

VL 1434

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Northbrook, Illinois • (708) 272-8800
Melville, New York • (516) 271-6200
Santa Clara, California • (408) 985-2400
Research Triangle Park,
North Carolina • (919) 549-1400



Subject 1434

333 Pfingsten Road
Northbrook, IL 60061-2096
November 15, 1993

TO: Electrical Council of Underwriters Laboratories Inc.;
Subscribers to UL's Recognition Service for
Thermistor-Type Devices;
and
Others Interested

SUBJECT: Report on Meeting of the Industry Advisory Group of UL
for Thermistor-Type Devices; Request for Comments on
Proposed Requirements for the First Edition of the
Standard for Thermistor-Type Devices, UL 1434

SUMMARY OF TOPICS

The following topics were discussed at the meeting:

1. Objectives of the Industry Advisory Group (IAG).
2. Background of the proposed Standard.
3. Scope, General, and Glossary Sections of the Standard.
4. Construction Sections of the Standard.
5. Performance requirements through Thermal Runaway Test, Section 18.
6. Next meeting.

Comments on this report due: December 27, 1993

A meeting of the Industry Advisory Group (IAG) of UL for Thermistor-Type Devices was held on October 13, 1993, at UL's Northbrook Office. The purpose of the meeting was to discuss proposed requirements in the proposed first edition of the Standard for Thermistor-Type Devices, UL 1434.

Attached for reference, as Appendix A, are the proposed requirements for the first edition of UL 1434 as reviewed by the IAG. The requirements in Appendix A do not include any modifications that were discussed at the IAG meeting. Attached as Appendix B is a list of those who attended the meeting.

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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 proposed requirements are published in final form.

* * * * *

The following report is not intended to be a verbatim transcript of the discussions at the meeting, but is intended to record the significant features of those discussions.

1. INDUSTRY ADVISORY GROUP OBJECTIVES

UL explained that Industry Advisory Groups (IAGs) are a means of obtaining advisory information from the involved and related industries concerning technical consideration involving Standards, investigations, Listing, Classification, Recognition, and Follow-Up Service for subscriber's products. UL seeks information from parties of diversified interests who may be affected by or interested in UL's Standards for Safety, and freely consults with these sources in the development of UL's Standards for Safety.

Members are appointed by UL and consist of representatives from UL and industry. The industry representatives are expected to function as individual representatives of industry rather than to represent any one manufacturer or trade association. Items considered by an IAG are in the nature of preliminary proposals and the advice of the Group is submitted for review and comment by all subscribers in that category and by other interested groups. Reports of Group meetings are prepared by UL as soon as practical following the meeting without prior review by Group members.

2. BACKGROUND OF THE STANDARD

For several years, UL has Listed and Recognized end-use products employing thermistor-type devices using positive temperature coefficient (PTC) or negative temperature coefficient (NTC) materials for such uses as self-limiting heaters, control circuit devices (current limiters, inrush limiters), and temperature sensing devices. Since February 1978, UL has investigated thermistor-type devices using the requirements contained in the Subject 1434 bulletin dated February 9, 1978.

In addition, the 1993 National Electrical Code (NEC), Section 725-31, Tables 725-31(a) and 725-31(b), note 1, permits a current limiting impedance to be used in combination with a nonpower-limited transformer or stored energy source to limit the output current for Class 2 and Class 3 circuits with or without

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overcurrent protection. As thermistors are commonly used as the current limiting impedance mentioned, industry requested UL to develop a standard containing the appropriate requirements.

Accordingly, to cover the previously Recognized devices and the new application related to the NEC, UL developed proposed requirements for thermistor-type devices in the proposed first edition of the Standard for Thermistor-Type Devices, UL 1434.

3. SCOPE, GENERAL, AND GLOSSARY SECTIONS

The Scope, General, and Glossary Sections were discussed as follows:

Scope, Section 1

The representatives of industry suggested that due to the significant differences between positive temperature coefficient (PTC) and negative temperature coefficient (NTC) devices that the Standard should be separated into two standards. UL indicated that consideration would be given to a two part standard, but a single standard covering both device types is preferred.

The representatives of industry suggested that heating cables constructed with thermistor-type material, such as self-regulating mobile home pipe heating cable, should not be covered by the UL 1434 Standard as these cables are covered by other UL documents. Therefore, the scope should be clarified to indicate these cable products are not covered by UL 1434. UL indicated that the scope would be modified.

General, Section 2

The representatives of industry had no comments on the General Section.

Glossary, Section 3

The representatives of industry indicated concern that some terms used in the performance requirements are not defined and suggested that they be added to the glossary to reduce possible misinterpretation. UL indicated that the glossary would be expanded to include such terms as "trip current," "rated voltage," and "rated current." The representatives of industry also noted that these terms are not used consistently in industry.

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The representatives of industry suggested changes to Figure 3.2, such as deleting R_m as it is not used elsewhere in the Standard and changing R_0 to R_{25} indicating resistance at 25°C. UL noted that the figure is intended to represent a typical graph, and UL will modify the figure for the suggested changes as appropriate and add "typical" to the title of the figure.

4. CONSTRUCTION SECTIONS

General, Section 4

The representatives of industry asked how compliance with paragraph 4.1 is determined. UL clarified that compliance is determined by conformance with the subsequent requirements of the Standard. UL will modify paragraph 4.1 accordingly.

Spacings, Section 7

Table 7.1, Minimum Acceptable Spacings, and the related aspect of metrification were discussed. UL advised that Table 7.1 is based on similar International Electrotechnical Commission (IEC) requirements but is not verbatim. The representatives of industry indicated preference for the IEC spacing requirements. As a result of the discussion at the meeting UL indicated that the IEC requirements would be substituted in a modified Table 7.1.

Metrification

UL explained that there is now a renewed emphasis on conversion to the metric system in the United States. The Omnibus Trade and Competitiveness Act of 1988 designates the metric system as the preferred system of measurement in the U.S. The Act also requires all Federal Agencies to use the metric system in procurement, grants, and other business related activities (unless impractical) by the end of the fiscal year 1992.

UL asked for comments on revising proposed UL 1434 so that all requirements are presented as metric values. The representatives of industry indicated that use of metric values would be acceptable.

Alternate Spacings — Clearance and Creepage Distances, Section 8

Concerning the alternate spacings approach covered by Section 8, the representatives of industry suggested that pollution degree 4 and overvoltage category 4 be added to Tables 8.1 and 8.2 to cover the possibility of a manufacturer wanting to design a device to these levels. UL indicated that the additional levels would be added.

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5. PERFORMANCE REQUIREMENTS

The performance requirements up through Thermal Runaway Test, Section 18, were discussed as follows:

General, Section 10

Table 10.1, Test Sample Distribution and Test Program, was discussed. As a result of the discussion at the meeting, UL determined that:

1. The interrupting and thermal runaway tests are not appropriate for control NTC thermistors,
2. As a result of clarification of the unique properties of NTC type devices, it was determined that further development of separate requirements for NTC type devices is necessary. **Consequently, the remaining review and discussion was confined to the performance requirements as they pertain to PTC type devices only.**
3. "Shape of" is to be removed from column 1, and
4. "Pellet" and "Package" will be defined in the Glossary to clarify sample testing and selection. UL noted that a package is considered to be any device with components, including leads for examples, added to a base pellet.

Table 10.2, Test Voltages, was discussed. The representatives of industry noted that some devices are given both a normal use voltage rating and a maximum operating voltage rating. The representatives asked which voltage rating would be used for tests. UL advised that the normal use voltage rating would be used and this would be clarified by expanded definitions and consistent use of terms.

Resistance/Temperature (R/T) or Voltage/Current (V/I) Characteristics, Section 11

As a result of discussion of paragraphs 11.1.1 and 11.1.2, UL determined that the following modifications and clarifications are needed:

1. Item (a) will be modified to indicate that the switch temperature (switch temperature will be defined in the Glossary) shall be within the manufacturer's specified limits before and after the tests, and
2. Items (a) and (b) will be modified to likewise indicate that the trip time and resistance respectively shall be within

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the manufacturer's specifications before and after the tests.

As a result of the discussion of paragraphs 11.1.1 and 11.1.2, UL determined that the scope of the Standard should be modified to clarify that current limiters are not intended to replace overcurrent protective devices such as fuses, but are intended, in conjunction with other components, to provide a level of protection complying with the end-use equipment requirements. Current limiting device manufacturers would specify the ratings and tolerances of a device, and UL 1434 would be used to verify the manufacturer's specifications.

**R/T Measurement for PTC Thermistor, Section 11.2; and
Alternate Method for R/T Measurement for
PTC Thermistor, Section 11.3**

Sections 11.2 and 11.3 were discussed. The representatives of industry noted that the results of 11.2 and 11.3 are different. UL advised that only one of the methods is to be used and the results compared before and after tests. UL suggested that the alternate method prescribed in Section 11.3 may not be applicable for PTC type devices, as experience indicates that the test may not show damage to a PTC device. The representatives of industry indicated that their experience is different and also suggested that an air-circulating oven be specified for the test. As a result of the discussion at the meeting, UL plans to further evaluate if the Alternate Method for R/T Measurement for PTC Thermistors, Section 11.3 is applicable and modify the requirement to specify use of an air-circulating oven. Also, the details of the test method will be expanded for clarification.

**V/I Measurement for PTC Thermistor Heaters, Section 11.4; and
V/I Measurement for PTC Thermistor Current Limiters, Section 11.5**

Sections 11.4 and 11.5 were discussed. UL advised that these Sections are intended to provide an easier, less time consuming test to establish the R/T characteristics. However, UL indicated concern that the V/I test may not provide accurate curves. UL suggested that Sections 11.4 and 11.5 be removed from the requirements.

The representatives of industry indicated they were in favor with dropping Sections 11.4 and 11.5 as experience showed that different R/T curves result when a device is heated versus when the device heats itself as is the case for resistance versus voltage/current measurements.

Calibration of PTC Thermistor Current Limiters, Section 11.7

The representatives of industry questioned the 20°C temperature specified in paragraph 11.7.2. UL advised that this is not a

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typographical error but relates to requirements in the Standard for Safety of Information Technology Equipment, Including Electrical Business Equipment, UL 1950, and a need to calibrate devices at 20°C. The representatives suggested that most devices are intended for use on the basis of a 25°C ambient. As a result of the discussion at the meeting, UL decided to modify the requirements to specify the test be conducted at the ambient specified by the thermistor device manufacturer for the rating.

Calibration of Sensing Thermistors, Section 11.8

Relative to paragraph 11.8.2, the representatives of industry noted that a temperature variation of the test medium of 0.5°C is too large for some devices. As a result of the discussion at the meeting, UL decided to combine the test with Section 11.3 and modify the requirement to indicate a test medium temperature within the device manufacturer's specified limits.

Aging Test, Section 12

As a result of the discussion of Section 12, UL determined that:

1. UL will clarify that the test is conducted on pellet samples only,
2. The surface temperature (T_s) used as a basis for the test will be that declared by the device manufacturer for the device type and condition tabulated in paragraph 12.2. The declared temperature will be verified by UL, and
3. The temperature used for a current limiting device will be based on either the temperature at the highest holding current or the highest rated ambient temperature, whichever is greater.

Heat-Cold-Humidity Conditioning, Section 13

From the discussion of Section 13, UL determined that:

1. Indoor and outdoor use will be defined in the Glossary,
2. Reference will be made to Section 12 for the surface temperature (T_s), and
3. The humidity tests will be conducted in a noncondensing atmosphere having a relative humidity of 90 — 95 percent at 40°C.

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Overload Test, Section 14

Regarding paragraph 14.3, the representatives of industry requested clarification of what current is to be used for the test. UL indicated that the normal operating conditions current is to be used. UL will clarify the requirement.

Regarding paragraph 14.4, the representatives of industry questioned if the normal operating temperature or the sensing temperature should be used, and also if 120 percent of the sensing temperature is appropriate. UL indicated that the sensing temperature is to be used and that UL will determine if 120 percent of that value is appropriate.

Endurance Test, Section 15

The discussion of Section 15 focused on (1) the type of sample (pellet or package) used for the test and (2) the number of cycles required for the test.

Sample Type

Table 10.1 specifies use of package samples for the endurance test. UL explained that use of a package is preferred to reduce or eliminate the need for testing in the end application. The representatives of industry confirmed the difficulty of use of pellets for the test as heat sinking, for example, significantly affects the results of the test.

UL asked if thermistor manufacturers could design a package to represent all uses. The representatives indicated that they could not, but noted that they work closely with the end-use product designer to provide maximum thermistor performance. UL advised that end-use products would not be needed for the test if worst-case conditions representative of the end-use application could be provided. UL noted that in some cases tests on pellets can be helpful and meaningful in the design and investigation of the end product. In some cases all the variations cannot be determined and tests on the final component or in the final product are necessary. As a result of the discussion at the meeting, UL will revise the test procedure to better convey how to test the various possible applications of PTC recognition.

Number of Cycles

The representatives of industry questioned the need for the number of cycles as specified in Table 15.1, Number of Cycles for Endurance Test. The representatives of industry suggested that the number of cycles should be based on the amount of cycles anticipated for the application - for example, 100,000 is appropriate for some motor applications but fewer for an air heater

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which does not cycle on and off as often (but may require a higher level of safety).

UL explained that the number of cycles (100,000 etc.) is based on the requirements for thermostats and the evolution over time that resulted from consideration of (1) whether or not the thermostat is used in a safety circuit, (2) whether or not the thermostat is used alone or with a backup thermostat, and (3) if the thermostat is a backup thermostat. The specific numbers were determined to indicate acceptable durability needed for the use.

UL indicated that the number of cycles could be adjusted if it could be determined that the number specified is not needed to provide the required level of safety for the end-use application. Accordingly, UL asked if the thermistor manufacturers have a test they perform at the factory to cover all problems that are likely for a particular thermistor design. The representatives of industry indicated that they did not have a test because a thermistor basically "wears out" and stops functioning. The number of cycles to failure is dependent on the specific application.

As a result of the discussion at the meeting, UL determined that the proposed number of cycles would be retained.

Interrupting Ability Test, Section 17

Section 17 was discussed. UL advised that the title of the test would be changed to "Limited Short Circuit Test" as "interrupting ability" has various definitions usually associated with high current applications, whereas, "limited short circuit" is usually associated with products on circuits having 5000 amperes or less available short circuit current, which better describes the currents anticipated by the requirement. The representatives of industry indicated that they were in favor with the proposed modification.

UL noted that the test prescribed in the proposal is taken from present requirements intended for heater type PTC thermistors used in limited-energy secondary and d-c circuit applications. UL modified the requirement to cover control thermistors. Not all thermistors are subject to the requirement. Control thermistors used only in secondary circuits that do not have an associated safety aspect, such as flame emission and the like, identified are not required to comply with the test. Thermistors are required to comply with the test when an associated safety aspect is identified.

To cover primary circuit connected control thermistors, UL proposed addition of another (limited short circuit) test for devices that are used in a-c limited available current applications, such as appliances used in the home on circuits where the available current

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is 1000 amperes maximum. The test would consist of connecting the thermistor to a 1000 ampere circuit having a power factor of 0.9 — 1.0 with a 30 ampere non-time-delay fuse in series.

UL asked for comments concerning the addition of the a-c test and the use of a time-delay fuse for the test instead of a non-time-delay fuse. UL estimated four seconds for opening of a time-delay fuse and two seconds for a non-time-delay fuse. UL proposed the use of a time-delay fuse to preclude the need for a marking indicating use only with a non-time-delay fuse. As a result of the discussion at the meeting, the representatives of industry indicated they were in favor of addition of the test using a non-time-delay fuse and require marking.

Thermal Runaway Test, Section 18

The discussion of Section 18 focused on the reason for application of 200 percent of rated voltage for the test. Some representatives of industry indicated the understanding that the test is a voltage test. UL advised that the test is not a voltage test but is a thermal test to determine if a risk of fire or electric shock results when thermal runaway occurs. Quoting from the Subject 1434 bulletin dated February 9, 1978, which is used for present investigations:

"To determine if thermal runaway is likely to take place in a PTC element and what effect it has on the function of the PTC, the voltage to the element is gradually increased until breakdown occurs and thermal runaway voltage results. The voltage at which breakdown occurs should be significantly greater than the normal voltage rating of the PTC element. Based on the discussion, it was believed that if thermal runaway has not occurred when applied voltage is 200 percent of the rated voltage, the test could be terminated."

The representatives of industry noted that at 200 percent of rated voltage, some designs may exhibit thermal runaway but are well below the design's intended maximum useful voltage. Therefore, although thermal runaway occurs, properties beneficial in the application and that do not present a risk of fire or electric shock are excluded by the test criteria. As a result of the discussion at the meeting, UL indicated that a study of the issue would be undertaken and UL will develop a position paper.

6. NEXT MEETING

As time did not permit completion of the review of the proposed requirements, a subsequent meeting of the IAG is planned to consider modified proposals, such as additional requirements relative to NTC type devices, and to review the remainder of the

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proposals not discussed at this meeting. UL plans to hold the next meeting in the first quarter of 1994.

Request for Comments

Please provide the following:

1. Your comments concerning the meeting report, and
2. Your comments on the unmodified proposed requirements.

Written comments should be sent to the attention of Dennis Sullivan at UL's Northbrook office, 333 Pfingsten Road, Northbrook, Illinois 60062-2096. Please reference all correspondence to Subject 1434.

All comments should be sent by December 27, 1993.

Unless specifically requested to do otherwise, UL will not acknowledge comments indicating concurrence with this report or the proposals.

Questions regarding interpretation of requirements should be directed to the responsible UL Staff. Please see Appendix C to this Bulletin regarding designated responsibility for the subject product category.

UNDERWRITERS LABORATORIES INC.

REVIEWED BY:

Dennis Sullivan

DENNIS SULLIVAN (Ext. 43357)
Staff Engineer
Standards Department

Marwan Alchammae

MARWAN ALCHAMMAE (Ext. 42747)
Senior Project Engineer
Engineering Services

Don. P. Grob

DONALD P. GROB (Ext. 43117)
Managing Engineer
Engineering Services

SR:FDA

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

APPENDIX A

PROPOSED FIRST EDITION OF THE STANDARD FOR
THERMISTOR-TYPE DEVICES, UL 1434

PROPOSED EFFECTIVE DATE: 18 months after publication

1434BAA.J02

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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.