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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
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 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
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 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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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.

A P P E N D I X 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. (UL)
333 Pfingsten Road
Northbrook, IL 60062-2096

UL Standard for Safety
for
Refrigerant Recovery/Recycling Equipment, UL 1963

Second Edition, Dated October 27, 1995

Revisions: This Standard contains revisions through and including July 31, 1996.

A change is indicated by a note following the affected item. The note is preceded and followed by an asterisk.

The new and/or revised requirements are substantially in accordance with UL's Bulletins on this subject dated August 18, 1995, October 2, 1995 and November 22, 1995. These bulletins are now obsolete and may be discarded.

The revisions dated July 31, 1996 include a reprinted title page (page 1) for this Standard.

The master for this Standard at UL's Northbrook Office is the official document insofar as it relates to a UL service and the compliance of a product with respect to the requirements for that product and service, or if there are questions regarding the accuracy of this Standard.

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The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a "SUPERSEDED REQUIREMENTS" notice.

A change in an effective date is indicated by a note following the affected item, and giving both the previous effective date and the new date the requirement becomes effective.

New product submittals made prior to a specified future effective date will be judged under all of the requirements in this Standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if the applicant elects 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.

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This Standard consists of pages dated as shown in the following checklist:

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UL 1963

Standard for

Refrigerant Recovery/Recycling Equipment

First Edition – October, 1989

Second Edition

October 27, 1995

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 set of revised requirements.

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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.

INTRODUCTION

1 Scope

1.1 These requirements cover refrigerant recovery and recycling equipment to be employed in accordance with the National Electrical Code, NFPA 70.

1.2 These requirements apply to equipment intended for indoor or outdoor use or both.

1.3 These requirements do not cover equipment rated more than 600 volts or employing a universal motor rated more than 250 volts or intended for installation and use in a hazardous (classified) location.

1.4 Refrigerant recovery/recycling equipment intended for use with commercial refrigerant systems, other than automotive, is judged on the basis of compliance with the requirements in this standard, insofar as they are applicable, and further examination and test to determine whether the equipment is acceptable for the purpose.

1.5 These requirements cover an evaluation to determine that automotive refrigerant recovery/recycling equipment recovers and, recycles Refrigerant R12 to the SAE J1991-1991 Standard of Purity for Use in Mobile Air-Conditioning Systems. This equipment is intended to operate according to SAE J1990-1992, Extraction and Recycle Equipment for Mobile Automotive Air-Conditioning Systems.

1.5 revised July 31, 1996

1.6 These requirements cover an evaluation to determine that automotive refrigerant recovery/recycling equipment recovers and recycles Refrigerant R134a to the SAE J2099-1991 Standard of Purity for Recycled HFC-134a for Use in Mobile Air-Conditioning Systems. This equipment is intended to operate to the standard SAE J2210-1991 HFC-134a Recycling Equipment for Mobile Air-Conditioning Systems.

1.7 These requirements cover an evaluation to determine that the equipment operate to the standard SAE J2209-1992 CFC-12 (R-12) Extraction Equipment for Mobile Automotive Air-Conditioning Systems.

1.8 Extraction and recovery/recycling equipment evaluated to the above SAE specs must 91 also be supplied with hoses that comply with the requirements in SAE J2196-1992 Service Hose for Automotive Air Conditioning.

1.9 These requirements contain an investigation to determine that automotive recycling equipment intended for use with both R12 and R134a in a common refrigerant circuit does not cross contaminate refrigerant above 0.5 percent when used under normal operating conditions.

1.9.1 These requirements cover an evaluation to determine that the equipment operates to the standard for HFC-134a Extraction Equipment for Mobile Automotive Air-Conditioning Systems, SAE J 1732-1994.

1.9.1 added July 31, 1996

1.10 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involves a risk of fire, electric shock, or injury to persons shall be evaluated using the appropriate additional component and end-product requirements as determined necessary to maintain the acceptable level of safety as originally anticipated by the intent of this standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this standard cannot be judged to comply with this standard. Where considered appropriate, revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

2 General

2.1 Components

2.1.1 Except as indicated in 2.1.2, a component of a product covered by this standard shall comply with the requirements for that component. See Appendix A for a list of standards covering components generally used in the products covered by this standard.

2.1.2 A component need not comply with a specific requirement that:

- a) Involves a feature or characteristic not needed in the application of the component in the product covered by this standard, or
- b) Is superseded by a requirement in this standard.

2.1.3 A component shall be used in accordance with its recognized rating established for the intended conditions of use.

2.1.4 Specific components are recognized as being incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions for which they have been recognized.

2.2 Units of measurements

2.2.1 If a value for measurement is followed by a value in other units in parentheses, the first stated value is the requirement.

2.2.2 Unless indicated otherwise, all voltage and current values mentioned in this standard are rms.

2.3 References

2.3.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

2.4 Terminology

2.4.1 The term "equipment" as used in these requirements refers to all refrigerant recovery/recycling and recovery (extraction) equipment or any part thereof covered by these requirements unless specifically noted otherwise.

3 Glossary

3.1 For the purpose of these requirements, the following definitions apply.

3.2 ACCESSORY – An optional electrical device or other component intended for installation in or connection to the equipment for the purpose of modifying or supplementing its functions. The accessory may be factory installed or intended for installation by the user or service personnel.

4.10 The operating instructions for non-automotive recovery or recovery/recycling equipment shall include a procedure to be followed to make sure that no oil is in the storage container prior to starting a recovery and/or recycling operation.

4.11 The instructions for equipment intended to service automotive air conditioning systems with R-134a shall contain the following or equivalent information:

"Avoid breathing A/C refrigerant and lubricant vapor or mist. Exposure may irritate eyes, nose and throat. To remove HFC-134a from the A/C system, use service equipment certified to meet the requirements of SAE J2210 (HFC-134a recycling equipment). Additional health and safety information may be obtained from refrigerant and lubricant manufacturers".

"Caution – Do not pressure test or leak test HFC-134a service equipment and/or vehicle air conditioning systems with compressed air. Some mixtures of air and HFC-134a have been shown to be combustible at elevated pressures. These mixtures, if ignited, may cause injury or property damage. Additional health and safety information may be obtained from refrigerant manufacturers."

Revised 4.11 effective January 30, 1998

4.12 The instructions for all equipment shall contain the following marking:

"CAUTION – Should be operated by certified personnel"

Added 4.12 effective January 30, 1998

CONSTRUCTION

5 General

5.1 Ferrous metal parts used to support or retain electrical components in position shall be protected against corrosion by metallic or nonmetallic coatings, such as plating or painting.

Exception: This requirement does not apply to parts, such as washers, screws, bolts, and the like, where corrosion of such unprotected parts would not affect compliance with the requirements of this standard.

5.2 Exposed unimpregnated asbestos material shall not be used. The unprotected edge of a gasket sandwiched between two parts is considered to be exposed.

5.3 Electrical insulating materials and systems used inside a hermetically sealed motor-compressor enclosure shall be compatible with the refrigerants and oils intended to be used in accordance with the Standard for Hermetic Refrigerant Motor-Compressors, UL 984. They shall also be compatible with each other and with other materials used within the system.

5.4 When different oils are used with the same refrigerant, the electrical insulating materials shall be compatible with a mixture of oils. The oil mixture shall be:

- a) 50/50 percent,
- b) 33 1/3, 33 1/3, 33 1/3 percent, or
- c) other percentages as agreed with the manufacturer.

5.5 Movable equipment employing carrying handles or straps shall be permanently marked according to 77.30.

6 Assembly

6.1 General

6.1.1 Refrigerant recovery and/or recycling equipment shall be provided with the necessary hoses for connection in the intended manner to the equipment being serviced. These hoses shall be no longer than 8 feet, shall be provided with shut-off devices within 12 inches of the ends, and shall be constructed in accordance with Section 31.

6.1.2 The shut-off devices mentioned in 6.1.1 shall prevent refrigerant flow when the hose is not connected.

6.1.3 The equipment shall be assembled so that removal and replacement of tanks and containers, and the like, will not result in damage to electrical components and wiring, or to refrigerant-containing components.

6.1.4 Equipment having provision for the storage of refrigerant cylinders or the like shall be provided with means for retaining the cylinders in position.

6.1.5 Electrical components shall be installed on the unit and wired as necessary for intended operation.

6.1.6 Pressure-limiting devices, when required, shall be installed on the assembly and connected to the high side of the system.

6.1.7 Refrigerant-containing parts shall be factory connected with tubing or piping.

Exception No. 1: As indicated in 6.1.8.

Exception No. 2: When needed for flexibility, hose less than 36 inches in length complying with 31.2.1 may be used in the equipment.

6.1.8 Driers, filters, hoses for connection to the equipment to be serviced, and the like that are intended for installation in the field may be packaged with the unit provided they comply with the requirements in this standard.

6.2 Mechanical protection

6.2.1 Horizontally-hinged doors that provide access to the storage compartments that may cause injury to persons upon unintentional closing shall be counterweighted, spring loaded, or provided with an automatic latch to retain them in the open position. Action members, such as springs and latches that may cause injury to persons due to pinching or the like, shall be enclosed or guarded.

6.2.2 A slideout component, such as a drawer or shelf, shall be restrained to prevent its being unintentionally pulled free of its supporting means. See Component Restraint Test, Section 69.

6.2.3 When installed in its intended manner (see Installation and Operating Instructions, Section 4), openings in the appliance shall be constructed or located to reduce the risk of injury to persons due to unintentional contact with:

- a) Moving parts, such as fan blades, blower wheels, gears, and belts, and

- b) Surfaces that exceed the temperatures permitted by subitems 2 and 3 of item D of Table 41.1.

The minor dimension of such openings shall not exceed 3 inches (76.2 mm). In evaluating openings, parts of the enclosure, such as covers, panels, grilles, and guards are to be removed unless tools are required for their removal, or when exposed, a moving part is made inoperative through the use of interlocking devices. See 8.2.1.

Exception: Openings may be larger than 3 inches if the part is unlikely to be contacted because of the location of fixed components, including baffles, refrigerant tubing, and the like.

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6.3.5 A switch, lampholder, an attachment-plug receptacle, or similar component shall be secured in position and shall be prevented from turning. See 6.3.6.

Exception No. 1: The requirement that a switch be prevented from rotating will be waived upon compliance with all of the following conditions:

- a) The switch shall be of a plunger or other type that does not tend to rotate when operated. A toggle switch is considered to be subject to forces that tend to rotate the switch during the operation of the switch.*
- b) Means of mounting the switch make it unlikely that operation of the switch will loosen it.*
- c) Electrical spacings shall not be reduced below the minimum required values if the switch rotates.*
- d) Operation of the switch shall be by mechanical means rather than direct contact by persons.*

Exception No. 2: A lampholder of a type in which the lamp cannot be replaced, such as a neon pilot or indicator light in which the lamp is sealed in a nonremovable jewel, need not be prevented from turning if rotation cannot reduce electrical spacings below the minimum acceptable values. See Spacings, Sections 23 and 24.

6.3.6 The means for preventing rotation mentioned in 6.3.5 is to consist of more than friction between surfaces. A toothed lock washer that provides both spring take up and an interference lock is acceptable as means for preventing a small stem-mounted switch or other device having a single-hole mounting from rotating.

6.3.7 An uninsulated current-carrying part, or a part that supports a live part, shall be secured to the base or mounting surface so that it will be prevented from turning or shifting in position if such motion may result in a reduction of electrical spacings less than the minimum acceptable values. See Spacings, Sections 23 and 24. Friction between surfaces is not acceptable as a means to prevent shifting or turning of a live part, but a lock washer as described in 6.3.6 is acceptable.

6.3.8 Flammable or electrically conductive thermal or acoustical insulation shall not contact uninsulated live parts. See 60.1.

7 Accessories

7.1 Equipment having provisions for the use of electrical accessories to be attached in the field shall be constructed so that the use of these accessories will not introduce a risk of fire, electric shock, or injury to persons. See 77.19 and 77.20.

7.2 The equipment shall comply with all requirements of this standard with or without the accessory installed.

7.3 Installation of accessories by the user shall be restricted to an arrangement that can be accomplished by means of receptacles and plug-in connectors.

7.4 Installation of accessories by service personnel shall be by means of receptacles, plug-in connectors, insulated wire connectors, or by connection to existing wiring terminals.

7.4.1 Accessories intended for connection to a source of field supply independent of that of the unit shall:

- a) Comply with the requirements specified in 9.2.1 through 9.2.2.1, if intended to be a permanently connected accessory.
- b) Comply with the requirements specified in 9.3.1 through 9.3.11, if intended to be a cord-connected accessory.

In no case shall a permanently connected accessory be used with supply cord connected equipment.

7.4.1 added July 31, 1996

7.4.2 If an accessory is powered from a source of supply separate from that supplying the unit, disconnection of any one supply shall automatically cause de-energization of all circuits within the unit and accessory.

Exception: Automatic de-energization may be omitted if the unit and accessory are marked in accordance with 77.36.

7.4.2 added July 31, 1996

7.5 Installation of accessories shall not require the cutting of wiring or the soldering of connections by the installer. Installation shall not require cutting, drilling, or welding either in electrical enclosures, or other areas where such operations may result in damage to electrical or refrigeration components and wiring within the enclosure.

7.6 Strain-relief means shall be provided for the wiring in the accessory if there is a possibility of transmitting stress to the terminal connections during installation. See Strain Relief Test, Section 52.

7.7 All terminals and wiring intended to be field connected shall be identified on the:

- a) Accessory,
- b) Equipment if connections are to be made between the accessory and the equipment, and
- c) Wiring diagram(s).

7.8 The mounting location of the accessory shall be indicated on the equipment.

Exception: If the mounting location is fixed due to the function of the accessory and arrangement of the equipment, and instructions are provided covering the installation and location for the accessory, the mounting location of the accessory need not be indicated.

7.9 As part of the investigation, accessories are to be trial-installed to determine that their installation is feasible, the instructions are detailed and correct, and the use of the accessories does not introduce a risk of fire, electric shock, and injury to persons.

8 Enclosures

8.1 General

8.1.1 An enclosure shall be formed and assembled so that it will have the strength and rigidity necessary to resist the conditions of intended use without increasing the risk of fire or injury to persons due to total or partial collapse and the resulting reduction of spacings, loosening or displacement of parts, or other defects. Enclosures for individual electrical components, outer enclosures, and combinations of the two are to be considered in determining compliance with this requirement.

8.1.2 Among the factors that are to be taken into consideration when judging the acceptability of an enclosure are:

- a) Mechanical strength,
- b) Resistance to impact,
- c) Moisture-absorptive properties,
- d) Flame resistance,

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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.

9.2.21 The free end of any lead that may not be used in every installation (such as an equipment-grounding lead) shall be insulated if that end could reduce spacings below the minimum acceptable values specified in Section 23.

9.3 Cord-connected equipment

9.3.1 Equipment intended for cord connection to the power supply shall be provided with

- a) A non-detachable power supply cord for connection to the supply by means of a plug; or
- b) An appliance inlet for connection of a detachable power supply cord and either a detachable power supply cord or instructions for selection of a suitable detachable power supply cord.

9.3.2 Cord connected equipment consisting of two separate units joined together or two of the same units in single structure may be provided with more than one power supply cord if all of the following conditions are met:

- a) Not more than two cords are provided.
- b) Each cord is of the type, size and rating required or permitted for the type of equipment and the load supplied to each unit.
- c) Each attachment plug cap is sized based on the load supplied to each unit.
- d) The total marked nameplate equipment load in amperes (current through both cords) is not more than 24 amperes.
- e) If both cords provide power to the same control enclosure or electrical panel that could result in an electrical shock, fire hazard or injury to persons, the product shall be provided with a mechanical or electrical interlock system that results in all ungrounded conductors of the supply being disconnected in the event that either cord is disconnected.

f) The marking in 79.3 (a) and (c) shall be provided.

g) The instructions for equipment provided with two power supply cords shall contain information as indicated in 4.9.

9.3.2 revised July 31, 1996

9.3.2.1 Where the rated current input to both units exceeds 80 percent of the branch circuit to which the equipment will be connected, the unit with the highest rated current input shall be marked adjacent to its cord in accordance with 79.3(b).

9.3.2.1 added July 31, 1996

9.3.3 The marked rating of cord-connected equipment, see 79.1, shall not exceed 80 percent of the rating of the attachment plug.

9.3.4 Cord-connected equipment shall employ a grounding-type attachment plug. Refer to Table 9.2 for some configurations that comply with ANSI.

Exception: Equipment rated 250 volts or less and intended for connection to circuits rated:

- a) Other than 60 hertz;*
- b) Other than the voltages specified in the first column of Table 37.1; or*
- c) Both,*

may employ a grounding-type attachment plug acceptable for the circuit involved.

Table 9.2
Attachment plugs

Nameplate rating			Attachment plug	
Volts	Phase	Amperes ^a	Rating	ANSI designation ^b
110 – 120	1	12.0	15 amperes, 125 volts	5-15P
110 – 120	1	16.0	20 amperes, 125 volts	5-20P
110 – 120	1	24.0	30 amperes, 125 volts	5-30P
110 – 120	1	40.0	50 amperes, 125 volts	5-50P
200 – 240	1	12.0	15 amperes, 250 volts	6-15P
200 – 240	1	16.0	20 amperes, 250 volts	6-20P
200 – 240	1	24.0	30 amperes, 250 volts ^c	6-30P
200 – 240	1	40.0	50 amperes, 250 volts ^c	6-50P
110 – 120/200 – 240	1	12.0	15 amperes, 125/250 volts	14-15P
110 – 120/200 – 240	1	16.0	20 amperes, 125/250 volts	14-20P
110 – 120/200 – 240	1	24.0	30 amperes, 125/250 volts ^c	14-30P
110 – 120/200 – 240	1	40.0	50 amperes, 125/250 volts ^c	14-50P
200 – 240	3	12.0	15 amperes, 250 volts	15-15P
200 – 240	3	16.0	20 amperes, 250 volts	15-20P
200 – 240	3	24.0	30 amperes, 250 volts ^c	15-30P
200 – 240	3	40.0	50 amperes, 250 volts ^c	15-50P

^a Ampere rating is maximum permitted to be marked on equipment nameplate for attachment plug indicated. See 9.3.3.

^b Standard for wiring devices – dimensional requirements, ANSI/NEMA WD6-1988.

^c 30 and 50 ampere attachment plugs permitted only on equipment intended to be moved from place to place in normal service for cleaning as specified in 9.3.6.

9.3.5 Cord connected equipment may employ Type SEO, SO, SOO, STO, STOO, SJEO, SJO, SJOO, SJTO, or SJTOO power supply cord rated for use at a voltage not less than the rated voltage of the equipment. The ampacity of the cord as given in the National Electric Code, ANSI/NFPA 70-1993, shall be not less than that required by the ampere input measured in the Temperature and Pressure Test, Section 41. The ampere input value shall include the loads for convenience outlets and the current drawn by accessories intended for use with the equipment. See 77.11 and 77.12.

9.3.5 revised July 31, 1996

Table 9.3
Equivalent cords

Table 9.3 deleted July 31, 1996

9.3.6 Equipment rated over 16 amperes may be provided with a supply cord if it is intended to be moved from place to place in normal service and if the equipment complies with (a) – (d).

- a) The equipment is self-contained.
- b) The equipment does not require connection to water lines, or the like.
- c) The equipment is permanently equipped with casters.
- d) The electrical rating of the equipment does not exceed 40 amperes, 250 volts, single phase.

9.3.7 The ampacity of a power supply cord on equipment intended for connection to a branch circuit which exceeds the limitations specified in 16.4 shall be not less than 80 percent of the maximum continuous current of the compressor motor determined in accordance with Protective Devices – Maximum Continuous Current Test, Section 62, plus the sum of all other loads, including accessories, which may operate concurrently.

Exception: The ampacity of the power supply cord need not be greater than the ampere rating of the attachment plug.

13.2 Aluminum may be used as a current-carrying part if treated to resist oxidation and corrosion.

13.3 Iron or steel shall not be used for current-carrying parts.

Exception: Iron or steel, if provided with a corrosion resistant coating, or stainless steel may be used for a current-carrying part if permitted in accordance with 2.1, such as within a motor.

14 Insulating Material

14.1 Material for the mounting of uninsulated live parts shall be porcelain, phenolic composition, or other material having equivalent electrical and mechanical properties.

14.2 Vulcanized fiber may be used for insulating bushings, washers, separators, and barriers, but not as the sole support for uninsulated live parts where shrinkage, current leakage, or warpage may introduce a risk of fire or electric shock. Polymeric materials may be used for the sole support of uninsulated live parts if found to have mechanical strength and rigidity, resistance to heat, flame resistance, dielectric voltage-withstand, and other factors involved with conditions of intended service. All these factors are to be considered with respect to aging.

15 Switches and Controllers

15.1 A motor controller(s) used for controlling the loads involved shall be provided for all equipment incorporating two or more motors, or a motor(s) and other load(s) intended for connection to the same power supply. See 15.2 and 15.3.

15.2 The attachment plug and receptacle may serve as the controller on cord connected equipment if the marked ampere rating does not exceed the values shown in Table 15.1 for the voltage indicated.

Table 15.1
Ampere rating

Amperes	Voltage
7.2	115
4.0	208
3.6	230

15.3 A controller is not required for any supply circuit of permanently connected equipment where the circuit supplies:

- a) Two or more motors, or
- b) A motor(s) and other load(s)

if, in either case, the marked maximum size of the supply circuit overcurrent protective device for that circuit does not exceed 20 amperes at 125 volts or less or 15 amperes at 600 volts or less, and if the rating of any motor in the circuit does not exceed 1 horsepower (746 W output) and 6 full load amperes.

15.4 Cord connected equipment shall be provided with a manually operable switch that will shut off the complete equipment or will shut off any motor load exceeding the values shown in 15.2. Such switches shall have a marked "off" position and, if the switch does not control the complete equipment, shall indicate which load it controls, such as compressor, fan motor, or the like. The switch shall be accessible without the use of tools.

Exception: The off position of the switching devices or the main disconnect switch on equipment, may be identified by the "off" symbol illustrated in Figure 15.1.

15.4.1 On cord-connected equipment, a manually operated switch with a marked off position that controls a hermetic refrigerant motor-compressor with or without other loads shall have a current rating that is at least 115 percent of the sum of the motor-compressor's rated load current and the rated current for other controlled loads. See 16.4.

Added 15.4.1 effective January 30, 1998

15.5 A switch or other control device shall be rated for the load it controls as determined by the Temperature and Pressure Test, Section 41.

15.6 If a branch-circuit selection current is marked on permanently-connected equipment, a controller for a refrigerant compressor shall have a full-load current rating not less than this marked value plus any additional loads controlled.

15.6.1 On permanently connected equipment, a manually operated switch with a marked off position that controls a hermetic refrigerant motor-compressor with or without other loads shall have a current rating that is at least 115 percent of the sum of (1) the motor-compressor's rated load current or branch-circuit selection current, whichever is greater, and (2) the rated current for other controlled loads, as shown on the refrigerator nameplate. See 16.3.1.

Added 15.6.1 effective January 30, 1998

15.7 The current rating of a switch that controls an inductive load (other than a motor), such as a transformer shall be not less than twice the current of the controlled load and shall have a voltage rating not less than the potential of the circuit in which it is used.

Exception: An ac general-use snap switch may be used to control an inductive load that does not exceed the current rating of the switch at rated voltage.

15.8 A switching device that may be called upon to break a motor load under locked-rotor conditions shall have a current interrupting capacity not less than the locked-rotor current of the motor.

15.9 If a switching device controls a compressor motor and fan motor and/or other load, it shall have a current interrupting capacity not less than the locked-rotor load of the compressor motor plus the full load of the fan motor and/or other load.

15.10 Opening of a switching device that interrupts the main power supply circuit to a heater of permanently connected equipment shall disconnect all ungrounded conductors of the power supply circuit if the switching device or the pilot device that controls the switching device has a marked "on" or "off" position.

Exception: Both the on and off positions of the switching devices or the main disconnect switch on equipment, may be identified by the symbols illustrated in Figure 15.1.

Figure 15.1
On and off symbols



S3486

IEC Publication 417, Symbols 5007 and 5008

15.11 Motor controllers shall be arranged so that they will simultaneously open a sufficient number of ungrounded conductors to interrupt current flow to the motor.

Exception: This requirement does not apply to crankcase heating arrangements where the circuit is arranged to permit current flow through a capacitor in series with the start winding of single-phase motors with the motor not operating.

15.12 Coil windings of switching devices shall be impregnated, dipped, varnished, or equivalently treated to resist absorption of moisture.

15.13 Switching devices shall be housed within an enclosure that will protect coils and contacts against mechanical damage, dirt, and moisture. The enclosure of the switching device may be provided by its method of mounting within the equipment enclosure, by inherent construction of the component, or by means of a separate enclosure.

15.14 A switch provided as an interlock shall have an endurance rating of 100,000 cycles of operation at not less than the load it controls.

16 Motors and Motor Overload Protection

16.1 All motors shall be protected against overload by thermal or overcurrent protective devices.

Exception: Direct-drive motors employing impedance protection and that comply with the locked-motor requirements specified in the Standard for Impedance-Protected Motors, UL 519, may be used, provided that it is determined that the motor will not overheat under intended conditions of use.

16.2 For a motor other than a compressor motor acceptable overload protection is provided by a separate overcurrent device that is responsive to motor current and is rated or set to trip at no more than the percentage of the motor nameplate full-load current rating shown in column A of Table 16.1. For an overload relay if the percentage protection indicated in column A of Table 16.1 does not correspond to the percentage value resulting from selection of a standard size of relay, the next higher size of overload relay may be used, provided that it provides protection no greater than the percentage protection indicated in column B of Table 16.1.

Table 16.1
Overload relay size

Motor	Maximum percentage protection	
	A	B
Motor with a marked service factor no less than 1.15	125	140
Motor with a marked temperature rise no more than 40°C (104°F)	125	140
Any other motor	115	130

16.3 A hermetic compressor motor complies with the requirement of 16.1 if the protection complies with (a), (b), (c) or (d).

a) A separate overload relay that is responsive to motor current and will trip at not more than 140 percent of the rated-load current of the motor marked on the equipment nameplate.

b) A thermal protector integral with the motor that complies with the Standard for Hermetic Refrigerant Motor-Compressors, UL 984, and will not permit a continuous current in excess of 156 percent of the rated-load current of the motor (or 156 percent of the branch-circuit-selection current, if the latter value is marked). The values of rated-load current and branch-circuit-selection current referred to are the values marked on the equipment nameplate. See 62.1.

Exception: The limitation of not permitting a continuous current in excess of 156 percent of the rated load current of the motor does not apply to the units described in 16.4.

c) A fuse or circuit breaker responsive to motor current and rated-load current of the motor marked on the equipment nameplate. The equipment shall start and operate as intended with the fuse or circuit breaker provided.

d) A protective system that complies with the Standard for Hermetic Refrigerant Motor Compressors UL 984 and will not permit a continuous current in excess of 156 percent of the rated load current of the motor (or 156 percent of the branch-circuit-selection current if the latter value is marked). The values of rated-load current and branch-circuit-selection current referred to are the values marked on the equipment nameplate. See 62.1.

Exception: The limitation of not permitting continuous current in excess of 156 percent of the rated load current of the motor does not apply to the units described in 16.4.

16.3.1 For equipment marked with a single-ampere rating, the rated-load current of the motor-compressor is the current drawn by the motor-compressor during the Temperature and Pressure Test, Section 41.

16.3.1 added July 31, 1996

16.4 Equipment employing a hermetic compressor equipped with a thermal protective device is not required to comply with the 156 percent limitation specified in 16.3 (b) or (d) if the equipment is intended for connection to a 15 or 20 ampere, 120 volt or a 15 ampere, 208 or 240 volt, single-phase branch circuit.

16.5 All components of the "protective system" mentioned in 16.3(d) shall be provided as part of the equipment.

21.4.3 The impedance, the fuse, the protector, or the regulating network, and the wiring between it and the isolating transformer mentioned in 21.4.1 shall be judged as if it were part of a line-voltage circuit.

21.4.4 A fuse or a circuit protector used to limit the power as specified in 21.4.1 shall be rated or set at not more than 3.2 amperes for a circuit operating between 15 and 30 volts, and at not more than 5.0 amperes for a circuit operating at 15 volts or less.

21.4.5 An impedance or a regulating network that is used to limit the current as specified in 21.4.1 shall limit the current under short circuit conditions to not more than 8.0 amperes measured after 2 minutes.

Exception: Transformers complying with Section 56 comply with this requirement.

21.4.6 The performance of a regulating network used to limit the power in accordance with 21.4.1 shall not be adversely affected by either short circuit or open circuit between any two terminals of any single rectifier, capacitor, transistor, or similar component in the network.

21.4.7 The wiring in a limited-energy-secondary circuit shall be routed away from the wiring of other circuits or shall be provided with insulation that is rated for use at the highest of the voltages in the other circuits.

21.4.8 The wiring in a limited-energy-secondary circuit shall be routed away from the uninsulated live components of other circuits.

21.4.9 Wires and cables that are part of a limited-energy-secondary circuit shall be provided with strain relief if stress on the wire or cable would cause the internal wiring of the circuits to contact an uninsulated live part of another circuit.

21A Electric Heaters

Section 21A added July 31, 1996

21A.1 An electric heater shall be an encased assembly constructed of materials that will not be damaged by the temperature to which they will be subjected in the unit.

21A.2 Metal tubing forming a heater element enclosure shall be constructed of corrosion resistant material or shall be plated, dipped, or coated to resist external corrosion and shall be acceptable for the temperatures to which it is subjected. See 21A.4.

21A.3 A heater element, installed in the complete unit, shall be protected against mechanical damage. The heater is considered to be protected if it (1) employs a copper or steel sheath that is at least 0.016 inch (0.41 mm) thick, or (2) cannot be contacted when the probe illustrated in Figure 6.1 is inserted with a force of 5 pounds (22.2 N).

21A.4 Uncoated copper tubing can be used for temperatures of 200°C (392°F) and lower; metallic coated copper tubing can be used for temperatures below the melting temperature of the coating. Uncoated or oxide-coated steel tubing is not to be used as a heater sheath. Plated steel tubing can be employed if the coating is corrosion resistant and will withstand the temperatures to which it may be subjected. Aluminum tubing can be employed if the alloy withstands the Burnout Test – Electric Heater, Section 55, without melting or other malfunction. Stainless steel tubing of the austenitic grades, such as ASTM Type 304, can be employed for heater sheaths.

21A.5 Insulating materials, such as washers and bushings, that are integral parts of a heating element shall be of a moisture-resistant material that will not be damaged by the temperatures to which they will be subjected in the unit.

21A.6 Insulating material employed in a heating element shall be used as the sole support of live parts. Materials, such as magnesium oxide, may be used in conjunction with other insulating materials if located and protected so that mechanical damage is prevented and if not subjected to the absorption of moisture. When conducting the investigation of an insulating material, consideration is to be given to its mechanical strength, dielectric strength, insulation resistance (see 60.2 and 60.3), heat resistant qualities, the degree to which it is enclosed or protected, and any other features involved that can result in a risk of fire and unintended contact in conjunction with conditions of service. All of these factors are to be considered with respect to thermal aging.

21A.7 A heater case or a terminal seal of rubber, neoprene, or thermoplastic materials shall comply with the Accelerated Aging Test – Electric Heaters, Section 70A.

21A.8 An electric heater assembly shall be sealed to prevent entrance of moisture. See Insulation Thermal and Acoustical Resistance Test, Section 60. Molded seal caps, vulcanized to the heater leads and heater sheath, shall have a wall thickness equivalent to that required for the heater leads.

21B Electric Heater Control

Section 21B added July 31, 1996

21B.1 If malfunction could result in risk of a fire or electric shock, electric heaters shall be provided with a thermal protective device or a replaceable thermal cutoff. See Burnout Test – Electric Heater, Section 55. Thermal cutoffs shall comply with the Standard for Thermal Cutoffs for Use in Electrical Appliances and Components, UL 1020.

21B.2 A temperature-limiting control that is required to reduce the risk of fire in the unit (see Burnout Test – Electric Heater, Section 55) shall be an integral part of the unit and shall (1) control the heater(s) directly, or (2) control the heater(s) indirectly through a switching device that is also an integral part of the unit. The switching device shall comply with the endurance test requirements for temperature-limiting controls (see 61A.1.1(b) and (c)).

21B.3 A thermal cutoff shall be secured in place and located so that it will be accessible for replacement without damaging other connections or internal wiring. See 21B.4 and 21B.5.

21B.4 Replacement of a thermal cutoff shall not necessitate the removal of the heater from its installation.

Exception: This requirement does not preclude the withdrawal of a removable heating element(s) to permit replacement of a thermal cutoff.

21B.5 Wiring connected to a thermal cutoff shall be secured so that replacement of the thermal cutoff will not result in displacement or disturbance of internal wiring other than leads to either the cutoff or to a heating element assembly on which the cutoff is mounted.

22 High-Voltage Control Circuit Conductor Overcurrent Protection

22.1 General

22.1.1 If a control-circuit is supplied through a transformer provided as part of the equipment, see Transformer Protection, Section 21, for additional requirements.

22.2 Direct-connected high-voltage control circuit

22.2.1 A direct-connected high-voltage control circuit shall be marked as specified in 78.24. See 3.6.

22.3 Tapped high-voltage control circuit

22.3.1 A tapped high-voltage control circuit conductor shall be provided with overcurrent protection (see 3.7). The rating of the overcurrent protective device or devices shall not exceed the applicable value specified in Table 22.1.

Exception No. 1: Nos. 18, 16, and 14 AWG (0.81, 1.3, and 2.1 mm²) conductors that do not exceed 4 feet (1.2 m) in length between points of opposite polarity may be protected by fuses or "HACR Type" circuit breakers rated 60 amperes or less.

Exception No. 2: An overcurrent protective device of a higher rating may be used if the conductors withstand short-circuiting when tested as specified in the Limited Short-Circuit Test, Section 61.

Exception No. 3: A lead 12 inches (305 mm) or less in length need not be provided with overcurrent protection.

Exception No. 4: A control-circuit conductor, supplied from the secondary of a single-phase transformer that is connected so that only a 2-wire (single voltage) secondary is used, may be protected by an overcurrent device(s) located on the primary side of the transformer provided this protection is in accordance with requirements specified in Transformer Protection, Section 21, and the rating of the device does not exceed the applicable value specified in Table 22.1 multiplied by the ratio of secondary-to-primary rated transformer voltage.

Exception No. 5: A control circuit conductor that is tapped from the main power circuit at a point outside of the control equipment enclosure shall be protected as specified in Column A of Table 430-72(b) of the National Electrical Code, ANSI/NFPA 70-1990.

Table 22.1
Overcurrent protective device rating for control circuit conductors

Trapped control-circuit conductor size, AWG	Maximum rating of overcurrent protective device, amperes			
	Conductors contained in control equipment enclosure		Conductors extending beyond control equipment enclosure	
	Copper	Aluminum ^a	Copper	Aluminum ^a
18	25	—	7	—
16	40	—	10	—
14	100	—	45	—
12	120	100	60	45
10	160	140	90	75
Larger than 10	b	b	c	c

^a Includes copper-clad aluminum
^b 400 percent of value specified for 60°C conductors in Table 310-17 of National Electrical Code, ANSI/NFPA 70-1993.
^c 300 percent of value specified for 60°C conductors in Table 310-16 of National Electrical Code, ANSI/NFPA 70-1993.

22.4 Overcurrent protective device

22.4.1 Overcurrent protection for a tapped high-voltage control circuit conductor, as required by 22.3.1 shall be provided as part of the equipment.

Exception: The overcurrent device(s) need not be provided as part of the equipment if, based on the marked rating(s) of the equipment, the rating of the branch circuit overcurrent protective device(s) does not exceed the values specified in Table 22.1.

22.4.2 A control circuit overcurrent protective device(s) shall:

- a) Be provided for all ungrounded conductors,
- b) Be sized in accordance with requirements in 22.3.1, and
- c) Have a voltage rating not less than the circuit in which it is used.

The device(s) shall be a circuit breaker acceptable for branch circuit protection, or a fuse acceptable for branch circuit protection, such as a Class CC, G, H, J, K, L, R, or T cartridge fuse or Type S plug fuse. See 77.18.

Exception: If the control-circuit is tapped from a circuit supplying other loads in the equipment, a device used for overcurrent protection may be of the supplementary type provided it has a short-circuit rating acceptable for the circuit in which it is used. See Table 61.1. If the supplementary type device used is a fuse, the equipment shall be marked in accordance with the Exception to 77.18.

SPACINGS

23 High-Voltage Circuits

23.1 The following electrical spacing requirements apply only to high-voltage circuits, as defined in 3.3(a).

23.1 revised July 31, 1996

23.2 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 23.1.

Table 23.1
Spacings other than in motors

Ratings		Minimum Spacings in Inch (mm)					
Volt-Amperes	Volts	Through Air ^c		Over Surface ^c		To Enclosure ^b	
2000 or less	300 or less	1/8 ^a	(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 2000	150 or less	1/8 ^a	(3.2)	1/4	(6.4)	1/2	(12.7)
	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 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.

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

^c 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.

Table 23.1 revised July 31, 1996

23.3 The "Through Air" and "Over Surface" spacings specified in Tables 23.1 and 23.2 at an individual component part are to be based on the total volt-ampere consumption of the load or loads that the component controls. For example, the spacings at a component that controls only the compressor motor are based on the volt-amperes of the compressor motor. Spacings at a component that controls loads in addition to the compressor motor are to be based on the sum of the volt-amperes of the loads so controlled. Spacings at a component that independently controls separate loads are to be based on the volt-amperes of the largest load controlled. The volt-ampere values for loads are to be determined by the marked rating of the loads. For loads that are not required to have a marked rating, the measured input is to be used in determining the volt-ampere values.

23.3 revised July 31, 1996

23.4 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 in 23.2 and shall be based on the highest voltage involved.

23.5 With reference to 23.2 and 23.3, the "To Enclosure" spacings specified in Table 23.1 are not to be applied to an individual enclosure of a component part within an outer enclosure or cabinet.

23.5 revised July 31, 1996

23.5.1 The spacings indicated in Table 23.2 are applicable only to electrical components mounted in totally enclosed nonrefrigerated and/or nonair handling compartments which 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 23.1 apply.

23.5.1 added July 31, 1996

Table 23.2
Spacings in non-refrigerated and/or non-air 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)
	125—250	3/32 (2.4 mm)	3/32 (2.4 mm)	1/4 (6.4 mm)
NOTE - See 23.5.1.				
^a Includes fittings for conduit or metal-clad cable.				

Table 23.2 added July 31, 1996

23.6 The spacings specified in 23.1 and 23.2 are not to apply to the inherent spacings of a component part of the equipment, such as a snap switch, controller, attachment plug, and the like, for which spacing requirements are given in a standard for the component. 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.

23.7 If higher than rated potential is developed in a motor circuit through the use of capacitors, the rated voltage of the system is to be employed in judging the required spacings:

Exception: If the developed steady-state potential as determined in the temperature and pressure test exceeds 500 volts, the developed potential is to be used in determining the spacings for the parts affected.

23.7 revised July 31, 1996

23.8 An insulating lining or barrier of fiber or similar material, employed where spacings would otherwise be less than the required values, shall be not less than 0.028 inch (0.7 mm) thick and shall be located or of such material so that it will not be deteriorated by arcing.

Exception No. 1: Fiber not less than 0.013 inch (0.3 mm) thick may be used in conjunction with an air spacing of not less than 50 percent of the spacing required for air alone.

Exception No. 2: Thinner material may be used if it has equivalent insulating, mechanical, and flame resistance properties when compared with materials in required thicknesses.

23.8 revised July 31, 1996

23.9 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.

23.9 added July 31, 1996

24 Low-Voltage Circuits

24.1 The following electrical spacing requirements apply to low-voltage circuits, as defined in 3.3(b).

24.1 revised July 31, 1996

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

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24.3 The spacing for low-voltage electrical components that are installed in a circuit that includes a pressure-limiting device, motor overload protective device, or other protective device, where a short or grounded circuit may result in a risk of fire, electric shock, or injury to persons shall comply with (a) – (c):

- 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 field 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, that 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, that 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 maintains required spacings.

24.3 revised July 31, 1996

24.4 The spacings in low-voltage circuits that do not contain devices such as indicated in 24.3 are not specified.

REFRIGERANT SYSTEM

25 Refrigerants

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

26 Automotive Recovery/Recycling Equipment

26.1 The automotive equipment shall comply with the requirements as defined in SAE J1990-1992, "Extraction and Recycle Equipment for Mobile Automotive Air-Conditioning Systems", and as outlined in the requirements specified in 26.2 – 26.9 and Section 42.

26.2 The automotive equipment shall be provided with a moisture sight-glass(es) or other moisture detection means that reliably indicate when the moisture in the refrigerant meets or exceeds the minimum purity level specified in 43.1 or 44.1 and reliably indicate when the filter/dryer(s) needs replacement.

26.3 The automotive equipment shall employ an oil separator at the equipment inlet incorporating a graduated scale with marked increments of 1 ounce or smaller or an equivalent means of measuring the amount of oil removed.

26.4 The automotive equipment shall incorporate a desiccant package that is intended to be replaced when saturated with moisture and whose acid capacity is at least 5 percent by weight of total system dry desiccant. The automotive equipment may employ an alternate acid scavenging means if it is proven to provide equivalent or better removal of acid and equivalent reliability in service to that provided by an acid-desiccant package.

26.5 The automotive equipment shall contain an in-line filter with a 15 micron porosity or less.

26.6 The automotive equipment shall be compatible with leak detector dye that may be present in the refrigerant.

26.7 The automotive equipment shall either automatically purge noncondensables or incorporate a means to reliably indicate noncondensables are present in the refrigerant storage section. Noncondensable gas removal shall be part of the test procedure noted in 42.6 or 43.6, and shall be included in the operating instructions. Noncondensable gas removal must be accomplished within 30 minutes after the recovery operation is complete and prior to using the recovered refrigerant for system charging.

26.7.1 Components such as pressure gauges, thermometers, temperature strips, temperature-pressure charts, thermistors and the like, that are required for noncondensable gas purging on automotive equipment shall be permanently mounted on the unit enclosure and/or storage cylinder.

26.7.1 added July 31, 1996

26.8 During the recovery operation, the automotive equipment shall be capable of evacuating the system to a minimum of 4 inches (102 mm) of mercury (adjusted to altitude).

26.9 The automotive equipment shall be so constructed that refrigerant for recharging is taken from the liquid phase.

26.10 The automotive equipment shall be capable of purging noncondensables to no more than 5% by weight of the total contaminated refrigerant removed from the system. The 5% by weight includes all contaminated refrigerant removed during noncondensable gas purging and during oil removal.

26.11 This automotive equipment shall be marked in accordance with 77.33 and with the Design Certified label described in Section 3 of SAE J1990-1992.

26.11 revised July 31, 1996

27 Automotive Refrigerant 12 Extraction Equipment

27.1 The automotive equipment shall comply with the requirements as defined in the Standard for CFC-12 (R-12) Extraction Equipment for Mobile Automotive Air-conditioning Systems, SAE J2209-1991, and as outlined in the requirements specified in 27.2 - 27.7 and Section 44.

27.2 The automotive equipment shall employ an oil separator at the automotive equipment inlet incorporating a graduated scale with marked increments of 1 ounce or smaller or an equivalent means of measuring the amount of oil removed.

27.3 The automotive equipment should be compatible with leak detector dye that may be present in the air-conditioning system.

27.4 This automotive equipment shall be marked in accordance with 77.33 and with the Design certified label described in Section 3 of SAE J2209-1992.

27.4 revised July 31, 1996

27.5 The container color must be gray with a yellow top to identify that it contains used R-12 refrigerant. It must be permanently marked on the outside surface in accordance with 77.34.

27.6 The movable refillable container shall have a SAE 3/8 inch flare male thread connection as identified in SAE J639-1991 CFC-12 High Pressure Charging Valve, Figure 2.

27.7 This automotive equipment is to be tested at 50 and 120°F (10 and 49°C).

28 Automotive Refrigerant 134a Recovery/Recycling Equipment

28.1 The automotive equipment shall comply with the requirements as defined in the Standard for HFC-134a Recycling Equipment for Mobile Air-conditioning Systems, SAE J2210-1991, and as outlined in the requirements specified in 28.2 – 28.7 and Section 43.

28.2 The automotive equipment shall employ an oil separator at the equipment inlet incorporating a graduated scale with marked increments of 1 ounce or smaller or an equivalent means of measuring the amount of oil removed.

28.3 The automotive equipment shall incorporate a desiccant package that is intended to be replaced when saturated with moisture and whose acid capacity is at least 5 percent by weight of total system dry desiccant. The automotive equipment may employ an alternate acid scavenging means if it is proven to provide equivalent or better removal of acid and equivalent reliability in service to that provided by an acid-desiccant package.

28.4 The automotive equipment shall contain an in-line filter with a 15 micron porosity or less.

28.5 The automotive equipment shall be provided with a moisture sight-glass(es) or other moisture detection means that reliably indicate when the moisture in the Refrigerant 134a meets or exceeds the minimum purity level specified in 43.1 and reliably indicate when the filter/dryer(s) need(s) replacement.

28.6 Compressed air (shop air) must not be used for leak detection in Refrigerant 134a systems.

28.7 The method to vent noncondensables from the recycled refrigerant is noted in 26.7.

28.8 This automotive equipment shall be marked in accordance with 77.33 and with the Design certified label described in Section 3 of SAE J2210-1991.

28.8 revised July 31, 1996

28.9 The automotive equipment, including a removable refrigerant storage cylinder, shall be provided with the fittings constructed in accordance with SAE J2197.

28.9 added July 31, 1996

29 Automotive Refrigerant Recovery/Recycling Equipment Intended for Use With Both R12 and R134a in a Common Refrigerant Circuit

29.1 Automotive refrigerant recovery/recycling equipment intended for use with both R12 and R134a in a common refrigerant circuit shall comply with the requirements in Sections 26 (except 26.10), 28 and 45.

29.2 Valves, including electrically operated solenoid valves, that are used to isolate R12 and R134a refrigerant circuits shall have a seat leakage rate not exceeding 1/2 oz/yr before and after 100,000 cycles of operation. This endurance test shall be conducted with a mixture of Refrigerant 134a and 45,000 ppm (by weight) of oil (polyalkylene glycol oil with 100 viscosity at 104°F (40°C), or equivalent) at maximum operating pressure as determined by Sections 42 and 43. The seat leakage test described above shall be performed at 1.5 times this pressure in an ambient of 75°F (24°C).

29.3 The equipment shall be capable of preventing cross contamination to the level required by Section 45 before an operation involving a different refrigerant can begin. The equipment must prevent initiation of the recovery operation if the equipment is not set up properly. If an operator action is required to clear the unit prior to reconnecting for a different refrigerant, the equipment shall be provided with a means which indicates which refrigerant was last processed.

29.4 Electrical interlock devices used to prevent cross contamination of refrigerant shall be operated for 100,000 cycles and there shall be no failure that would permit cross contamination of refrigerant. Solid state interlock devices shall comply with the Transient Overvoltage Test and Fast Transient (Electrical Noise) test contained in the Standard for Tests for Safety Related Controls Employing Solid-State Devices, UL 991.

29.5 The equipment shall be capable of purging noncondensables, oil removal, and refrigerant clearing with no more than 5 percent by weight of the total amount of refrigerant processed through the equipment as detailed in Sections 42, 43, and 45.

29.6 The filter to remove particulates, as noted in 26.5 and 28.4, shall be located before any electrically operated valves that may cause cross contamination.

29.7 Means shall be provided to prevent recovery from both an R12 and R134a mobile air conditioning system concurrently.

29.8 Separate inlet and outlet hoses, connections, and storage cylinders shall be provided for each refrigerant circuit.

29.9 This automotive equipment shall be marked in accordance with 77.33 and with the Design Certified labels described in Section 3 of SAE J1990-1992 and SAE J2210-1991.

29.9 added July 31, 1996

29A Automotive Refrigerant 134a Extraction Equipment

Section 29A added July 31, 1996

29A.1 The automotive equipment shall comply with the requirements as defined in the Standard for HFC-134a (R134a) Extraction Equipment for Mobile Automotive Air-Conditioning Systems, SAE J 1732-1994, and as outlined in the requirements specified in 29A.2 – 29A.7 and Section 45A.

29A.2 The automotive equipment shall employ an oil separator at the automotive equipment inlet incorporating a graduated scale with marked increments of 1 ounce (30 mL) or smaller or an equivalent means of measuring the amount of oil removed.

29A.3 The automotive equipment should be compatible with leak detector dye that may be present in the air-conditioning system.

29A.4 The automotive equipment shall be marked in accordance with 77.33 and with the Design Certified Label described in Section 3 of SAE J1732-1994.

29A.5 The container color must be blue with a yellow top to identify that it contains used R134a refrigerant. It must be permanently marked on the outside surface in accordance with 77.34.1.

29A.6 The movable refillable container shall have a 1/2 inch ACME thread connection.

29A.7 This automotive equipment is to be tested at 50 and 120°F (10 and 49°C).

29A.8 The instruction manual shall include the following information on the lubricant removed: "Only new lubricant, as identified by the system manufacturer, should be replaced in the mobile air conditioning system. Removed lubricant from the system and/or the equipment shall be disposed of in accordance with the applicable federal, state, and local procedures and regulations."

29A.9 The instruction manual shall include the information outlined in 4.11.