JJF

NATIONAL METROLOGICAL VERIFICATION REGULATIONS

OF THE PEOPLE'S REPUBLIC OF CHINA

JJF 1107-2003

Calibration Specification of Infrared Thermometers for Measurement of Human Temperature

测量人体温度的红外温度计校准规范

Issued on: June 19, 2003 **Implemented on: June 29, 2003**

Issued by: General Administration of Quality Supervision, Inspection and Quarantine

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1 Scope

This Specification is applicable to calibration of infrared thermometers for measurement of human temperature and infrared quick screening instruments for measurement of human body surface temperature.

2 Normative references

JJF 1001-1998, *General Terms in Metrology and Their Definitions*

JJF 1007-1987, *Temperature Metrological Terms and Their Definitions*

JJF 1059-1999, *Evaluation and Expression of Uncertainty in Measurement*

GB/T 19146-2003, *General requirements for infrared devices for instant screening of human skin temperature*

EN 12470-5:2003 (E) *Clinical thermometers - Part 5: Performance of infrared ear thermometers (with maximum device)*

ASTM E 1965-98, *Standard Specification for Infrared Thermometers for Intermittent Determination of Patient Temperature*

When using this regulations, the existing valid editions of above quoted standards shall be used.

3 Terms and units of measurement

3.1 Terms

3.1.1 Calibration mode (direct measurement mode)

The display mode for infrared thermometer measurement or calibration. Display the temperature without any correction, that is, the measurement result of the blackbody temperature.

3.1.2 Estimation mode

The display mode for infrared thermometer measurement. Display the

The protection cover that isolates the probe from the measured object to meet hygienic requirements when using an infrared thermometer.

3.1.10 Warning temperature value

The blackbody temperature value corresponding to the preset warning temperature point of the infrared screening instrument.

3.1.11 Warning temperature measurement error

At the preset warning temperature point, the infrared screening instrument uses the difference between the measured value of the correction value and the blackbody temperature.

3.2 Unit of measurement

The unit of temperature is Celsius, the symbol is °C.

4 Overview

The infrared thermometer for measuring human body temperature is an instrument for measuring human body temperature by radiation exchange between the probe and the measured object. It includes infrared thermometer designed to measure human body temperature and infrared screening instrument.

Infrared thermometer and infrared screening instrument are composed of optical system, detector, electronic measuring part and mechanical device.

Infrared thermometer can be divided into: infrared ear thermometer and infrared body surface thermometer. The estimation mode of infrared thermometer may properly correct the directly-measured radiation temperature and convert to body surface temperature or/and convert the temperature of measured part to the estimated temperature of other body parts.

5 Metering characteristics

5.1 Display temperature range

In any display mode, the display temperature range of the infrared thermometer shall cover the range specified in Table 1.

5.2 Maximum allowable error

Under the product's nominal use environmental conditions (see 5.3) and within the specified display temperature range, the laboratory error of the infrared

If the manufacturer requires to use a protection cover to sanitarily isolate the measured object and the probe, the use of probe protection cover shall not make the laboratory error defined in 5.2 exceed the specified range.

5.6 Thermometer mark and user manual

5.6.1 The thermometer shall clearly indicate its temperature unit.

5.6.2 The infrared thermometer shell or/and outer packaging shall clearly mark the brand name or instrument type, model, manufacturer or distributor name, batch number or production serial number.

5.6.3 The infrared thermometer shall indicate the body part corresponding to the measured value. For a single non-clinical infrared thermometer without estimation mode, this mark is optional.

NOTE: All marks shall not be damaged during long-term use and cleaning.

5.6.4 Infrared thermometer user manual shall include but not limited to the following:

Display temperature range, maximum allowable error, body part corresponding to display temperature, temperature range, humidity range of use and storage, type approval number or manufacturing instrument license number.

Infrared thermometer with estimation mode shall specify the body part (such as mouth, rectum) corresponding to the estimated temperature indication, and list the calculation method or comparison table from the calibration mode indication to each estimation mode indication.

Thermometer with both calibration mode and estimation mode shall explain the method to switch to calibration mode.

6 Calibration conditions

6.1 Environmental conditions

The temperature and humidity of the calibration laboratory environment shall meet the requirements of 18°C~28°C, (30~70)% RH and the operating environment conditions of the calibration equipment.

NOTE: On-site calibration shall indicate the environmental conditions. Calibration environment shall be free of strong ambient radiation and strong air convection.

6.2 Standard and other equipment

6.2.1 Blackbody radiation source

7.2.1.1 Repeat the measurement of the blackbody temperature at the set blackbody temperature specified in Table 3. It can only select part of the blackbody set temperature in Table 3 or select the blackbody set temperature according to user requirements.

7.2.1.2 Before testing, the infrared thermometer shall be stable for at least 30 minutes or longer under test temperature and humidity conditions (if specified by the manufacturer).

7.2.1.3 Take at least 4 measurement readings of the blackbody at each black body set temperature. It shall be equipped with infrared thermometer with probe protection cover. It shall be used in accordance with the requirements of the user manual and keep it clean and complete. Determine the method and rate of temperature measurement data acquisition according to the method recommended in the user manual.

7.2.1.4 The temperature reading in the estimation mode (if any) shall be converted to the temperature reading in the calibration mode $t_{i,j}$ according to the method recommended by the manufacturer. The manufacturer shall provide the conversion method and give it in the use and maintenance manual.

7.2.1.5 To calibrate the indicated value, measure and record the indicated value $t_{i,j}$ and blackbody temperature t_{BBi} of the calibrated infrared thermometer at the nominal set temperature t_{si}. Calculate the corrected value Δt_i of the displayed infrared thermometer corresponding to the i^{th} blackbody nominal set temperature t_{si} and the repeatability of multiple measurements R_i.

$$\Delta t_i = t_{BBi} - \frac{1}{4}\sum_{j=1}^{4} t_{i,j},\ j = 1,\ 2,\ 3,\ 4$$

Where, $t_{i,j}$ is the j^{th} temperature reading when the calibrated thermometer measures the blackbody temperature t_{BBi} in the calibration mode; j indicates the order of readings. Repeatability of multiple measurements is expressed by extreme deviation R_i:

$$R_i = \mathrm{Max}\ (t_{i,j}) - \mathrm{Min}\ (t_{i,j}),\ j = 1,\ 2,\ 3,\ 4$$

Where, Max ($t_{i,j}$), Min ($t_{i,j}$) are the maximum and minimum values of $t_{i,j}$ when j = 1,2,3,4 respectively.

7.2.1.6 For laboratory error determination, measure and record the corrected infrared thermometers $t_{i,j}$ and blackbody temperature t_{BBi} (if blackbody is traceable to the radiation temperature, it shall be converted to the radiation temperature) at the nominal set temperature t_{si} of each black body. Determine laboratory error for each measurement. The laboratory error $e_{i,j}$ is defined as:

shall indicate the warning temperature correction value used by the infrared screening instrument and the correction setting value of the infrared screening instrument emissivity.

8 Expression of calibration results

Calibration results shall be reflected on the calibration certificate or calibration report. The calibration result of the infrared thermometer includes the blackbody temperature, the corresponding correction value of the indicated thermometer and the repeatability of the indicated value or the blackbody temperature and the maximum laboratory error of the corresponding corrected thermometer. The calibration result of the infrared screening instrument includes the warning temperature set point and the warning temperature measurement error. Calibration results shall include calibration uncertainty. On-site calibration shall indicate "on-site calibration" and environmental conditions.

The calibration certificate or report shall include at least the following information:

a) Title, such as "Calibration Certificate" or "Calibration Report";

b) Laboratory name and address;

c) Location where the calibration is performed (if not performed in the laboratory);

d) Unique identification of the certificate or report (such as the number), the identification of each page and the total number of pages;

e) Name (and address) of organization submitted for calibration;

f) Name, model, product number and manufacturer of the thermometer to be calibrated;

g) Date of calibration;

h) If related to the validity and application of the calibration results, the sampling procedures shall be explained;

i) Identification of the technical specifications on which the calibration is based, including the name and code;

j) Description of traceability and validity of measurement standards used in this calibration;

k) Description of calibration environment;

Annex A

Evaluation on calibration uncertainty of infrared thermometer

The infrared thermometer for measuring the temperature of the human body is calibrated by the standard instrument--the black body radiation source in its calibration mode.

A.1 Black body radiation source

The blackbody radiation source used to calibrate the infrared thermometer is composed of an isothermal cavity with a certain opening, a known wall temperature, and a high emissivity of the inner surface layer. The radiation characteristics of the blackbody cavity depend on the sealing of the cavity, the uniformity of the cavity wall temperature and the radiation characteristics of the inner surface material.

Due to the large field of view of some infrared thermometer probes (for example, the field of view of some infrared ear thermometer probes is close to the hemisphere), the blackbody cavity shall ensure that the temperature unevenness and effective emissivity characteristics of the infrared thermometer meet the calibration requirements in the field of view of the infrared thermometer.

Common blackbody cavities with uniform temperature are:

(1) Thin-walled cavity that is placed in a constant-temperature water bath with uniform temperature;

(2) Heat pipe cavity;

(3) Other cavities with good heat design.

Because of the good spatial uniformity of the temperature of the water tank and convenient measurement, the water tank scheme is often used in the blackbody radiation source at normal temperature. When the effective emissivity of the blackbody cavity is close to 1, the blackbody radiation temperature can use a platinum resistance thermometer or a mercury thermometer to measure the temperature of the cavity wall or the temperature of the area close to the cavity wall temperature.

Platinum resistance can use standard platinum resistance thermometer or other precision platinum resistance with measurement uncertainty to meet measurement needs.

The radiation temperature of the blackbody radiation source shall be traced to the ITS-1990 temperature reference.

2 Resolution.

For the specific uncertainty assessment steps, refer to national metrology technical specification JJF 1059-1999 “Evaluation and Expression of Uncertainty in Measurement”.

A.3 Examples of evaluation on uncertainty of infrared ear thermometer calibration

According to this Specification, use blackbody radiation source of which the effective emissivity is greater than 0.999 to calibrate the infrared ear thermometer of which the display resolution is 0.1°C at 37°C. The ambient temperature is 22°C. The temperature-controlled temperature measurement value of the blackbody radiation source is directly read from the temperature controller.

A.3.1 Evaluation on standard uncertainty

a) Calibration uncertainty of black body radiation source, u_1

Taken from the blackbody radiation source calibration certificate. The expanded uncertainty U = 0.04°C, k = 2. u_1 = 0.02°C.

b) Uncertainty introduced by long-term instability of radiant temperature during calibration period, u_2

The absolute difference in radiation temperature in the last two calibration certificates of the blackbody radiation source is 0.02°C. Evaluate according to uniform distribution, $u_2 = (0.02/\sqrt{3})℃$.

c) Influence of environmental temperature difference on the recurring temperature control temperature, u_3

The ambient temperature for blackbody radiation source calibration is 20°C. The ambient temperature for infrared thermometer calibration is 22°C. Both the infrared thermometer calibration and the blackbody radiation source calibration experiment use the temperature measurement value of the blackbody radiation source temperature controller to determine the wall temperature of the recurring cavity. The temperature measurement indication value of the temperature controller is not affected by the change of the ambient temperature not exceeding 0.03°C/10°C. Therefore, when the ambient temperature difference is 2°C, the temperature measurement value of the thermostat shall not change more than 0.006°C. Evaluate according to uniform distribution, $u_3 = (0.006/\sqrt{3})℃$.

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