

UL 984

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Hermetic Refrigerant Motor-Compressors

Underwriters Laboratories Inc. (UL)
333 Pfingsten Road
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UL Standard for Safety
for
Hermetic Refrigerant Motor-Compressors, UL 984

Seventh Edition, Dated May 31, 1996

The new and revised requirements are substantially in accordance with UL's Bulletin on this subject dated September 22, 1995. The bulletin is now obsolete and may be discarded.

As indicated on the title page (page 2), this UL Standard for Safety has been adopted by the Department of Defense.

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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that have been revised and that have a future effective date are located after the Standard, and are preceded by a "SUPERSEDED REQUIREMENTS" notice.

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 Recognition and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

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C22.2 No. 140.2-96



Fourth edition

Underwriters Laboratories Inc.
UL 984



Seventh edition

HERMETIC REFRIGERANT MOTOR- COMPRESSORS

May 31, 1996

Commitment for Amendments

This Standard is issued jointly by Canadian Standards Association and Underwriters Laboratories Inc. Amendments to this Standard will be made only after processing according to the Standards writing procedures by both Canadian Standards Association and Underwriters Laboratories Inc.

The Department of Defense (DoD) has adopted UL 984 on January 13, 1992. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

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FOREWORD (UL)

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TECHNICAL COMMITTEE ON CONSUMER AND COMMERCIAL PRODUCTS

SUBCOMMITTEE ON C22.2 NO. 140

PREFACE

This is the second edition of the Standard for *Hermetic Refrigerant Motor-Compressors*, published under the dual designation CSA-C22.2 No. 140.2-96 and UL 984. This Standard will supersede the following Standards:

- a) CSA Standard CAN/CSA-C22.2 No. 140.2-M91; and
- b) UL Standard 984, Sixth Edition, October 31, 1991.

This Standard addresses safety requirements and industry concerns for hermetic refrigerant motor-compressors.

This common Standard was prepared by Canadian Standards Association, Underwriters Laboratories Inc., and the heating and cooling equipment industry. The efforts and support of the Air Conditioning and Refrigeration Institute (ARI) and the Heating, Refrigerating and Air Conditioning Institute of Canada (HRAI) are gratefully acknowledged.

This Standard was

- a) reviewed by the CSA Subcommittee of the Technical Committee on Consumer and Commercial Products under the jurisdiction of the CSA Standards Steering Committee on the Canadian Electrical Code, Part II, and was formally approved by these Committees; and
- b) processed according to the method of development, revision and implementation of UL Standards for Safety.

This Standard will be submitted to the Standards Council of Canada for approval as a National Standard of Canada and will be submitted to the American National Standards Institute for publication as an American National Standard.

May 1996

NOTE: *Although the intended primary applications of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.*

UL Effective Date

This edition of the standard is now in effect.

CSA Effective Date

The effective date for CSA will be announced through CSA informs.

FOREWORD (CSA)

Certification organizations, as accredited by the Standards Council of Canada, have their own criteria procedures for certification services. The following paragraphs define CSA Certification policies.

The Canadian Standards Association provides certification services for manufacturers who, under license from CSA, wish to use the appropriate registered CSA Marks on certain products of their manufacture to indicate conformity with CSA Standards.

CSA Certification for a number of products is provided in the interest of maintaining agreed-upon standards of quality, performance, interchangeability and/or safety, as appropriate. Where applicable, certification may form the basis for acceptance by inspection authorities responsible for enforcement of regulations. Where feasible, programs will be developed for additional products for which certification is desired by producers, consumers or other interests.

In performing its functions in accordance with its objectives, CSA does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of the Association represent its professional judgement given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed.

Products in substantial accord with this Standard but which exhibit a minor difference or a new feature may be deemed to meet the Standard providing the feature or difference is found acceptable utilizing appropriate CSA Certification Division Operating Procedures. Products which comply with this Standard shall not be certified if they are found to have additional features which are inconsistent with the intent of this Standard. Products shall not be certifiable if they are discovered to contravene applicable Federal laws or regulations.

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If this Standard is to be used in obtaining CSA Certification please remember, when making application for certification, to request all current Amendments, Bulletins, Notices and Technical Information Letters that may be applicable and for which there may be a slight charge. For such information or for further information concerning details about CSA Certification please address your inquiry to the Applications and Records Section, Canadian Standards Association, 178 Rexdale Boulevard, Etobicoke (Toronto), Ontario M9W 1R3.

FOREWORD (UL)

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.

1 Scope

1.1 This Standard applies to hermetic refrigerant motor-compressors (hereinafter referred to as motor-compressors) rated 7200 V or less, for use in air-conditioning and refrigerating equipment that comply with the Standards applicable to such equipment.

1.2 This Standard also applies to motor protection systems that may be provided with motor-compressors.

1.3 This Standard does not include additional requirements applicable to equipment designed for use in hazardous locations as defined in the *National Electrical Code*, ANSI/NFPA 70-1996, and the *Canadian Electrical Code*, Part I.

1.4 The values given in SI (metric) units are the standard. The values given in parentheses are for information only.

2 Definitions

2.1 For the purpose of this Standard, the following definitions apply:

Ambient compensated current overload protective device – a current overload protective device, the calibration of which does not change over a designated range of ambient temperature.

Circuit, extra-low-voltage – a circuit that has an ac potential of not more than 30 V (42.4 peak), and power of 100 V•A or less; or 30 V dc supplied by a primary battery; or supplied by a Class 2 transformer; or supplied by a combination of a transformer or fixed impedance that, as a unit, complies with all the performance requirements for a Class 2 transformer.

A circuit that is derived from a circuit which exceeds 30 V by connecting resistance or impedance, or both, in series with the supply circuit to limit the voltage and current, is not considered to be an extra-low-voltage circuit.

Circuit, hazardous voltage – a circuit having characteristics in excess of those of an extra-low-voltage circuit.

Dual-voltage (multi-connection) motor – a motor that can be used at more than one voltage by adjusting the motor winding connection and connecting the motor to the appropriate electrical supply.

Dual-voltage (single-connection) motor – a motor that is suitable for use at more than one voltage without requiring adjustment of the motor winding connections.

Hermetic refrigerant motor-compressor – a combination consisting of a compressor and motor, both of which are enclosed in the same housing, with no external shaft or shaft seals; the motor operating in the refrigerant. The enclosure may be

- a) permanently sealed, such as by welding or brazing; or
- b) sealed by one or more gasketed joints.

Part-winding-start motor – a motor arranged for starting by first energizing part of its winding and, subsequently, energizing the remainder of this winding in one or more steps, both parts then carrying current.

Overload relay – a thermal or magnetic device responsive to motor current and calibrated to operate at a predetermined value above the full- or rated-load current rating of the motor.

Residual current operated circuit-breaker – a mechanical switching device designed to make, carry and break currents under normal service conditions and to cause the opening of the contacts when the residual current attains a given value under specified conditions.

Residual current – vector sum of the instantaneous values of the current flowing in the main circuit of the residual current operated circuit-breaker (expressed as rms value).

Single phase failure – as applied to three-phase motors, a condition in which one leg of a three-phase circuit is open and under which the connected load may continue to operate.

Primary single phase failure is the condition occurring in the primary side of the supply transformer(s).

Secondary single phase failure is the condition occurring in the secondary side of the supply transformer(s).

Thermal protector – a protective device for assembly as an integral part of a motor-compressor and that, when properly applied, protects the motor against dangerous overheating due to overload and failure to start. The thermal protector may consist of one or more sensing elements integral with the motor-compressor and an external control device.

3 General requirements

3.1 Where reference is made to any Standards (see Sections 47 to 49) such reference shall be considered to refer to the latest editions and revisions thereto, available at the time of printing, unless otherwise specified. Also, except as indicated in Clause 3.2, a component of a product covered by this Standard shall comply with all the requirements for that component.

3.2 A component 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.

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

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

CONSTRUCTION

4 Motor-compressor enclosures

4.1 As used in these requirements, a motor-compressor enclosure is a sealed housing that contains the compressor, motor, and in some cases, an overload protective device, all of which are subjected to refrigerant pressures.

4.2 Ferrous metal enclosures shall be protected against corrosion by coatings such as plating or painting. Nonferrous enclosures may be used without special corrosion protection.

4.3 Enclosures shall have sufficient strength to withstand, without failure, the pressure test specified in Section 34.

4.4 **Pressure relief** A positive displacement compressor operating at pressures exceeding 103 kPa (15 psig), and having a displacement exceeding $0.02 \text{ m}^3/\text{s}$ ($50 \text{ ft}^3/\text{min}$) shall be equipped with a pressure relief device having the capacity and the pressure setting necessary to prevent rupture of the compressor. The pressure relief device shall be located between the compressor and stop valve on the discharge side. Discharge from the device may be vented to the atmosphere or into the low pressure side of the system.

4.5 Pressure-relief valves shall comply with the requirements in the ASME, *Unfired Pressure Vessel Code*. Valves shall have a nameplate bearing the authorized code "UV" symbol together with the set pressure and capacity.

Exception: If the size of valves of less than nominal one-half inch pipe size does not permit a nameplate, the code symbol may be omitted and the set pressure and capacity may be stamped on the valve or on a metal plate attached to it. Manufacturers of valves which do not bear the code symbol shall provide evidence of certification of the valve and its pressure and capacity rating by code authorities.

4.6 **Bypass valve** A motor-compressor may employ a bypass valve that relieves high-side pressure into the low-side at a predetermined pressure differential. (See Clause 34.2 and Section 37.) Ferrous metal parts of these devices shall be protected against corrosion by coatings such as plating.

5 Electrical enclosures

5.1 Enclosures of electrical parts provided as part of the motor-compressor assembly shall be so formed and assembled that they will have the strength and rigidity necessary to resist the abuses to which they may be subjected, without total or partial collapse resulting in reduction of spacings, or loosening or displacement of parts.

5.2 Among the factors that are 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;

- e) resistance to distortion at temperatures to which the material may be subjected under conditions of use; and
- f) resistance to corrosion.

For a nonmetallic enclosure or part of an enclosure, all of these factors, including the effect of exposure to weathering if intended for outdoor use, are considered with respect to aging.

5.3 Ferrous metal parts located outside of the motor-compressor enclosure and 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.

5.4 Enclosures of nonmetallic material, or parts thereof, shall comply with the flame test specified in Section 39.

5.5 Ferrous metal electrical enclosures for motor-compressors intended for indoor use only shall be protected against corrosion by metallic or nonmetallic coatings such as plating or painting.

5.6 If the manufacturer intends the motor-compressor assembly to be employed in outdoor-use equipment, the requirements of Clauses 5.7 to 5.14 also apply to electrical enclosures.

5.7 A sheet steel electrical enclosure of a motor-compressor assembly intended for exposure to the effects of weathering shall be protected against corrosion as specified in Clauses 5.8 to 5.14 or by other metallic or nonmetallic coatings that have been found to give equivalent protection.

5.8 If contained within another enclosure and if 1.35 mm (0.053 in) thick or heavier, protection is to be provided by one of the following coatings:

- a) Hot-dipped mill galvanized sheet steel conforming with the coating designation G60 or A60 in Table 1 of the *Specification for Sheet Steel, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process, ASTM A653/A653M-94*, with not less than 40 per cent of the zinc on any side, as determined by the minimum single spot test requirement in this ASTM designation. The weight of zinc coating may be determined by any recognized method; however, where results are in question, the weight of coating shall be established in accordance with the *Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings, ASTM A90/A90M-93*.
- b) A zinc-coating, other than that provided on hot-dipped mill-galvanized sheet steel, uniformly applied on each surface to an average thickness of not less than 0.01041 mm (0.00041 in), and to a minimum thickness of 0.00864 mm (0.00034 in). The thickness of the coating shall be established by the Metallic Coating Thickness Test, Section 43. An annealed coating shall also comply with Clause 5.10.
- c) Two coats of an organic finish of the epoxy or alkyd-resin type or other outdoor paint on both surfaces. Unless acceptability of the paint can be determined by consideration of its composition, corrosion tests are required.

5.9 If intended to provide the sole enclosure of current-carrying parts, or if lighter than 1.35 mm (0.053 in), protection is to be provided by one of the following coatings:

a) Hot-dipped mill-galvanized sheet steel conforming with the Coating Designation G90 in Table 1 of Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, ASTM A653/A653M-94, with not less than 40 per cent of the zinc on any side, based on the minimum single spot test requirement in that ASTM specification. The weight of zinc coating may be determined by any acceptable method; however, in case of question the weight of the coating shall be established in accordance with the Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings, ASTM A90/A90M-93.

b) A zinc coating, other than that provided on hot-dipped mill-galvanized sheet steel, uniformly applied to an average thickness of not less than 0.0155 mm (0.00061 in) on each surface with a minimum thickness of 0.0137 mm (0.00054 in). The thickness of the coating shall be established by the Metallic Coating Thickness Test, Section 43. An annealed coating shall also comply with Clause 5.10.

c) A cadmium coating not less than 0.025 mm (0.001 in) thick on both surfaces. The thickness of coating shall be established in accordance with the Metallic Coating Thickness Test, Section 43.

d) A zinc coating conforming with Items (a) and (b) of Clause 5.8 with one coat of outdoor paint as specified in Item (c) of Clause 5.8.

e) A cadmium coating not less than 0.0191 mm (0.00075 in) thick on both surfaces with one coat of outdoor paint on both surfaces, or not less than 0.0127 mm (0.0005 in) thick on both surfaces with two coats of outdoor paint on both surfaces. The thickness of the cadmium coating shall be established in accordance with the Metallic Coating Thickness Test, Section 43, and the paint shall be as specified in Item (c) of Clause 5.8.

5.10 An annealed zinc coating that is bent or similarly formed after annealing shall be painted in the bent or formed area if the bending or forming process has damaged the zinc coating.

5.11 The zinc coating is considered damaged if flaking or cracking of the zinc coating at the outside radius of the bent or formed section is visible at 25-power magnification. Simple sheared or cut edges and punched holes are not considered formed, but extruded and rolled edges and holes shall comply with Clause 5.10.

5.12 With reference to Clause 5.7, other finishes, including paint, special metallic finishes and combinations of the two, are acceptable if comparative tests with galvanized sheet steel, without annealing, wiping, or other surface treatment, complying with Item (a) of Clause 5.8 or 5.9, as applicable, indicate that they provide equivalent protection. A paint finish shall comply with the requirements in the *Standard for Organic Coatings for Steel Enclosures for Outdoor Use Electrical Equipment*, UL 1332.

5.13 Nonferrous enclosures may be employed without special corrosion protection. See also Clause 5.2.

5.14 Metals shall not be used in combinations such as to cause galvanic action that will adversely affect cabinets or enclosures.

6 Openings in enclosures

6.1 The requirements specified in Clauses 6.2 and 6.3 apply only to parts of hazardous voltage circuits as defined by Clause 2.1. Compliance may be obtained when the motor-compressor is installed in the end-use equipment.

6.2 Uninsulated live parts of motor-compressors shall be located, guarded, or enclosed to reduce the risk of unintentional contact by persons through openings in enclosures.

6.3 In an electrical enclosure of a motor-compressor assembly, an opening shall be of such size or shape as to prevent passage of a probe, illustrated in Figure 6.1, from contacting uninsulated live parts. The configuration of the probe shall be changed (articulated) after insertion. See Clause 6.4 for film coated wire.

6.4 A probe illustrated in Figure 6.2 shall not touch film-coated wire when inserted through the opening.

Figure 6.1
Articulated probe with web stop (See Clause 6.3.)

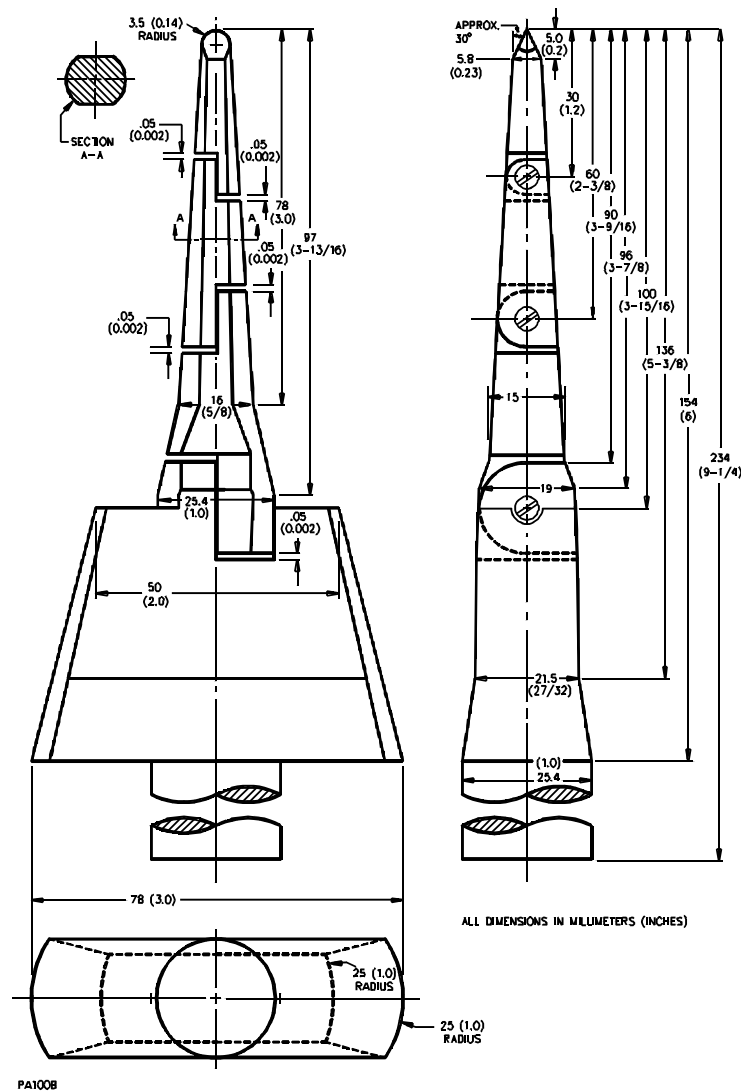
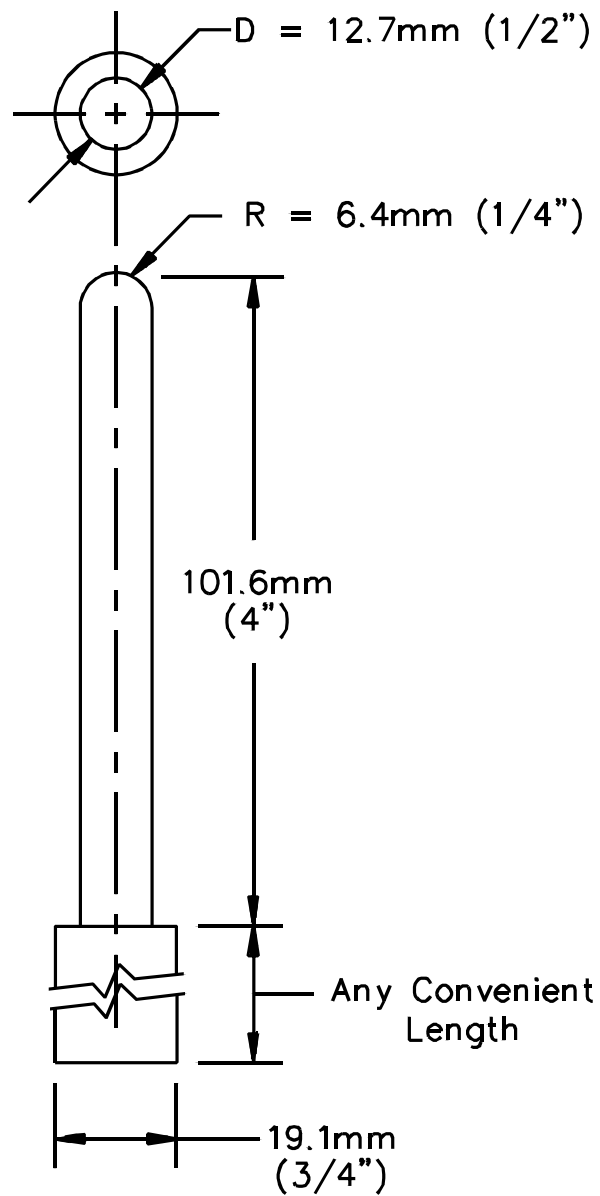


Figure 6.2
Probe (See Clause 6.4.)



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7 Gaskets

7.1 Gaskets required to seal electrical enclosures for outdoor equipment shall be formed of materials such as neoprene, rubber, or thermoplastic and shall be held in place by mechanical fasteners or adhesives.

Exception: Gaskets that are prevented from displacement either by their location or placement of other components in the enclosure when the cover is removed, and that would be reengaged in the intended manner when the cover is replaced, are not required to be held by mechanical fasteners or adhesives. Consideration shall be given to the intended mounting of the gaskets in the application.

7.2 Where such materials are required, gaskets, adhesives, and sealing compounds shall comply with the requirements for Gasket-Accelerated Aging Tests, Section 42.

8 Field wiring supply connections

8.1 See the applicable end-use product standard for the field wiring requirements if a motor-compressor is intended for field wiring.

9 Factory wiring supply connections

9.1 Terminals on motor-compressors intended to be factory wired shall be investigated to determine their ability to retain the conductors in position.

9.2 Among the factors that determine the acceptability of factory wiring terminals are the

- a) type and size of wire to be connected;
- b) ampacity of the terminals; and
- c) mechanical protection.

These are dependent on requirements of the end-use equipment.

9.3 A terminal shall be secured in position by means other than friction between surfaces if turning or shifting of the terminal may result in reduction of spacings to less than those required.

10 Current-carrying parts

10.1 All current-carrying parts of a motor-compressor shall be of silver, copper, a copper alloy, or other metal recognized for use as an electrical conductor.

Exception: Multimetallic thermal elements and heater elements of a thermal protector need not comply with this requirement.

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