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Standard Practice for Selecting Temperatures for Evaluating and Reporting Thermal Properties of Thermal Insulation[1]

This standard is issued under the fixed designation C1058/C1058M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers standard mean temperatures for reporting thermal properties of thermal insulations, products, and materials, and of related systems and components, both insulated and uninsulated.

1.2 Thermal properties shall be determined as a function of temperature by standard test methods. (Test Methods C177, C201, C335/C335M, C518, C745, C1114, C1363, Guide C653, and Practice C687, all in combination with Practice C1045.)

NOTE 1—Standard referenced materials are needed to span the temperature range of the tests.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.4 This practice recommends standard conditions for use in testing and evaluating thermal properties as a function of temperature by standard test methods.

1.5 General applications of thermal insulations include:
1.5.1 Building envelopes,
1.5.2 Mechanical systems or processes, and
1.5.3 Building and industrial insulations.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C168 Terminology Relating to Thermal Insulation
C177 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
C201 Test Method for Thermal Conductivity of Refractories
C335/C335M Test Method for Steady-State Heat Transfer Properties of Pipe Insulation
C518 Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
C653 Guide for Determination of the Thermal Resistance of Low-Density Blanket-Type Mineral Fiber Insulation
C687 Practice for Determination of Thermal Resistance of Loose-Fill Building Insulation
C745 Test Method for Heat Flux Through Evacuated Insulations Using a Guarded Flat Plate Boiloff Calorimeter (Withdrawn 2008)[3]
C1045 Practice for Calculating Thermal Transmission Properties Under Steady-State Conditions
C1114 Test Method for Steady-State Thermal Transmission Properties by Means of the Thin-Heater Apparatus
C1363 Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus

3. Terminology

3.1 *Definitions*—For definitions of terms and symbols used in this practice, refer to Terminology C168.

[1] This practice is under the jurisdiction of ASTM Committee C16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.30 on Thermal Measurement.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

4. Significance and Use

4.1 The various methods for measuring and calculating thermal properties provide data and information for manufacturer's published information, for comparison of related products, and for designers and users to evaluate insulation products for particular applications. For these purposes it is advisable to provide basic data and information produced under standard temperature conditions.

4.2 It is possible that thermal properties of a specimen will change with mean temperature, with temperature difference across the specimens, and with high temperature exposure. Data and information at standard temperatures are necessary for valid comparison of thermal properties.

4.3 The mean test temperatures to measure thermal properties shall be selected from those listed in Table 1. It is recommended that thermal properties of insulation materials be evaluated over a mean temperature range that represents the intended end use. For this situation, the lowest and greatest mean temperatures need to be within 10°C of the maximum and minimum mean temperature of interest. The temperature differences for any chosen mean temperature will depend upon both the thermal insulation application (see appropriate materials specification), the method of evaluation, and the limitations of the apparatus. Temperature differences or relevant temperature conditions required by ASTM material specifications shall take precedence over those recommended in this practice.

TABLE 1 Mean Test Temperatures for Reporting and Evaluation of Thermal Properties of Thermal Insulations

Insulation Classification	Mean Test Temperature	
	°C	[°F][A]
Building Envelopes	–4	[25]
	4	[40]
	10	[50]
	24	[75]
	38	[100]
	43	[110]
Mechanical Systems or Processes and Building and Industrial Insulations: Use those listed in this table above and the following:	–200	[–300]
	–100	[–200]
	–75	[–100]
	–50	[–50]
	–25	[0]
	100	[200]
	150	[300]
	200	[400]
	250	[500]
	300	[600]
	350	[700]
	400	[800]
	500	[1000]
	600	[1200]
	700	[1400]
	800	[1600]
	1000	[1800]
	1100	[2000]

[A] The values in degrees Fahrenheit given in this table are not intended to be exact conversions of those values in degrees Celsius.

4.3.1 Standard conditions are presented where both surfaces are exposed to fixed ambient temperatures that are typical for testing building constructions, both insulated and uninsulated (Table 2).

4.3.2 Standard conditions are presented where the temperatures of the two surfaces are fixed and surface coefficients are not considered (Table 3).

4.3.3 For conditions where the temperature of only one surface is fixed with the other exposed to fixed ambient temperature, use the mean temperatures of Table 1.

4.4 These conditions must be stated to describe accurately thermal properties such as thermal conductivity versus mean temperature for thermal insulating materials. Thermal insulations exhibiting inflection points due to the change of state of insulating gases (see Note 2), must be tested at sufficiently small temperature differences between (*1*) the hot and cold sides and (*2*) between mean temperatures. The test temperature differences used depend on the vapor pressure versus temperature relationship of the gases involved and the ability of the test apparatus to provide accurate measurements of low temperature differences.

NOTE 2—Certain closed-cell cellular plastic insulations are of this type.

5. Procedure

5.1 Since there are distinctly different needs or uses for thermal performance information, the test conditions selected must be appropriate to the need or use.

5.2 Determine the use classification described in 5.3 and choose the appropriate temperature conditions from the tables.

NOTE 3—These mean temperatures result from test temperatures for the hot and cold surfaces. Report the hot and cold surface temperatures that are used in Practice C1045 to analyze non linear temperature dependencies for the thermal performance.

5.2.1 If the tables do not contain the appropriate temperature conditions, specifically report exceptions.

5.3 Thermal insulation classifications are:

5.3.1 *Building Envelopes*—Typically, building assemblies or constructions, both insulated and uninsulated, are tested with both surfaces exposed to fixed ambient temperatures as prescribed in Table 2. Normally, Test Method C1363 is used for evaluation of building assemblies. For building envelopes in moderate climates with an anticipated exterior temperature range of 0 to 50°C (nominally [30 to 120°F]), recommended mean temperatures are 4, 24, and 43°C [40, 75 and 110°F].

5.3.2 *Mechanical Processes or Systems and Building and Industrial Insulations*—Evaluations of thermal performance are generally limited to a single material where data is needed for codes, specifications, and technical literature. Evaluations involve either (*1*) fixing both surface temperatures as prescribed in Tables 2 and 3 or (*2*) fixing one surface temperature with the other exposed to a fixed ambient temperature using the mean temperatures of Table 1 and Test Method C335/C335M. For mechanical systems and processes for applications from -100 to 150°C [nominally -200 to 300°F], recommended mean temperatures are those in 5.3.1 plus 100 and -50°C [200 and

TABLE 2 Standard Temperatures for Thermal Transmittance Evaluations With Both Specimen Surfaces Exposed to Fixed Ambient Temperatures[A]

Temperature, °C[B]			Temperature, [°F][B]		
Mean	Hot Ambient[C]	Cold Ambient[C]	Mean	Hot Ambient[C]	Cold Ambient[C]
–4	24 ± 5	–32± 5	[25]	[75 ± 9]	[–25 ± 9]
4	24 ± 5	–15± 5	[40]	[75 ± 9]	[5 ± 9]
10	24 ± 5	–4 ± 5	[50]	[75 ± 9]	[25 ± 9]
24	38 ± 5	10 ± 5	[75]	[100 ± 9]	[50 ± 9]
38	52 ± 5	24 ± 5	[100]	[125 ± 9]	[75 ± 9]
43	63 ± 5	24 ± 5	[110]	[145 ± 9]	[75 ± 9]

[A] Thermal transmission properties of panels of various building constructions are thermal transmittance (U), and thermal conductance (C).
[B] Celsius temperatures are standard. The values in degrees Fahrenheit given in this table are not intended to be exact conversions of those values given in degrees Celsius.
[C] It is possible that ambient temperatures other than shown will be required for applications other than normal building interior ambient temperatures. It is acceptable to determine thermal properties from test data using ambient temperatures suitable for the applications, but the change must be reported.

TABLE 3 Standard Temperatures for Thermal Transmission Property Testing and Evaluation Both Surface Temperatures Fixed[A]

NOTE 1—Typical for use with Test Methods C177, C201, C518, and C1114.

Temperature, °C[B]			Temperature, [°F][B]		
Mean	Temperature Difference[CD]		Mean	Temperature Difference[CD]	
	Small	Large		Small	Large
–200	25± 5	100 ± 20	[–300]	[50± 10]	[200 ± 30]
–100	25 ± 5	200 ± 20	[–200]	[50 ± 10]	[300 ± 30]
–75	25 ± 5	150 ± 20	[–100]	[50 ± 10]	[300 ± 30]
–50	25 ± 5	150 ± 20	[–50]	[50 ± 10]	[300 ± 20]
–25	25 ± 5	100 ± 10	[0]	[50 ± 10]	[300 ± 20]
–4	25± 5	50 ± 10	[25]	[50 ± 10]	[100 ± 20]
4	25 ± 5	40± 10	[40]	[50 ± 10]	[80 ± 20]
10	25± 5	40± 10	[50]	[50± 10]	[80 ± 20]
24	25 ± 5	40± 10	[75]	[50 ± 10]	[80 ± 20]
38	25 ± 5	40± 15	[100]	[50 ± 10]	[80 ± 25]
43	25 ± 5	40± 15	[110]	[50 ± 10]	[80 ± 25]
100	50 ± 15	150 ± 30	[200]	[100 ± 25]	[250 ± 50]
150	50± 15	275 ± 30	[300]	[100 ± 25]	[450 ± 50]
200	50 ± 15	400 ± 30	[400]	[100 ± 25]	[650 ± 50]
250	50± 15	525 ± 30	[500]	[100± 25]	[850 ± 50]
300	50 ± 15	650 ± 30	[600]	[100 ± 25]	[1050 ± 50]
350	50 ± 15	775 ± 30	[700]	[100 ± 25]	[1250 ± 50]
400	100 ± 30	800 ± 60	[800]	[200 ± 50]	[1400 ± 100]
500	100 ± 30	900 ± 60	[1000]	[200 ± 50]	[1800± 100]
600	100± 30	1000 ± 60	[1200]	[200± 50]	[2200 ± 100]
700	100 ± 30	1300 ± 60	[1400]	[200 ± 50]	[2600 ± 100]
800	100 ± 30	1500 ± 60	[1600]	[200± 50]	[3000 ± 100]
1000	100 ± 30	1700 ± 60	[1800]	[200 ± 50]	[3200± 100]
1100	100 ± 30	2100 ± 60	[2000]	[200 ± 50]	[3600 ± 100]

[A] Thermal properties of insulation materials and systems such as thermal transference (T_t), conductance (C), and surface heat transfer coefficient (h_o) are calculated from test measurements of heat input, hot surface temperature, cold surface temperature and ambient air temperature.
[B] Celsius temperatures are standard. The values in degrees Fahrenheit are not intended to be exact conversions of those values in degrees Celsius.
[C] Ambient temperatures other than shown may be required for applications other than normal building interior ambient temperatures. Thermal properties should be determined from test data using ambient temperatures suitable for the applications, but the change must be reported.
[D] Selection of temperature difference for property evaluations needs to reflect the actual temperature differences of the intended applications.

-50°F]. For industrial applications from -200 to 600°C [nominally -300 to 1200°F], recommended mean temperatures are -100, 24, 150, 300, and 500°C [-200, 75, 300, 600, and 1000°F].

6. Keywords

6.1 building envelope; industrial application; mean test temperature; mechanical process; selecting temperatures; thermal insulation; thermal property