UL 2333

STANDARD FOR SAFETY

Infrared Thermometers

UL Standard for Safety for Infrared Thermometers, UL 2333

Third Edition, Dated May 31, 2016

Summary of Topics

This revision of ANSI/UL 2333 dated August 7, 2019 is being issued to update the title page to reflect the most recent designation as a Reaffirmed American National Standard (ANS). No technical changes have been made.

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

The requirements are substantially in accordance with Proposal(s) on this subject dated May 17, 2019.

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MAY 31, 2016
(Title Page Reprinted: August 7, 2019)

ANSI/UL 2333-2003 (R2019)

UL 2333

Standard for Infrared Thermometers

First Edition – May, 2001
Second Edition – March, 2008

Third Edition

May 31, 2016

This ANSI/UL Standard for Safety consists of the Third edition including revisions through August 7, 2019.

The most recent designation of ANSI/UL 2333 as a Reaffirmed American National Standard (ANS) occurred on August 7, 2019. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These requirements cover portable, battery operated infrared thermometers and accessories affecting accuracy intended for food safety.

1.2 These requirements do not cover temperature indicating devices intended for non-food uses.

2 Devices

2.1 The devices covered by this standard are evaluated for their intended use as SCREENING TOOLS only. As such, they are not intended to take the place of or supersede the readings of food contact thermometers used in accordance with the FDA Food Code or the related requirements of Authorities Having Jurisdiction.

2.2 The devices indicate surface temperature at a minimum accuracy of ±2.2°C (4°F) for food product surfaces at 60°C (140°F) and 5°C (41°F). This accuracy is determined at an intended use range of 2.54 cm (1 in) to 30.5 cm (1 ft) with a surface area larger than the area of measurement of the unit in a range of ambient air temperatures.

2.3 Because external environmental use conditions, thermal shock, cleanliness of optics, mechanical abuse and other use factors influence the accuracy of the devices, the operator needs to adhere to all manufacturer's instructions for their use and care.

3 Reference publications

3.1 Equipment shall comply with the applicable requirements of the following publications:

a) Food and Drug Administration (FDA) Food Code, 1999;

b) Code of Federal Regulations (CFR), Title 21, Chapter I, Subchapter J, 1999;

c) International Electrotechnical Commission 1000-4-2 (IEC 1000-4-2): Electromagnetic Compatibility (EMC) Part 4; Testing and Measuring Techniques – Section 2: Electrostatic Discharge Immunity Test – Basic EMC Publication (1995);

d) International Electrotechnical Commission 1000-4-3 (IEC 1000-4-3): Electromagnetic Compatibility (EMC) Part 4; Testing and Measurement Techniques – Section 3: Radiated, Radio Frequency, Electromagnetic Field Immunity Test (1995);

e) Standard for Marking and Labeling Systems, UL 969; and

f) Standard for Class 2 Power Units, UL 1310

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

4 Units of Measurement

4.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

5 Definitions

5.1 For the purpose of this standard, the following definitions apply.

5.2 FIELD OF VIEW – Ratio of distance to spot area.

5.3 INFRARED THERMOMETER – Opto-electronic instrument adapted for non-contact measurement of temperature of a surface by utilizing infrared radiation exchange between the surface and the sensor.

5.4 THERMAL SHOCK – The result of an abrupt change in ambient temperature affecting the accuracy of the device.

6 Components

6.1 Except as indicated in 6.2, a component of a product covered by this standard shall comply with the requirements for that component. See Appendix A for a list of standards covering components used in the products covered by this standard.

6.2 A component is not required to comply with a specific requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or

b) Is superseded by a requirement in this standard.

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

6.4 Specific components are 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.

CONSTRUCTION

7 Enclosures and Lenses

7.1 Enclosures and lenses shall be constructed of non-toxic, corrosion-resistant, nonabsorbent materials allowing effective removal of soil by normal, manual cleaning methods.

7.2 The enclosure shall be formed and assembled so that it will have the strength and rigidity necessary to resist the abuses to which it may be subjected, without increasing the risk of inaccurate temperature display by dislocation of protective lenses, creation of openings, or loosening of parts.

7.3 Polymeric materials used in enclosures and lenses shall comply with Ambient Temperature – Accuracy Verification Test, Section 16.

7.4 Materials that shatter or leave shards shall not be used.

Exception No. 1: This requirement does not apply to a lens that is no larger than technically required and is located such that it is protected against impact as determined by a 12.7 mm (0.5 in) diameter hemispherical rod.

Exception No. 2: This requirement does not apply to a visual display or lens that remains intact following testing as described in Section 19, Mechanical Abuse – Accuracy Verification Test.

7.5 External surfaces shall be free of any ledges, projections, and crevices that are decorative or gratuitous and are not required for effective design or proper operation of the equipment.

7.6 Fasteners shall not have deep recesses or wells in the head. Slot, hex and Phillips head screws and flush break pop rivets are considered acceptable. Allen head screws and non-flush break pop rivets are not considered acceptable. The fastener shall fit tight against the enclosure surface. A maximum of one washer may be used under the fastener head. An external tooth washer is not acceptable.

8 Operating Mechanism

8.1 A device shall be assembled so that it will not be adversely affected by the vibration of normal operation.

8.2 The position of all user adjustments and controls shall be marked to indicate proper operation.

9 Accessories

9.1 A device having provisions for the use of an accessory intended to be attached in the field (e.g. printer, data logger) shall comply with the requirements in this standard, with and without an accessory installed.

9.2 Installation of an electrical accessory by the user shall be by means of a receptacle and plug-in connector.

9.3 The installation of an electrical accessory by service personnel shall be by means of receptacles, plug-in connectors, insulated wire connectors, or by connection to existing wiring terminals.

9.4 With reference to 9.3, an installation shall not require the cutting of wiring or the soldering of connections by the installer. Installations shall not require cutting, drilling, or welding in electrical enclosures and in other areas where such operations may damage electrical and optical components and wiring within the enclosure.

9.5 An accessory is to be trial installed to determine that the installation is feasible, the instructions are detailed and correct, and the use of the accessory does not adversely affect the accuracy of the device.

10 Batteries

10.1 Batteries shall be replaceable without causing damage to the device or its components.

10.2 A battery compartment intended for the use with rechargeable batteries that emit gases during charging shall be provided with vent holes and a coating that is resistant to the corrosive action of the electrolyte.

10.3 The device shall alert the user when the battery becomes discharged and the device accuracy is affected as specified in Section 15, Initial Accuracy Verification Test. The indication shall be audible or visible at the discharge condition that initiates inaccurate readings.

11 Lasers

11.1 Devices that use a laser shall comply with the current construction and labeling requirements of the U.S. Code of Federal Regulations (CFR), Title 21, Chapter I, Subchapter J, Sections 1010.2 and 1010.3 and Sections 1040.10 and 1040.11.

12 User Information

12.1 The device shall be capable of providing an indication of the measured temperature in degrees Celsius, degrees Fahrenheit, or any other scalable format.

12.2 The device shall be provided with a means of sighting. The means can be mechanical or optical.

13 Power Supplies

13.1 External power supplies or battery charging devices shall comply with the Standard for Class 2 Power Units, UL 1310.

PERFORMANCE

14 General

14.1 The performance of an infrared thermometer shall be evaluated as described in Sections 15 – 19. Unless otherwise specified, each test is to be performed on one sample. With the agreement of the manufacturer, more than one test may be conducted using the same sample. Insofar as is practicable, the tests shall be conducted in the order in which they are presented.

14.2 For the tests, it may be necessary or preferable to modify the device to permit remote actuation of temperature measurement and/or temperature recording. Any modifications made to the device shall be acceptable to the manufacturer and shall not adversely affect or enhance device accuracy.

15 Initial Accuracy Verification Test

15.1 When tested as described in 15.2 – 15.6, no individual reading of a device shall indicate a surface temperature with less accuracy than ±2.2°C or ±4°F, as appropriate.

15.2 The initial accuracy verification test on a device is to be performed on a representative production sample that has been produced and calibrated within the same tolerances permitted in factory production. Devices that have multiple set points and display modes shall be tested at the maximum and minimum set points and in each display mode.

Exception No. 1: Devices intended for multiple applications that are marked "food temperature" or equivalent at the relevant operating mechanism settings.

Exception No. 2: Devices that have toggled Celsius / Fahrenheit display modes may be tested in only one mode, whichever mode is the default factory production setting.

15.3 Prior to accuracy verification, the device shall be stabilized following the manufacturer's use and care instructions at approximately 25° C (77° F), 40 – 60 percent relative humidity. The device shall be securely supported such that its outermost edge is located perpendicular to the surface to be measured. The area of and distance to the surface to be measured shall be that specified by the manufacturer's instructions on field of view and spot area except that the distance shall not be less than 25.4 mm (1 in) or greater than 304.8 mm (1 ft). The device and surface to be measured shall be protected against external

sources of reflected infrared radiation and mechanical vibration as well as condensation of moisture on the lens.

15.4 Distilled water shall be used to represent food during accuracy verification testing. The water shall be maintained at 5°C (41°F). It may be necessary to agitate the water to produce uniform and controlled temperature conditions. However, agitation shall be kept to a minimum such that the device under test has a stable surface to measure.The means to achieve the required water temperature is not specified, but the volume of water, geometry and materials of the water container, and other characteristics of the heating / cooling source shall not adversely affect temperature measurement by the device under test. Any convenient means may be used to actuate the device for temperature measurement, however the actuation means shall not adversely affect temperature measurement.

15.5 The device shall take six water surface temperature measurements. These measurements shall comply with the requirements in 15.1.

15.6 The test described in 15.1 – 15.5 shall be repeated except that the water temperature indicated in 15.4 shall be 60°C (140°F).

16 Ambient Temperature – Accuracy Verification Tests

16.1 General

16.1.1 Following ambient temperature conditioning specified in this section, the device shall comply with 15.1.

16.2 Extended exposure conditioning

16.2.1 The device shall be maintained per the manufacturer's minimum specified period until stabilization at 32.2°C (90°F), 40 – 60 percent relative humidity. It shall then be tested as specified in 15.2 – 15.6.

16.2.2 The test described in 16.2.1 shall be repeated, except that the device shall be maintained per the manufacturer's minimum specified period until stabilization at 5° C (41° F), 40 – 60 percent relative humidity.

16.3 Extreme ambient conditioning

16.3.1 The device shall be placed in an air circulating oven for a period of seven hours at a temperature of 50°C (120°F). Following the oven conditioning, the device under test shall be permitted to cool to room temperature. The device shall comply with 15.1 and all of the following:

a) There shall not be softening of the device enclosure material, as determined by handling immediately after the oven conditioning;

b) There shall not be cracking of the enclosure material. Surface blemishes – such as crazing – of a polymeric enclosure material are acceptable; and

c) There shall not be exposure of optical parts to the extent that the product would not comply with provisions of this standard that guard against unintentional contact with such parts.

17 Ambient Moisture – Accuracy Verification Test

17.1 During and following the conditioning specified in 17.2, the device shall comply with 15.1.

17.2 The device shall be conditioned for a period of 1 hour at a relative humidity of 93 ±2 percent without condensation. The temperature of the air shall be maintained within 1.1°C (2°F) of any convenient value between 20°C (68°F) and 30°C (86°F). The device shall then be tested as specified in 15.2 – 15.6.

18 Resistance to Electrostatic and Electromagnetic Noise – Accuracy Verification Tests

18.1 General

18.1.1 A device shall demonstrate immunity from failure to provide protection and from false operation when exposed to the conditions described in 18.2 and 18.3. The levels for immunity specified in this Section represent those that could be expected in a typical domestic/commercial electromagnetic environment. Following the electrostatic discharge conditioning and during the environmental noise conditioning, the device shall comply with 15.1.

18.2 Electrostatic discharge immunity

18.2.1 International Electrotechnical Commission 1000-4-2 (IEC 1000-4-2): Electromagnetic Compatibility (EMC) Part 4; Testing and Measuring Techniques – Section 2: Electrostatic Discharge Immunity Test – Basic EMC Publication (1995), is to be used as the reference for testing and measuring techniques. The test limits are:

a) 4kV, positive and negative polarity, for direct contact discharge; and

b) 8kV, positive and negative polarity, for air discharge.

18.2.2 Ten air and ten contact discharges shall be applied. An air discharge shall be aimed at non-electrically conductive parts of the device. For these tests, the device shall be in a "power on" state with any accessory covers removed.

Exception: If the device has no exposed electrically conductive parts, only air discharge shall be applied.

18.3 Radiated electromagnetic field immunity

18.3.1 International Electrotechnical Commission 1000-4-3 (IEC 1000-4-3): Electromagnetic Compatibility (EMC) Part 4: Testing and Measurement Techniques – Section 3: Radiated, Radio Frequency, Electromagnetic Field Immunity Test (1995), is to be the test measurement reference. The frequency range to be evaluated is to be from 30 MHz to 1 GHz. The exposure would be level 2, 3 V/M modulated with 80 percent AM modulation at 1 kHz. The frequencies to be used encompass the standard broadcast frequency ranges for commercial and "ham" radio and television. The step size for the test frequency ranges is to be 1 percent of fundamental. In addition the device should be exposed to radiated electromagnetic fields that simulate those generated by digital radio telephones (commonly known as "cell phones"). This test consists of exposure to 3 V/m field using a 200 Hz digital modulation technique with a 50 percent duty cycle on one frequency between 895 MHz and 905 MHz. Other frequency ranges that are used in the intended country of use are to be considered.

19 Mechanical Abuse – Accuracy Verification Test

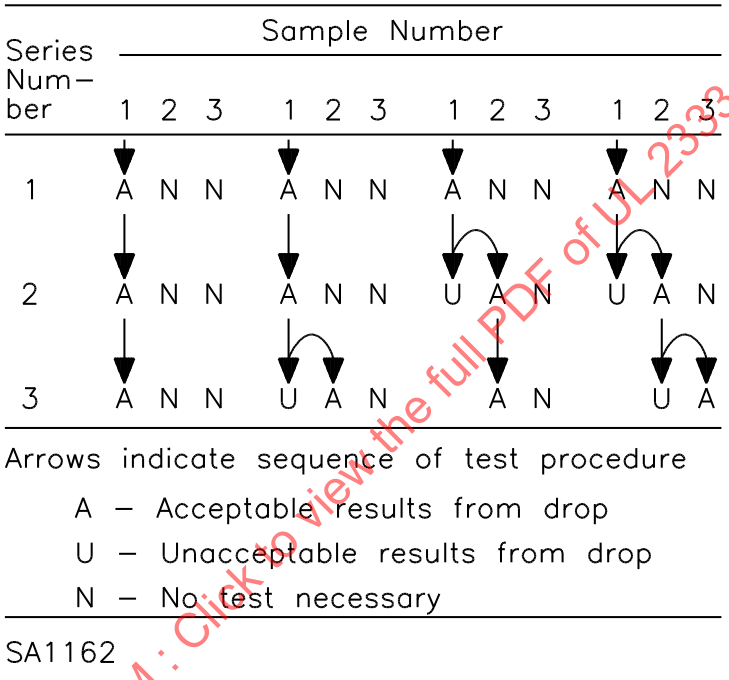
19.1 Following the conditioning test described in 19.2 – 19.3, the devices shall comply with the tests of Section 15, Initial Accuracy Verification Test.

19.2 Except as noted in 19.3, each of three samples are to be dropped three times from a height of 0.91 m (3 ft) onto a concrete surface in such a manner as to test the device most severely. The test is to be conducted with or without any accessories and attachments recommended by the manufacturer so as to

result in the most severe test. The test is to be conducted so that, in each drop, the sample strikes the surface in a position different from those of the other drops.

19.3 Three individual samples may be employed for the test described in 19.2, or if the manufacturer so elects, fewer samples may be used in accordance with Figure 19.1. The overall performance is acceptable upon completion of any one of the procedures represented in the Figure 19.1. Each series is to consist of three drops, and if any sample does not comply with the test criteria on the first series, the results of the test are unacceptable.

Figure 19.1
Procedures for impact tests



NOTE: Each series consists of three drops on each sample as applicable.

MARKING

20 General

20.1 Unless specifically exempted, all required markings shall be printed on the device or on labels mechanically affixed or adhered to the device. Pressure sensitive labels shall comply with the Standard for Marking and Labeling Systems, UL 969. Unless otherwise specified markings shall be raised, embossed, or printed in a color contrasting with the background.

20.2 Devices shall be plainly marked as follows, at a location where the marking will be readily visible:

a) The manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the product may be identified – hereinafter referred to as the manufacturer's name;

b) The catalog number or the equivalent; and

c) The date, or other dating period, of manufacture not exceeding any three consecutive months.

Exception No. 1: The manufacturer's identification may be in a traceable code if the equipment is identified by the brand or trademark owned by a private labeler. The date code repetition cycle shall not be less than 20 years.

Exception No. 2: The date of manufacture may be abbreviated or in an established or otherwise accepted code. The date code repetition cycle shall not be less than 20 years.

20.3 If a manufacturer produces or assembles devices at more than one factory, each finished unit shall have a distinctive marking, which may be in code, to identify it as the product of a particular factory.

20.4 The field of view shall be marked on a device where it is visible.

20.5 The battery voltage and battery orientation shall be marked on the device where visible during battery replacement.

Exception No. 1: A replacement part number may be provided in place of the battery voltage rating.

Exception No. 2: Battery orientation and voltage need not be marked if the battery compartment is designed to reject incorrect battery installation.

20.6 The device shall be clearly marked on its front in red letters: "SCREENING TOOL FOR SURFACE TEMPERATURE MEASUREMENT" or equivalent.

INSTRUCTIONS

21 Use and Care Instructions

21.1 Instructions shall be included with devices which provide necessary information on proper operation and maintenance. Instructions shall clearly identify correct procedures and conditions to avoid which may result in inaccurate temperature readings.

21.2 The following headings and associated instructional information specified in 21.3 – 21.18 shall be included with each device. The headings shall be as specified except where instructions are not applicable (e. g. Laser Safety may be omitted on devices that do not incorporate an integral or accessory laser sighting feature).

a) The Infrared Thermometer as a Screening Tool – Measuring Surface Temperatures

b) Proper Application and Operation

c) Temperature Scales

d) Operating and Ambient Temperature Range (Thermal Shock)

e) Humidity

f) Field of View

g) Angle of Measurement

h) Emissivity

i) Accuracy and Repeatability

j) Response Time

k) Storage Temperatures

l) Batteries

m) Cleaning Instructions

n) Other Operational Considerations

o) Laser Safety

p) Field Verification of Accuracy

21.3 The infrared thermometer as a screening tool instructions shall state, "INFRARED THERMOMETERS ONLY MEASURE SURFACE TEMPERATURE. THEREFORE WHEN USED IN FOOD APPLICATIONS, CRITICAL TEMPERATURES MUST BE VERIFIED WITH AN INTERNAL TEMPERATURE-MEASURING DEVICE," or equivalent.

21.4 The proper application and operation section shall provide a specific method for measuring temperature. In addition, the instructions shall state any limitations, including but not limited to the effects of transparent and reflective surfaces, steam, dust, smoke, and vapors.

21.5 The temperature scale instructions shall provide information on how to switch from Celsius to Fahrenheit, if the device is capable of both forms of measurement.

21.6 The operating and ambient temperature range instructions shall specify the intended range and state how to precondition the device, if used outside the specified ambient temperature range. In addition, the instructions shall also state "FAILURE TO PRECONDITION THE INSTRUMENT MAY RESULT IN THERMAL SHOCK AND/OR INACCURATE MEASUREMENTS," or equivalent.

21.7 The humidity instructions shall state "INFRARED THERMOMETERS ARE NOT DESIGNED FOR USE IN HIGH HUMIDITY-CONDENSING ENVIRONMENTS," or equivalent.

21.8 The field of view instructions shall specify how the operator is to determine the distance to hold the device from the surface being measured and how large a surface area is being measured at that distance.

21.9 The angle of measurement instructions shall state "FOR THE MOST ACCURATE TEMPERATURE MEASUREMENTS, AIM THE INFRARED THERMOMETER PERPENDICULAR TO THE TARGET," or equivalent.

21.10 The emissivity instructions shall cite any limitations of use for the device and provide information on the appropriate setting for devices with adjustable emissivity controls.

21.11 The accuracy and repeatability instructions shall provide specifications on device accuracy and repeatability of results when used in accordance with the manufacturer's instructions. The operating instructions shall also state "EXPOSURE TO ELECTROMAGNETIC AND ELECTROSTATIC NOISE, SUCH AS FROM WIRELESS COMMUNICATION DEVICES, MAY RESULT IN INACCURATE MEASUREMENTS," or equivalent.

21.12 The response time instructions shall provide response time specifications to obtain an accurate reading.

21.13 The storage temperature instructions shall state "AVOID STORING THE UNIT IN EXTREME TEMPERATURE CONDITIONS. DO NOT STORE INFRARED THERMOMETERS BELOW FREEZING TEMPERATURE OR WHERE THE RADIANT TEMPERATURE MAY EXCEED 48.9° C (120° F)," or equivalent.

21.14 The battery instructions shall provide estimated battery life in hours of operation, instruction on how to access the battery compartment, and details on voltage and recommended type of replacement battery.

21.15 The cleaning instruction instructions shall state "THE LENS SHOULD BE FREE OF DIRT, DUST, MOISTURE, FOG, SMOKE, AND DEBRIS," and include instructions on how to clean the lens and overall device.

21.16 The other operational consideration instructions shall provide information on protecting the device from damage and what to do in the event the device receives mechanical abuse or damage.

21.17 The laser safety instructions shall state "WARNING – AVOID DIRECT EXPOSURE OF HUMAN EYES TO LASER LIGHT. EYE DAMAGE MAY RESULT", "NEVER POINT THE LASER LIGHT AT ANOTHER PERSON", "KEEP THE LASER-EQUIPPED UNIT OUT OF THE REACH OF CHILDREN", "AVOID INDIRECT EXPOSURE VIA REFLECTIVE SURFACES, SUCH AS GLASS AND MIRRORS."

21.18 The field verification of accuracy instructions shall provide a method to verify the accuracy of the device and a recommendation that such verification be performed on a regular basis.

MANUFACTURING AND PRODUCTION TESTS

22 General

22.1 The manufacturer shall provide regular production control, inspections, and calibration verification and adjustment of set point under prescribed conditions and following the prescribed method(s).

APPENDIX A

Standards for Components

Standards under which components of the products covered by this standard are evaluated include the following:

Title of Standard − UL Standard Designation

Class 2 Power Units – UL 1310
Controls for Household and Similar Use, Part 1: General Requirements, Automatic Electrical – UL 60730-1 and/or the applicable Part 2 standard from the UL 60730 series
Lithium Batteries – UL 1642
Specialty Transformers – UL 506
Marking and Labeling Systems – UL 969
Polymeric Materials – Fabricated Parts – UL 746D
Polymeric Materials – Long Term Property Evaluations – UL 746B
Polymeric Materials – Short Term Property Evaluations – UL 746A
Polymeric Materials – Use in Electrical Equipment Evaluations – UL 746C
Printed-Wiring Boards – UL 796
Switches for Appliances – Part 1: General RequirementsUL 61058-1
Temperature-Indicating and -Regulating Equipment – UL 873[1)]
Vehicle Battery Adapters – UL 2089
Thermoplastic-Insulated Wires and Cables – UL 83
Thermoset-Insulated Wires and Cables – UL 44

[1)] Note: Compliance with the UL 60730-1, and/or the applicable Part 2 standard from the UL 60730 series fulfills these requirements.