AMERICAN NATIONAL STANDARD

Temperature and Humidity Environment for Dimensional Measurement

ANSI B89.6.2 - 1973

REAFFIRMED 2012

FOR CURRENT COMMITTEE PERSONNEL
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SECRETARIAT

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

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THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

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FOREWORD

American National Standards Committee B89 on Dimensional Metrology, organized under the procedures of the American National Standards Institute, was formed to develop certain minimum standards for the various parameters in metrology and represents the consensus of United States industry. The various subcommittees of Committee B89 deal with the different parameters, i.e., environment, angle, length, geometry, etc. Subcommittee B89.6 is assigned the task of developing standards in physical environment and the effects of this environment and other extraneous influences on accuracy and precision of dimensional measurements. This standard for temperature and humidity is the work of the ANSI B89.6.2 Working Group. The results of its cooperative efforts are expressed in this document.

The effect of heat flow and resulting temperature gradients, differences and variation from measurement to measurement can result in errors of dimensional measurement because of the thermal expansion properties of materials. By international agreement the true size and shape of an object is that which exists at a uniform temperature of 68° F (20° C). The purpose of this standard is to provide American industry with practical requirements, procedures, and methods by which the intent of the international agreement can be satisfied without compromise to economical operation.

In discharging its responsibilities, the Working Group has recognized two basic needs of industry. First, it recognizes the need for standard approaches to the buying and selling of artificially controlled environments. Second, it recognizes the need for the qualification of individual measurements regarding errors induced by non-ideal temperature conditions.

Standard specifications for artificially controlled environments, in terms of the quality of temperature control, are especially necessary as a means of communicating metrological requirements to construction agencies such as heating and air-conditioning contractors. In specific instances, sufficient experience has been obtained such that required dimensional accuracies can be translated directly into temperature control specifications. However, the Working Group has concluded that no general set of temperature control specifications can be stated that will simultaneously assure levels of measurement accuracy and avoid the risk of overdesign or underdesign. Indeed, no recommendation can be made on which type of artificial environment, or even whether one is necessary or not, that would represent the most satisfactory engineering for every application. Consequently, the Working Group has chosen to list those properties of an artificially controlled environment that must be specified for an adequate description, to specify standard procedures for the administration of the required specifications, and to provide advisory information in the form of guidelines that the users of this standard may find helpful in the development of specifications adapted to individual needs.

The metrologist, his management, or a potential customer of a metrological service has, each for his own purpose, a need and a right to know the magnitude of measurement errors induced by the thermal environment. Therefore, this standard includes a description of procedures for the estimation of the error contributions caused by various defects of the thermal environment. Further, there is a need for a convenient means of communication between these parties. For this purpose, the Working Group has provided a standard figure of merit, the Thermal Error Index. Because this document, for the first time, presents the Thermal Error Index for use by industry at large, the methods for its determination and use are carefully developed in an appendix.

Recommendations for the control of humidity in metrological environments are included in this document, because it is often directly affected by and related to the control of temperature, especially in the design of room enclosures.

After approval by the B89 National Standards Committee and submittal to public review the Standard was approved by ANSI as a National Standard on October 30, 1973.

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DIMENSIONAL METROLOGY

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AMERICAN NATIONAL STANDARD

TEMPERATURE AND HUMIDITY ENVIRONMENT FOR DIMENSIONAL MEASUREMENT

1. SCOPE AND INTENT

This standard is intended to fill industry's need for standardized methods of:

a. Describing and testing temperature-controlled environments for dimensional measurements, and

b. Assuring itself that temperature control is adequate for the calibration of measuring equipment, as well as the manufacture and acceptance of workpieces.

2. REFERENCED DOCUMENTS

2.1 Standards and Specifications

This standard has been coordinated insofar as possible with the following standards and specifications. Unless stated otherwise, the latest issue is implied.

2.1.1 Governmental

a. MIL-C-45662A–Calibration System Requirements

b. MIL-HDBK-52–Evaluation of Contractor's Calibration System

c. MIL-Q-9858A–Quality Program Requirements

d. Fed. Std. #209–Clean Room and Work Station Requirements, Controlled Environment.

2.1.2 Non-governmental

a. Standards of the American National Standards Institute (ANSI), formerly United States of America Standards Institute (USASI),

b. Standards of the American Society for Testing and Materials (ASTM),

c. Standards of the Society of Automotive Engineers, Inc. (SAE),

d. Recommendation R1–Standard Reference Temperature for Industrial Length Measurements, International Organization for Standardization (ISO).

2.2 Other Publications

a. ASHRAE–Handbook of Fundamentals published by the American Society of Heating, Refrigeration, and Air-Conditioning Engineers, 345 East 47th Street, New York, New York 10017

3. DEFINITIONS

3.1 Average Coefficient of Expansion

The average coefficient of expansion of a body over the range of temperature from 68° F (20° C) to t is defined as the ratio of the fractional change of length of the body to the change in temperature.

Fractional change of length is based on the length of the body at 68° F (20° C).

$$\alpha(68, t) = \frac{L_t - L_{68}}{L_{68}\,(t - 68)} \qquad (1)$$

Hereinafter the term "coefficient of expansion" shall refer only to the average value over a range from 68 F (20 C) to another temperature, t.

3.2 Coefficient of Expansion

The true coefficient of expansion, α, at a temperature, t, of a body is the rate of change of length of the body with respect to temperature at the given temperature divided by the length at the given temperature.

$$\alpha = \frac{1}{L_t}\left(\frac{dL}{dt}\right)_t \qquad (2)$$

3.3 Comparator

Any device used to perform the comparison of the part and the master is called a comparator.

3.4 Differential Expansion

Differential expansion is defined as the difference between the expansion of the part and the expansion of the master from 68° F (20° C) to their time-mean temperatures at the time of the measurement.

3.5 Differential Response

Differential response is defined as the relative length variation between any two objects per unit sinusoidal environment temperature oscillation as a function of frequency of temperature oscillation.