions are met:

- 1) Internal wiring shall be cabled, routed, located or secured to reduce the likelihood of damage to the wiring during routine servicing such as replacing fuses, adjusting the settings of controls, or the like; and
- 2) Internal wiring shall be separated from flammable material in accordance with 10.3.2.

10.3.1 revised February 22, 1994