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NEMA STANDARDS PUBLICATION NO. DC 3

nema

Residential Controls — Electrical Wall-Mounted Room Thermostats

NEMA

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION ■ 2101 L STREET, N.W., WASHINGTON, D.C. 20037

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NEMA Standards Publication DC 3-1989 (R1996)

Residential Controls—Electrical Wall Mounted room Thermostats

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Foreword

This Standards Publication defines the basic standards for rating, classification, construction, test, and performance of wall-mounted room thermostats and describes the thermostat test equipment necessary to test thermostat operation and performance. It has been developed in the public interest and is designed to promote a better understanding between the manufacturer and the user and to assist the user in selecting and obtaining the proper thermostat for his or her particular application.

If a value for measurement as given in this Standards Publication is followed by an equivalent value in other units, the first stated value is to be regarded as the requirement. The given equivalent value may be only approximate.

These standards are periodically reviewed by the Residential Controls Section of NEMA for any revisions necessary to keep them up-to-date with advancing technology. Proposed or recommended revisions should be submitted to:

Vice President, Engineering
National Electrical Manufacturers Association
2101 L Street, N.W.
Washington, DC 20037

Publication No. DC 3-1989 revises and supersedes the NEMA Standards Publication for *Wall-Mounted Room Thermostats,* Publication No. DC 3-1984. Prior to publication, the NEMA Standards, Suggested Standards for Future Design, and Authorized Engineering Information that appear in this publication unchanged since their appearance in DC 3-1984 were reaffirmed. Those that have been revised are followed by their appropriate classification and the date.

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Scope

This Standards Publication covers self-contained, electrical and electronic, wall-mounted room thermostats for controlling the temperature of the space in which the thermostat is mounted by controlling the applied energy for heating, cooling, or heating-cooling.

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History of Standards

The Residential Controls Section of NEMA was formed in 1940 to promote the standardization of products within the scope of the Section. These product standards cover definitions, ratings, performance, testing, and dimensions. NEMA Standards are voluntary and are designed to eliminate misunderstandings between the purchaser and the manufacturer.

This publication is one of a series sponsored by the Residential Controls Section. Other publications in this series are identified as Pub. No. DC ____ (followed by the year of issue).

The development of NEMA standards for room thermostats was prompted by the need for a basic set of standards for construction and performance that were not covered by other standards.

Action was first taken in 1941 to develop a standard for room thermostats. The standard was published in 1948 and covered low-voltage and line-voltage room thermostats. It was revised several times.

The need for separate standards to cover line-voltage electric-heat room thermostats became evident with the growth and acceptance of electric heat. NEMA Publication No. DC 15 was first published in 1968 and covered only line-voltage electric-heat room thermostats. It became apparent that a more logical division in the standards for room thermostats would be to incorporate all line-voltage room thermostats in one publication and low-voltage room thermostats in another. Therefore, NEMA Publication No. DC 3, covering only low-voltage room thermostats, and DC 15, covering only line-voltage room thermostats, were published in 1972.

In 1981, a review of DC 3 and DC 15 indicated that there was a substantial similarity in definitions, functions, and testing of both line-voltage and low-voltage thermostats. Consequently, it was deemed practical to again consolidate all wall-mounted room thermostats into a single standard, DC 3-1984.

The current publication, DC 3-1989, is published in accordance with NEMA's policy of periodic review and revision to keep NEMA standards contemporary with industry needs and technological advancement. It replaces the 1984 edition.

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ELECTRICAL WALL-MOUNTED ROOM THERMOSTATS

Section 1
REFERENCED STANDARDS AND DEFINITIONS

1.1 REFERENCED STANDARDS

Provided below is a complete listing of the titles and publication numbers of all standards referenced, in part or in full, in this Standards Publication. The mailing address of each referenced organization is also provided.

National Electrical Manufacturers Association (NEMA)
2101 L Street, N.W.
Washington, DC 20037

DC 2-1982 (R 1988) — *Quick Connect Terminals*

National Fire Protection Association (NFPA)
Batterymarch Park
Quincy, MA 02269

ANSI/NFPA 70-1987* — *National Electrical Code*

Underwriters Laboratories, Inc. (UL)
333 Pfingsten Road
Northbrook, IL 60062

UL 310-1985 — *Quick Connect Terminals*
ANSI/UL 486A-1980* — *Wire Connectors and Soldering Lugs for Use With Copper Conductors*
ANSI/UL 486B-1987* — *Wire Connectors for Use with Aluminum Conductors*
ANSI/UL 514A-1983* — *Metallic Outlet Boxes, Electrical*
ANSI/UL 514C-1988* — *Non-metallic Outlet Boxes, Flush Device Boxes, and Covers*
ANSI/UL 873-1988* — *Electrical Temperature-Indicating and -Regulating Equipment*

*Also available from the American National Standards Institute (ANSI), 1430 Broadway, New York, NY 10018.

1.2 DEFINITIONS

1.2.1 Actuation

Denotes a movement of the actuating member of the control by the user, by hand, by foot, or by any other human activity.

NEMA Standard 3-8-1978.

1.2.2 Actuating Member

Denotes that part which is manually or similarly moved, pushed, or turned to cause initiation of a control action for the purpose of varying or changing a controlled parameter.

NEMA Standard 11-15-1984.

1.2.3 Anticipating Heater

A means for adding heat within the thermostat to provide heating anticipation or cooling anticipation.

NEMA Standard 7-19-1972.

1.2.4 Anticipation, Cooling

The ability of a thermostat to initiate cooling at a lower temperature and in advance of the time that the air temperature at the thermostat would normally cause the thermostat to initiate cooling.

NEMA Standard 7-19-1972.

1.2.5 Anticipation, Heating

The ability of a thermostat to terminate heating at a lower temperature and in advance of the time that the air temperature at the thermostat would normally cause the thermostat to terminate heating.

NEMA Standard 7-19-1972.

1.2.6 Battery Backup

Provision in a thermostat, generally an electronic thermostat, that permits the thermostat to retain program memory or clock time, or both, when electric power to the thermostat is interrupted.

NEMA Standard 11-15-1984.

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1.2.7 Changeover, Automatic

The provision for changing from heating to the cooling mode, or vice versa, automatically.

NEMA Standard 3-8-1978.

1.2.8 Changeover, Manual

The provision for selecting the heating or cooling mode by means of manual switch(es) or device(s), or both, that are typically located at the room thermostat.

NEMA Standard 3-8-1978.

1.2.9 Class 2 Remote-Control and Signal System*

A system, depending on the voltage, that has the current limited as follows:

1. Maximum 20 volts, 5 amperes. Circuits in which the open-circuit voltage does not exceed 20 volts and having overcurrent protection of not more than 5-amperes rating. Where the current supply is from a transformer or other device having energy-limiting characteristics and approved for the purpose, or from primary batteries, the overcurrent protection is not required.
2. 20 to 30 volts, 3.2 amperes. Circuits in which the open-circuit voltage exceeds 20 volts but does not exceed 30 volts and having overcurrent protection of not more than 3.2 amperes rating. Where the current supply is from a transformer or other device having energy-limiting characteristics and approved for the purpose, or from primary batteries, the overcurrent protection is not required.

NEMA Standard 11-16-1989.

*Based on Tables 725.31 (a) and (b) for Power Limitations for AC and DC Circuits from the **National Electrical Code**, NFPA 70.

1.2.10 Control Point

The value of the mean air temperature at the thermostat under specified operating conditions.

NEMA Standard 3-8-1978.

1.2.11 Cut-in Point

The air temperature at the thermostat at which it initiates action.

NEMA Standard 7-19-1972.

1.2.12 Cut-out Point

The air temperature at the thermostat at which it terminates action.

NEMA Standard 6-19-1972.

1.2.13 Cycle Rate

The number of cycles per hour under specified operating conditions.

NEMA Standard 7-19-1972.

1.2.14 Cycle Time

The time that elapses between successive cut-in points.

NEMA Standard 3-8-1978.

1.2.15 Differential, Mechanical

The difference in temperature setpoints between cut-in and cut-out points determined by manually raising and lowering the thermostat setting with no electrical load.

NEMA Standard 11-16-1989.

1.2.16 Differential, Operating

The difference between cut-in and cut-out points as measured at the thermostat under specified operating conditions.

NEMA Standard 7-19-1972.

1.2.17 Double-line-break Cycling Thermostat

A thermostat that opens all ungrounded conductors of a single electrical load during cycling.

NEMA Standard 5-17-1972.

1.2.18 Double-line-break Disconnect Thermostat

A thermostat that includes two single-pole single-throw switches that open all ungrounded conductors of a single electrical load when set in the "off" position.

NEMA Standard 5-17-1972.

1.2.19 Droop

The deviation in the cut-in point that results from a change in the duty cycle, heating load or cooling load.

NEMA Standard 7-19-1972.

1.2.20 Duty Cycle

The ratio of ON time to cycle time within a specific cycle.

NEMA Standard 3-8-1978.

1.2.21 Load, Cooling

The rate of heat gain of the space being controlled.

NEMA Standard 3-8-1978.

1.2.22 Load, Electrical

The controlled load expressed in volts and amperes, volt-amperes, or watts.

NEMA Standard 11-15-1984.

1.2.23 Load, Heating

The rate of heat loss of the space being controlled.

NEMA Standard 3-8-1978.

1.2.24 Multi-stage Thermostat

A thermostat that controls two or more electrical loads with separate switching actions. The calibration of

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each action shall be separated by an appropriate amount of temperature difference.

NEMA Standard 11-16-1989.

1.2.25 Offset

The intentional temperature difference between the cut-in point and the temperature setpoint with no electrical load.

NEMA Standard 5-17-1972.

1.2.26 Pilot Duty

A class of operation in which the ultimate electrical load is controlled by auxiliary means.

NEMA Standard 5-17-1972.

1.2.27 Programmable Thermostat

A thermostat with the capability of automatically adjusting temperature setpoint(s) to preselected settings at preselected times.

NEMA Standard 11-16-1989.

The program may repeat daily or on preselected days.

Authorized Engineering Information 11-16-1989.

1.2.28 Range

The temperature difference in degrees from the maximum to the minimum temperature setpoints of the thermostat.

NEMA Standard 11-16-1989.

1.2.29 Rating, Electrical

The maximum specified electrical load of the thermostat.

NEMA Standard 7-19-1972.

1.2.30 Room Thermostat, Independently Powered

A thermostat that utilizes a power source such as a battery or transformer that is independent of the controlled load circuit.

NEMA Standard 11-16-1989.

This thermostat may be programmable.

Authorized Engineering Information 11-16-1989.

1.2.31 Room Thermostat, Line-voltage

A device that acts to automatically control the temperature of the room or space in which it is installed by controlling the line-voltage electrical load directly or indirectly through a line-voltage operating control.

NEMA Standard 11-16-1989.

1.2.32 Room Thermostat, Low-voltage

A device that acts to automatically control the temperature of the room or space in which it is installed by controlling the applied energy to a low-voltage operating control in a Class 2 circuit.

NEMA Standard 7-19-1972.

1.2.33 Setback (or Setup)

The automatic alteration of the control point(s) by means other than manually changing the temperature setpoint.

NEMA Standard 11-16-1989.

1.2.34 Single-line-break Cycling Thermostat

A thermostat that opens one ungrounded conductor of a single electrical load during cycling.

NEMA Standard 11-16-1989.

1.2.35 Single Stage Thermostat

A thermostat that controls all of the electrical load, either heating or cooling, with one switching action.

NEMA Standard 11-16-1989.

1.2.36 Subbase

A part to which a thermostat is attached.

NEMA Standard 11-15-1984.

It may contain terminals or auxiliary components such as switches or indicator lamps.

Authorized Engineering Information 11-15-1984.

1.2.37 Temperature Setpoint

The indicated temperature or position to which the thermostat is set.

NEMA Standard 11-16-1989.

1.2.38 Thermostat, Millivolt

A low-voltage room thermostat suitable for operation in a millivolt system typically supplied from a self-generating source.

NEMA Standard 7-19-1972.

1.2.39 Two-circuit Thermostat

A thermostat that controls two separate electrical loads with one switching action.

NEMA Standard 11-16-1989.

1.2.40 Wallplate

A part that is attached to an outlet box or directly to the wall and to which a thermostat or subbase is, in turn, attached. Also a plate used in masking wall surfaces.

NEMA Standard 11-15-1984.

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Section 2
RATINGS AND CLASSIFICATIONS

2.1 ELECTRICAL RATINGS

The electrical ratings of thermostats shall be as follows:

2.1.1 Low Voltage Thermostats

Volts	Amperes
0 to 20	5 (Max)
Over 20 to 30	3.2 (Max)

2.1.2 Line Voltage Thermostats (AC)

a. Line-Voltage Resistive Non-Inductive Thermostats

Volts	Amperes
120	24 (Max)
208	24 (Max)
240	24 (Max)
277	24 (Max)

b. Line-Voltage Inductive Thermostats

Amperes			
Full Load		Locked Rotor	
120 Volts	240 Volts	120 Volts	240 Volts
3	1½	18	9
6	3	36	18
8	4	48	24
10	5	60	30
14	7	84	42
16	8	96	48

NEMA Standard 11-16-1989.

Line voltage thermostats may also carry a pilot duty rating of 125 voltamperes at 120, 240, or 277 volts.

Authorized Engineering Information 11-16-1989.

2.2 FUNCTIONAL GROUPS

Thermostats may be classified as shown in 2.2.1 and 2.2.2.

2.2.1 Group

A Heating only (1 stage)

B Cooling only (1 stage)

C Heating-cooling – manual changeover (1 stage)

D Heating-cooling – automatic changeover (1 stage)

E 2-stage heating

F 2-stage cooling

G 1-stage heating, 2-stage cooling – manual changeover

H 1-stage heating, 2-stage cooling – automatic changeover

I 2-stage heating, 1-stage cooling – manual changeover

J 2-stage heating, 1-stage cooling – automatic changeover

K 2-stage heating, 2-stage cooling – manual changeover

L 2-stage heating, 2-stage cooling – automatic changeover

M Modulating

N 3-stage heating, 2-stage cooling – manual changeover

O 3-stage heating, 2-stage cooling – automatic changeover

P Not otherwise classified

Authorized Engineering Information 11-16-1989.

2.2.2 Sub-Group

For additional identification, a suffix number may be added to the group letter, as follows:

-1 Single Line Break Thermostat
-2 Double Line Break Disconnect
-3 Double Line Break Cycling
-4 Two Circuit Thermostat
-5 Programmable Thermostat

For example, a heating only, double line disconnect thermostat is classified as A-2.

Authorized Engineering Information 11-16-1989.

2.3 AUXILIARY COMPONENTS

2.3.1 Functions

Thermostats may be provided with the following functions that may be integral to the thermostat or mounted on a subbase.

1. System selector switch(es) (heating, cooling, OFF, automatic, emergency heat);
2. Fan selector switch (ON, OFF, automatic, low, medium, and high);
3. Control point setback(s) [or setup(s)];
4. Clocks or timers;

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5. Components for the biasing of the control point based on relative humidity;
6. Battery backup;
7. Independently powered; or,
8. Other functions as appropriate.

2.3.2 Thermometers

Thermostats may be provided with an integral thermometer.

2.3.3 Indicator Lamps

Thermostats or subbases may be provided with one or more indicator lamps.

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Section 3
CONSTRUCTION

3.1 CONNECTIONS

3.1.1 Terminals shall be provided and arranged so that circuit conductors or terminals will not be accidentally shorted or grounded when the thermostat is installed.

3.1.2 Low-Voltage Thermostats

The terminal spacings for low-voltage thermostats are not specified except that the space between the wiring terminals shall be not less than 1.6 mm (1/16 in.) through air or over the surface. When barriers are used, the thickness shall be not less than 0.4 mm (1/64 in.).

Terminals to which field wiring connections are made shall provide good mechanical and electrical connections. If a wire-binding screw is employed at a wiring terminal, the screw shall not be smaller than M3 (No. 4). If a quick connect terminal is used, it shall be either 4.8×0.5 mm (0.187×0.020 in.) or 6.4×0.8 mm (0.250×0.032 in.) in size in accordance with NEMA Standards Publication No. DC 2.

3.1.3 Line-Voltage Thermostats

Wiring terminal spacings or external wire leads shall be in accordance with Underwriters Laboratories, Inc., Publication No. UL 873.

Terminals to which field connections are made shall provide good connections without loosening during field wiring and mounting. If a wire-binding headscrew is used at a wiring terminal, the screw shall comply with Underwriters Laboratories, Inc., Publication No. UL 873.

In the case of pressure-type connectors, terminals shall also comply with Underwriters Laboratories, Inc., Publication No. UL 486A and UL 486B.

Thermostats shall be provided with means for mounting on a standard outlet box or shall be provided with a suitable outlet box. In the latter case, the outlet box shall comply with the Underwriters Laboratories, Inc., Publication No. UL 514.

Thermostats shall be so constructed as to permit their installation in accordance with the *National Electrical Code,* ANSI/NFPA 70.

NEMA Standard 11-15-1984.

3.2 MATERIALS

3.2.1 Thermostats shall be so designed that their control point and function will not be affected when they are mounted on uneven surfaces having a projection or projections not exceeding 1.6 mm (1/16 in.) in height or from normal handling during the mounting of the thermostat to an outlet box.

3.2.2 Parts that are intended for setting by the user after the thermostat is installed shall be sufficiently rigid to provide reliable means of setting. All parts of the thermostat shall be constructed to withstand vibration and shock anticipated in the residential environment.

3.2.3 Thermostats shall be capable of withstanding the following conditions that may be encountered during shipping and storage:

1. A temperature range of –40°C (–40°F) to 65°C (150°F); and
2. Normal handling and high humidity.

3.2.4 Iron and steel parts (except in the case of bimetals, bearings, etc., where such protection is impractical) shall be suitably protected against corrosion by enameling, galvanizing, sherardizing, plating, or other equivalent means.

3.2.5 Thermostats shall have enclosures sufficiently rigid to protect the operating parts against damage.

3.2.6 Enclosures for line voltage thermostats shall be in accordance with Underwriters Laboratories, Inc., Publication No. UL 873.

NEMA Standard 11-15-1984.

3.3 ASSEMBLY

Thermostats shall be assembled in a manner that will afford normal protection to the installer and user with regard to sharp edges.

NEMA Standard 11-15-1984.

3.4 ADJUSTMENTS AND SETTINGS

3.4.1 Temperature Setting

Thermostats shall have a visible and easily accessible means for setting, except where specified for particular applications.

3.4.2 Accuracy of Temperature Setting Adjustment

When a thermostat is in exact adjustment at a specific setting, the accuracy at 5.0°C (9.0°F) above and below this point shall be within 1.7°C (3.0°F) with no connected electrical load.

3.4.3 Factory Adjustment

When measured at the factory adjustment reference point, the cut-in/cut-out point of thermostat shall be within 1.1°C (2.0°F) for low-voltage thermostats and

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within 1.7°C (3.0°F) for line-voltage thermostats with no connected electrical load.

Allowance shall be made for thermostats that incorporate a specified offset. For other than single-stage thermostats, the thermostat manufacturer shall specify the adjusted stage and the specific offset for each of the other stages.

3.4.4 Sealing and Locking

To discourage tampering by unqualified persons when adjustments are intended for factory use only, the parts shall be sealed or locked or shall be so made as to require special tools.

NEMA Standard 11-15-1984.

3.5 SPACINGS (LINE-VOLTAGE THERMOSTATS)

Thermostats shall have spacings in accordance with Underwriters Laboratories, Inc., Publication No. UL 873.

NEMA Standard 11-15-1984.

3.6 LINE-VOLTAGE THERMOSTAT GROUNDING (EARTHING)

Thermostats shall be provided with means for grounding all exposed metal noncurrent-carrying parts that may become energized, except that small metal parts that are insulated by their location, such as nameplates and monograms, need not be grounded.

Provision for conduit connection shall be suitable means for grounding the thermostat provided that continuity of the circuit to noncurrent-carrying parts is assured.

Provisions for grounding shall meet all of the requirements of the Underwriters Laboratories, Inc., Publication No. UL 873.

NEMA Standard 11-15-1984.

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Section 4
TESTING AND PERFORMANCE

4.1 DIELECTRIC TESTS

4.1.1 Low-Voltage Thermostats

Thermostats shall be capable of withstanding for 1 minute, without breakdown, the application of a 50/60 hertz alternating potential of 500 volts, applied between uninsulated low-voltage live-metal parts of opposite polarity (with contacts closed) and between uninsulated low-voltage live-metal parts and the enclosure and grounded dead-metal parts.

As an alternative, the dielectric test on thermostats may be conducted for 1 second with a 50/60 hertz test voltage of 600 volts.

NEMA Standard 3-8-1978.

4.1.2 Line-Voltage Thermostats

Thermostats shall meet the dielectric test requirements described in the Underwriters Laboratories, Inc. Publication No. UL 873.

NEMA Standard 11-15-1984.

4.2 ENDURANCE

4.2.1 Low-Voltage Thermostats

Thermostats shall be capable of thermally operating at the maximum rated electrical load for at least 100,000 cycles at a rate of not more than 4 cycles per minute.

NEMA Standard 11-15-1984.

4.2.2 Line-Voltage Thermostats

Thermostats shall meet the endurance test requirements described in the Underwriters Laboratories, Inc. Publication No. UL 873.

NEMA Standard 11-15-1984.

4.3 OVERLOAD TEST (Line-Voltage Thermostats)

Thermostats shall meet the overload test requirements in the Underwriters Laboratories, Inc. Publication No. UL 873.

NEMA Standard 11-15-1984.

4.4 TEMPERATURE (Line-Voltage Thermostats)

Temperature rises and test procedures for thermostats shall be in accordance with the Underwriters Laboratories, Inc. Publication No. UL 873.

NEMA Standard 11-15-1984.

4.5 ENVIRONMENTAL TESTS

4.5.1 General Conditions

All environmental tests shall be conducted in accordance with the equipment and operating instructions described in Section 7.

All tests shall be conducted with the air velocity through the test chamber set at 0.15 m/s (30 feet per minute) in the downward direction.

All tests shall be conducted with the temperature setpoint between 21.1°C (70°F) and 26.7°C (80°F). A different setting may be used if required to complete the performance tests within the range of the test equipment.

All tests on anticipating-type thermostats shall be conducted with anticipation in effect. Where more than one choice of anticipation is supplied, the manufacturer's instructions for electrical load under test shall be followed.

1. Thermostats having adjustable anticipation shall be set at the midpoint of the anticipation range and tested with current represented by the setting.
2. Thermostats with fixed-series anticipation shall be tested at the midpoint of the manufacturer's specified anticipation rating.
3. Thermostats having fixed-parallel-voltage-type anticipation shall be tested at their current and nominal voltage rating (27 volts ac or as specified).

All tests on nonanticipating-type thermostats shall be conducted at the manufacturer's specified rating.

All tests on thermostats that have heat-generating elements shall be conducted with those elements energized as they would be in normal operation.

Refer to 4.5.5 for additional electrical load information and standard test values for noninductive rated line-voltage thermostats.

These test conditions shall be used for conducting the tests of 4.5.2, 4.5.3, and 4.5.4.

NEMA Standard 11-16-1989.

4.5.2 Differential Tests

The differential tests shall be conducted with the test equipment set for uniform rates of temperature change of 3.3°K (6°F) per hour and 6.7°K (12°F) per hour for heating tests and 1.7°K (3°F) per hour and 3.3°K (6°F) per hour for cooling. Tests shall be conducted at 50 percent duty cycle.

The thermostat under test shall be connected so that it determines the direction of the temperature change during the cycle.

The operating differential shall be recorded.

NEMA Standard 11-15-1984.

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4.5.3 Cycle Rate Test

The cycle rate test shall be conducted at 20, 50, and 80 percent duty cycle and recorded.

The thermostat under test shall determine the direction of temperature change during the cycle with the rate change set as follows:

Percent Duty Cycle	Rate of Change, °K (°F)/Hour			
	Heating Thermostat		Cooling Thermostat	
	Rise	Fall	Rise	Fall
20	4.4(8)	1.1(2)	1.1(2)	4.4(8)
50	3.3(6)	3.3(6)	3.3(6)	3.3(6)
80	1.1(2)	4.4(8)	4.4(8)	1.1(2)

The thermostat shall be allowed to cycle until it has stabilized to a uniform rate.

NEMA Standard 11-15-1984.

4.5.4 Droop Test (Heating and Cooling)

The effective operating droop value shall be recorded as the average temperature difference between the cut-in points at the 20 percent and 80 percent duty cycles as determined from the cycle rate test.

NEMA Standard 3-8-1978.

4.5.5 Test Data Forms

The test data may be presented in one or more of the following forms:

1. Noninductive Rated Line – Voltage Thermostats See Table 4-1.
2. Inductive Rated Line – Voltage Thermostats unchanged from DC 3-1984 and Low Voltage Thermostats. See Table 4-2.
3. Test Data Curves – The curves shown in Figure 4-1 are typical effective operating droop and cycle rate curves for a heating thermostat that graphically represent the test results tabulated on the test data forms shown in Tables 4-1 and 4-2. A curve can be shown for each electrical load tested.

Authorized Engineering Information 11-15-1984.

Table 4-1
NONINDUCTIVE RATED THERMOSTAT TEST DATA FORM

Electrical Load at 240 Volts (±1 Percent), Watts	Operating Differential, Heating		Effective Operating Droop Value 20 to 80 Percent Duty Cycle	Cycle Rate, Heating		
	3.3°K(6°F)/hour	6.6°K(12°F)/hour		20%	50%	80%
1000*						
2500*						
4000*						
(Rated Load)						

*Any additional electrical loads up to the maximum rating of the thermostat under test may be included. (Rated Load) Fill in Blank.

Table 4-2
INDUCTIVE RATED THERMOSTAT TEST DATA FORM

Electrical Load		Operating Differential				Effective Operating Droop Value 20 to 80 Percent Duty Cycle	Cycle Rate					
		Heating		Cooling			Heating			Cooling		
Volts*	Amperes*	3.3°K(6°F)/hour	6.6°K(12°F)/hour	1.7°K(3°F)/hour	3.3°K(6°F)/hour		20%	50%	80%	20%	50%	80%

*Any electrical loads up to the maximum rating of the thermostat under test may be included.

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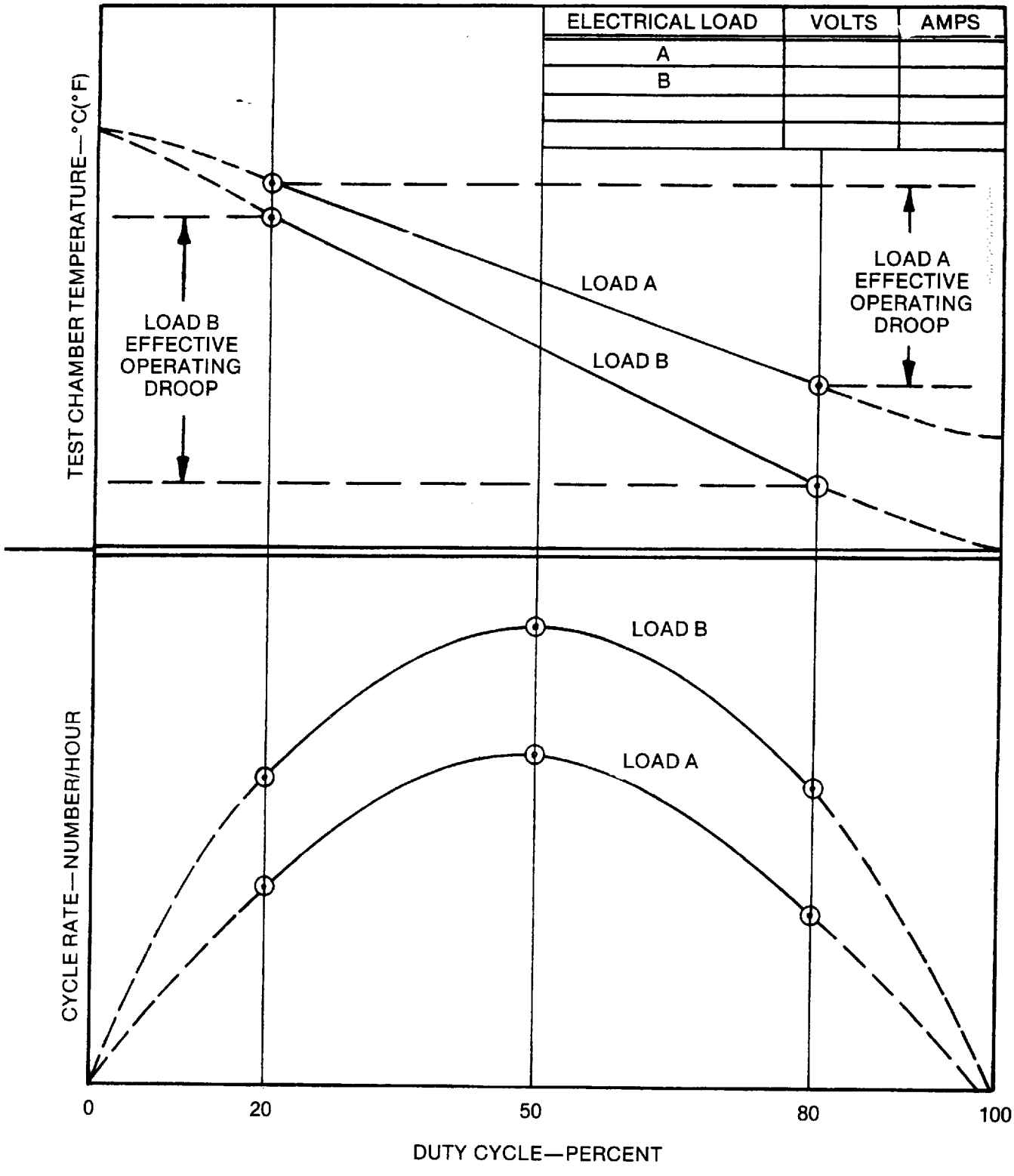


Figure 4-1
TEST DATA CURVES

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Section 5
MARKING

5.1 Thermostats shall have the following markings plainly visible.

1. A company name or trademark;
2. Catalog number or the equivalent;
3. Voltage rating and the ampere, wattage, or pilot duty rating for line voltage thermostats;* and,
4. The date of manufacture, including the year and week of manufacture.†

The requirement shall be considered as having been fulfilled if the information is on the inside of the cover assembly or on the base and is visible after installation with the cover assembly removed.

NEMA Standard 11-16-1989.

*For low voltage thermostats, this may be on the package label or with enclosed literature.

†The preferred method of marking is to indicate the date of manufacture in the form of the last two numbers of the year followed by the number of the week of manufacture.

Authorized Engineering Information 11-16-1989.

5.2 Markings shall be of a permanent nature.

5.3 Labels, stampings, or decalcomanias shall be located where they will not be exposed to mechanical damage.

5.4 When there are more than two wiring connections, the terminals shall be suitably marked.

1. Low-voltage thermostats shall be marked in accordance with Table 5-1.
2. Line-voltage thermostats shall be marked to identify line, load, and ground (earth) terminals.

5.5 The markings for the scale and for adjustments shall be clearly legible; and for line, load, and ground (earth) terminals on line-voltage thermostats, shall comply with the Underwriters Laboratories, Inc. Publication No. UL 873.

Cautionary markings shall be in accordance with UL 873.

NEMA Standard 11-15-1984.

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Table 5-1
TERMINAL MARKINGS FOR LOW-VOLTAGE CLASS 2 CONTROLS

Heating	W
1st Stage	W1
2nd Stage	W2
3rd Stage	W3
Cooling	Y
1st Stage	Y1
2nd Stage	Y2
3rd Stage	Y3
Fan	G
Switched Side, Class 2 Power (Single Source)	R
Switched Side, Class 2 Power, Heating Side	RH
Switched Side, Class 2 Power, Cooling Side	RC
Unswitched Side, Class 2 Power (Number Sequentially)	C□
Damper (heat); Reversing Solenoid (heat)	B
Damper (cool); Reversing Solenoid (cool)	O
General Purpose (Any Number)	A
Lockout Reset	X
One Side, Class 2 Circuit Switch-Heat	TT
Other Side, Class 2 Circuit Switch-Heat	TT
Indicator Circuits; System Monitors (Number Sequentially)	L□
Switched Side, Second Source-Class 2 Power	K1
Unswitched Side, Second Source-Class 2 Power	K2
Defrost	DF
Emergency Heat Relay	E
Outdoor Thermistor	T

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Section 6
APPLICATION

6.1 Room thermostats are designed to control room temperature by opening and closing circuits to heating and/or cooling equipment in response to temperature changes. The control point is selected by positioning the temperature setpoint to the desired comfort level.

Authorized Engineering Information 11-16-1989.

6.2 Switches, where included in the thermostat itself or the thermostat subbase, allow for the selection of the system operation, i.e., heating, cooling, off, fan mode, emergency heat.

Authorized Engineering Information 11-15-1984.

6.3 Low-voltage thermostats are designed for wall mounting and may be used with wallplates or subbases to facilitate mounting and wiring and to provide manual auxiliary switching.

Authorized Engineering Information 3-8-1978.

6.4 Line-voltage thermostats are designed for mounting to an appropriate outlet box and shall be so installed to comply with local electrical codes and the *National Electrical Code,* ANSI/NFPA 70.

NEMA Standard 11-15-1984.

6.5 Thermostats shall be accompanied by proper instructions.

NEMA Standard 11-15-1984.

These instructions should be followed for installation, adjustment, and operation.

Authorized Engineering Information 3-8-1978.

6.6 Connected electrical loads shall be within the rating that is marked on the thermostat.

NEMA Standard 11-15-1984.

6.7 Thermostats with anticipating heaters require proper setting of adjustable anticipators or proper selection of fixed anticipators if the system is to function properly. System performance may suffer with improper anticipation. Excessive loads on an anticipator heater can cause permanent damage to the anticipator.

Authorized Engineering Information 11-15-1984.

6.8 The selection of thermostats based on performance tests involves the characteristics of operating differential, effective operating droop and cycle rate. In general, the smaller the differential and the greater the cycle rate, the better the degree of comfort that can be expected. The smaller the droop, the more consistent will be the indoor temperature with changes in outdoor temperatures.

Authorized Engineering Information 3-8-1978.

6.9 The selection of the correct thermostat for satisfactory performance depends on a number of factors. In addition to the thermostat performance capabilities, these factors include the type of heating or air conditioning system to be controlled, the type of occupancy to be expected in the space controlled, the location of the thermostat in the controlled space, and the amount of electrical load to be switched by the thermostat. It is beyond the scope of this publication to cover in depth these many factors.

Authorized Engineering Information 3-8-1978.

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Section 7
NEMA THERMOSTAT TEST EQUIPMENT

7.1 GENERAL

The equipment for testing room thermostats in accordance with the provisions for this publication shall include the following:

1. Thermostat test chamber;
2. Program controller;
3. Temperature and event recorder; and
4. Thermostat test loads.

NEMA Standard 11-15-1984.

7.2 THERMOSTAT TEST CHAMBER

The thermostat test chamber shall be an adequately insulated airtight cabinet containing the following:

1. Thermostat mounting panels;
2. Heating system;
3. Cooling system;
4. Air duct system;
5. Blower system; and
6. Electric terminal board.

The test chamber shall be designed to operate in an ambient of 21.1°C (70°F) to 26.7°C (80°F) and with an appropriate supply voltage.

7.2.1 Thermostat Mounting Panel

Mounting panels shall be suspended within the thermostat test chamber on shock cords and shall contain suitable leads for connection to the electrical terminal boards.

7.2.2 Heating System

The test chamber shall incorporate resistance heating elements of sufficient wattage to provide a ramp of 6.7°K (12°F)/h with maximum cooling from 10°C (50°F) to 32°C (90°F).

7.2.3 Cooling System

The cooling system shall consist of an evaporator coil connected to an external air-cooled condensing unit. The cooling capacity shall be sufficient to provide a ramp of 6.7°K (12°F)/h from 10°C (50°F) to 32°C (90°F).

7.2.4 Air Duct System

The air duct system shall provide the thermostat test panel with air velocities of 0.1 to 0.2 m/s (20 to 40 feet per minute) when measured 25 mm (1 in.) in front of the center of the test panel. 0.15 m/s (30 feet per minute) is nominal.

The variation in velocity shall be no more than 0.03 m/s (6 feet per minute) as measured in two planes; plane "A" is horizontal 25 to 100 mm (1 to 4 in.) in front of the test panel and extends 75 mm (3 in.) on either side of the center of the test panel; plane "B" is vertical 25 to 100 mm (1 to 4 in.) in front of the test panel and extends 75 mm (3 in.) above and below the center of the test panel.

The variation in velocity at a point 25 mm (1 in.) in front of the center of the panel shall be not more than 0.015 m/s (3 feet per minute) over a 5-minute period. These measurements of variations shall be taken at nominal air velocity of 0.15 m/s (30 feet per minute) at 21.1°C (70°F).

7.2.5 Blower System

The blower system shall provide a flow of air in the downward direction. The blower, when operated from a constant-supply voltage source, ±5 volts, shall provide an air velocity of 0.1 to 0.2 m/s (20 to 40 feet per minute), 0.15 m/s (30 feet per minute) nominal, when measured at a point 25 mm (1 in.) in front of the center of the test panel. The variations in air velocity shall not exceed those specified in 7.2.4.

7.2.6 Electrical Terminal Board

Appropriate leads from the test thermostat shall exit from the back side of the thermostat test panel and terminate at a terminal block that is mounted on the right or left side and within the test chamber.

NEMA Standard 11-15-1984.

7.3 PROGRAM CONTROLLER

The program controller shall be capable of maintaining a constant temperature within 0.1°C (±0.2°F) throughout the setpoint range of the test chamber as measured with the recorder described in 7.4. The time constant of the sensor shall be approximately 45 seconds when measured in air having a velocity of 0.15 m/s (30 feet per minute).

The program controller shall be capable of programming a continuously adjustable linear temperature ramp* from 0.28°K to 6.7°K (½°F to 12°F) per hour heating and cooling between 10°C to 32°C (50°F to 90°F), with deviations of ±0.05°C (±0.1°F) or less from the linear measured with the sensor described in the preceding paragraph. The program controller shall be capable of changing the direction of the ramp by manual selection, internal adjustable setpoints in the instrument, or by the thermostat under test. The direction of the ramp shall be manually reversible for operating either a heating or a cooling thermostat.

*Linerar temperature ramp is a straight line between two temperatures at a stated slope. This ramp can be positive or negative.

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The program controller shall be capable of performing a stop-hold function of the ramp to maintain a constant temperature.

When changing the direction of the ramp, the overshoot or undershoot shall not exceed 0.05°C (0.1°F).

NEMA Standard 11-15-1984.

7.4 TEMPERATURE AND EVENT RECORDER

The temperature and event recorder shall be of the continuous type with an accuracy of 0.05°C (0.1°F) over the chart range.

The chart speed shall be 50.8 mm/h (2 inches per hour) (normal speed) or 25.4 mm (1 in.) to 101.6 mm (4 in.) per hour.

The chart markings shall be in 0.1°C (0.2°F) increments, with 0.05°C (0.1°F) readability.

The temperature recorder chart shall have a temperature span of 10°C or 20°F and be suitable for recording temperatures from 10°C to 30°C or 50°F to 90°F. Recommended spans are 10°C to 20°C or 50°F to 70°F, 15°C to 25°C or 60°F to 80°F, and 20°C to 30°C or 70°F to 90°F.

A two-channel event recording shall be provided coincident in time and on the same chart as the temperature recording for one- and two-stage thermostat operation.

The temperature sensor shall have a time constant of approximately 45 seconds when measured in air having a velocity of 0.15 m/s (30 feet per minute).

NEMA Standard 11-15-1984.

NOTE – The program controller and temperature event recorder may be combined into one instrument provided that the combination meets the foregoing individual requirements. A reversing switch may be included to change the ramp direction during the droop test.

Authorized Engineering Information 11-15-1984.

7.5 TEST LOADS, SUPPLIES, AND CONTROLS

1. For millivolt thermostats, one test load and one power supply to 100 millivolts direct current at 60 to 30 milliamperes are provided in the test equipment.*
2. For Class 2 thermostats, four Class 2 (as defined in Article 725 of the *National Electrical Code,* ANSI/NFPA 70) test loads and power supplies of 24 volts alternating current at 0 to 5 amperes are provided in the test equipment.*
3. For line-voltage thermostats, two sets of line-voltage wiring, 120 to 240 volt alternating current, are provided in the test equipment for external loads up to 25 amperes.†
4. The millivolt control will reverse the direction of ramp as the thermostat opens or closes on temperature rise, depending on the setting of the manual changeover switch.
5. Opening or closing of any contact to any of the four NEC Class 2 loads or to either of the two line-voltage loads will reverse the direction of the ramp as selected on the control panel when controlled by the thermostat under test.
6. Either event pen can be selected to operate on any load as selected on the control panel.

NEMA Standard 7-19-1972.

NOTE – Figure 7-1 is a schematic representation of the test chamber. Full details of the test equipment in the form of complete manufacturing drawings and material specifications are available from NEMA. Contact the Staff Executive of the Residential Controls Section.

Authorized Engineering Information 11-15-1984.

*The voltage supplies, loads, voltage, and current meters shall be mounted in the control cabinet. Test jacks shall also be supplied for external measurement of current and voltage.

†The supply voltage, loads, and metering shall be external to the equipment; only jacks, controls, and wiring shall be included in the cabinet.

NEMA Standard 7-19-1972.

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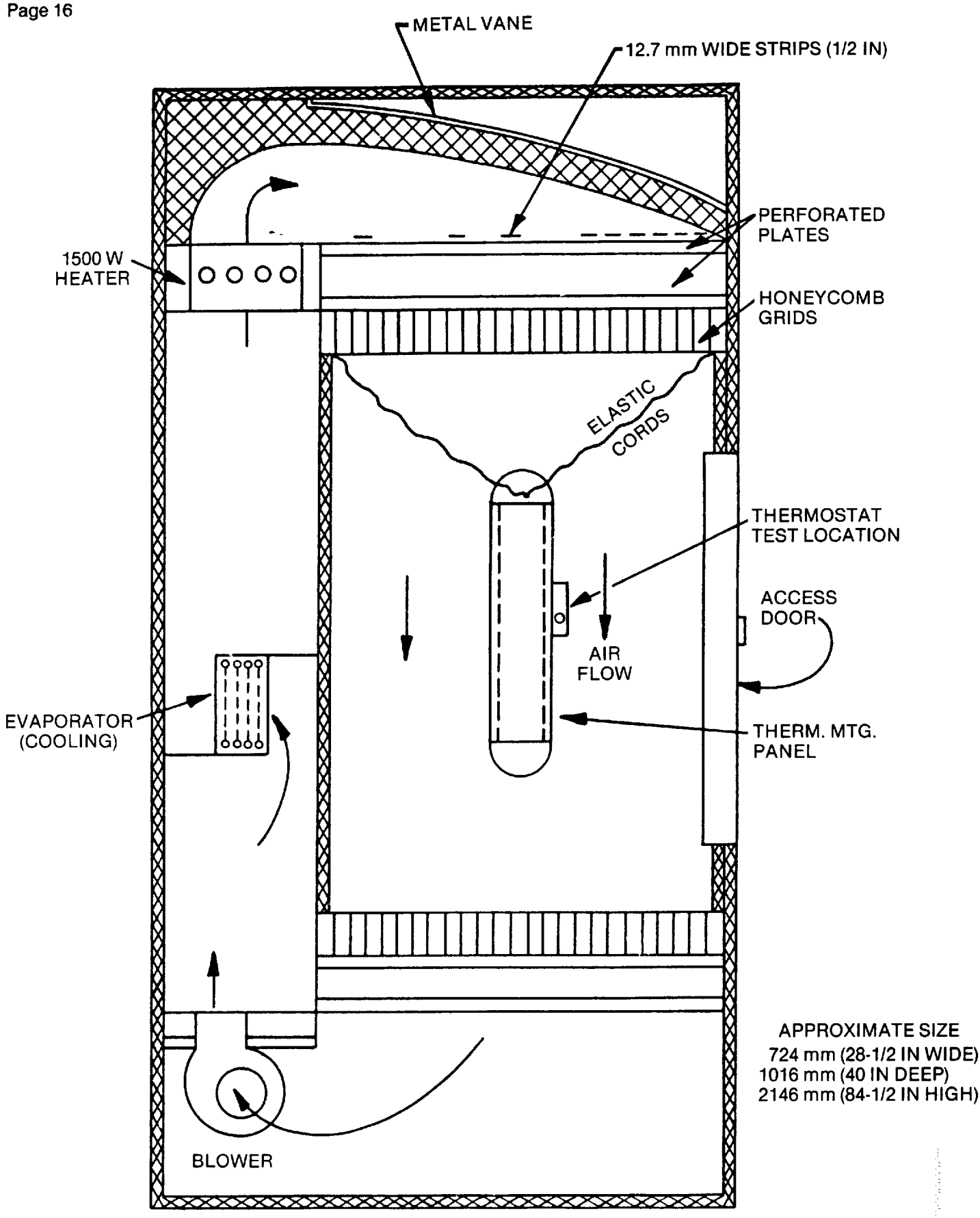


Figure 7-1
SCHEMATIC OF TEST CHAMBER

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Controls Division
Carol Stream, IL 60187

Emerson Electric Company
White-Rodgers Division
St. Louis, MO 63123

GE
Morrison, IL 61270

GTE Products Corporation
Control Device Operation
Standish, ME 04084

Hamilton Standard Controls, Inc.
Fort Wayne, IN 46859

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Minneapolis, MN 55422

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Milwaukee, WI 53209

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Mallory Timers Company
Div. of Emhart Industries, Inc.
Indianapolis, IN 46206

Ranco, Inc.
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NEMA STANDARDIZATION

The purpose of NEMA Standards, their classification and status, are set forth in certain clauses of the NEMA *Standardization Policies and Procedures* manual and are referenced below.

Purpose of Standards

National Electrical Manufacturers Association standards are adopted in the public interest and are designed to eliminate misunderstandings between the manufacturer and the purchaser and to assist purchasers in selecting and obtaining the proper product for their particular needs. Existence of a National Electrical Manufacturers Association standard does not in any respect preclude any member or nonmember from manufacturing or selling products not conforming to the standard.

(Standardization Policies and Procedures, p. 1)

Definition of a Standard

A standard of the National Electrical Manufacturers Association defines a product, process, or procedure with reference to one or more of the following: nomenclature, composition, construction, dimensions, tolerances, safety, operating characteristics, performance, rating, testing, and the service for which they are designed.

(Standardization Policies and Procedures, p. 2)

Dimensions

Where dimensions are given for interchangeability purposes, alternate dimensions satisfying the other provisions of the Standards Publication may be capable of otherwise equivalent performance.

(Standardization Policies and Procedures, p.8)

Categories of Standards

National Electrical Manufacturers Association Standards are of two classes:

1. NEMA Standard, which relates to a product, process, or procedure commercially standardized and subject to repetitive manufacture, which standard has been approved by at least 90 percent of the members of the Subdivision eligible to vote thereon;
2. Suggested Standard for Future Design, which may not have been regularly applied to a commercial product, but which suggests a sound engineering approach to future development, which standard has been approved by at least two-thirds of the members of the Subdivision eligible to vote thereon.

(Standardization Policies and Procedures, pp. 7 & 16)

Authorized Engineering Information

Authorized Engineering Information consists of explanatory data and other engineering information of an informative character not falling within the classification of NEMA Standard or Suggested Standard for Future Design, which standard has been approved by at least two-thirds of the members of the Subdivision eligible to vote on the standard.

(Standardization Policies and Procedures, pp. 7 & 16)

Official Standards Proposal

An Official Standards Proposal is an official draft of a proposed standard which is formally recommended to an outside organization(s) for consideration, comment, and/or approval, and which has been approved by at least 90 percent of the members of the Subdivision eligible to vote thereon.

(Standardization Policies and Procedures, pp. 7 & 16)

Identification of Status

Standards in NEMA Standards Publications are identified in the foreword or following each standard as "NEMA Standard" or "Suggested Standard for Future Design." These indicate the status of the standard. These words are followed by a date which indicates when the standard was adopted in its present form by the Association.

The material identified as "Authorized Engineering Information" and "Official Standards Proposal" is designated similarly.

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