National Institute of Standards & Technology

Certificate

Standard Reference Material® 1450c

Thermal Resistance - Fibrous Glass Board

This Standard Reference Material (SRM) is intended primarily for use in the measurement of the thermal resistance of insulation materials. The SRM may be used in conjunction with ASTM C 177, "Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus" [1] or ASTM C 518, Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus" [2]. A unit of SRM 1450c consists of a square panel of fine-glass fibers and phenolic binder molded into a semi-rigid board. The nominal dimensions of a unit are 610 mm × 610 mm × 25.4 mm and the bulk density ranges from 150 kg m^{-3} to 165 kg m^{-3}.

The certified thermal resistance values, R_0, and expanded uncertainties of the nominal 25.4 mm thick unit as a function of bulk density and temperature are listed in Table 1.

Expiration of Certification: The certification of **SRM 1450c** is valid **indefinitely**, within the measurement uncertainty specified, provided the SRM is handled in accordance with instructions given in this certificate (see "Instructions for Use"). The certification is nullified if the SRM is damaged, contaminated, or otherwise modified.

Maintenance of SRM Certification: NIST will monitor this SRM over the period of its certification. If substantive technical changes occur that affect the certification before the expiration of this certificate, NIST will notify the purchaser. Registration (see attached sheet) will facilitate notification.

The technical measurements and characterization of this SRM were performed by E.H. Anderson and M.W. Davis under the supervision of R.R. Zarr of the NIST Building Environment Division.

The original statistical analysis of the data was provided by E.S Lagergren with additional consultation by S.D. Leigh of the NIST Statistical Engineering Division.

Support aspects involved in the issuance of this SRM were coordinated through the NIST Measurement Services Division.

INSTRUCTIONS FOR USE: A unit must be air dried in an oven at 368 K ± 5 K for 24 hours before thermal conductivity measurements are made. Because the thickness of the unknown unit to be tested will most likely be different from 25.4 mm, the R-values of this SRM for thickness L can by calculated from:

$$R = \frac{R_0}{0.0254} \times L \qquad (1)$$

where R is the thermal resistance at the test thickness L (m) and R_0 (m^2 K W^{-1}) is the certified value interpolated from Table 1 or calculated from the equation given below.

$$R_0 = \frac{0.0254}{\lambda(\rho, T)} \qquad (2)$$

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See Certificate Revision History on Last Page

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The procedures specified in ASTM C 177 [1] must be followed to determine bulk density and thickness.

Certified values of thermal resistance are valid for a single unit, and are invalid for stacked units.

The SRM unit will should not heated above 375 K, or compressed more than 10 % of original thickness. The SRM will experience permanent damage if heated above 470 K.

Table 1. Certified Thermal Resistance Values and Expanded Uncertainties

Thermal Resistance, R_0 (m^2 K W^{-1})				
Temperature (K)	Bulk Density (kg/m^3)			
	150	155	160	165
280	0.813 ± 0.013	0.806 ± 0.013	0.799 ± 0.013	0.792 ± 0.012
285	0.799 ± 0.013	0.792 ± 0.012	0.785 ± 0.012	0.778 ± 0.012
290	0.786 ± 0.012	0.779 ± 0.012	0.772 ± 0.012	0.766 ± 0.012
295	0.773 ± 0.012	0.766 ± 0.012	0.760 ± 0.011	0.754 ± 0.011
300	0.761 ± 0.011	0.754 ± 0.011	0.748 ± 0.011	0.742 ± 0.011
305	0.749 ± 0.011	0.742 ± 0.011	0.736 ± 0.011	0.730 ± 0.011
310	0.737 ± 0.011	0.731 ± 0.011	0.725 ± 0.010	0.719 ± 0.010
315	0.726 ± 0.010	0.720 ± 0.010	0.714 ± 0.010	0.709 ± 0.010
320	0.715 ± 0.010	0.709 ± 0.010	0.703 ± 0.010	0.698 ± 0.010
325	0.704 ± 0.010	0.699 ± 0.010	0.693 ± 0.009	0.688 ± 0.009
330	0.694 ± 0.009	0.688 ± 0.009	0.683 ± 0.009	0.678 ± 0.009
335	0.684 ± 0.009	0.679 ± 0.009	0.673 ± 0.009	0.668 ± 0.009
340	0.674 ± 0.009	0.669 ± 0.009	0.664 ± 0.009	0.659 ± 0.009

Source:[1] SRM 1450c is a commercial grade of molded fibrous glass board that was supplied from a special run by Owens Corning Fiberglas, Corporation.

Sample Selection: Test specimens for characterizing the steady-state thermal transmission properties of SRM 1450c were selected based on a randomized full factorial experimental design that required 30 test specimens (15 pairs) covering three nominal levels of density. The breakdown consisted of five pairs having the lowest density, five pairs about the median density, and five pairs having the highest density. Each pair was selected to have nearly the same bulk density.

Measurement Technique: Thermal conductivity measurements were made on the NIST one-meter line-heat-source guarded-hot-plate apparatus in accordance with ASTM Test Method C 177 [1]. Following a randomized full factorial design, the thermal conductivity (W m^{-1} K^{-1}) was determined for three levels of bulk density ranging from 150 kg m^{-3} to 165 kg m^{-3} and five levels of mean temperature ranging from 280 K to 340 K. A temperature difference of 20 K was maintained across the thickness of the test specimens. A model, linear in bulk density (ρ, kg m^{-3}) and mean temperature (T, K), was fit from the experimental data by least squares regression.

$$\lambda(\rho, T) = -7.2661\times10^{-3} + 5.6252\times10^{-5}\rho + 1.0741\times10^{-4}T \qquad (3)$$

The last digit of the regression coefficients is provided to reduce rounding errors. The standard uncertainty for predicted values from the regression analysis was 0.00 014 W m^{-1} K^{-1}. Measurement uncertainties are discussed below.

Measurement Uncertainty: The uncertainties for the predicted values of thermal conductivity and certified values of thermal resistance were computed in accordance with ISO and NIST Guides [3]. These uncertainties apply only to this lot of fibrous glass board and can be expressed as an expanded uncertainty $U = ku_c$ with U determined from a combined

[1] Certain commercial equipment, instruments, or materials are identified in this certificate to adequately specify the experimental procedure. Such identification does not imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the materials or equipment identified are necessarily the best available for the purpose.

standard uncertainty u_c and a coverage factor of $k = 2$.

The standard uncertainties ($k = 1$) for the measured mean temperature and bulk density were 0.034 K, and 0.72 kg/m^3, respectively, which were propagated in equation 1 to yield a standard uncertainty of 0.00004 W/(m K). The standard uncertainty for the measured thermal conductivity was 0.00 020 $W{\cdot}m^{-1}\ K^{-1}$. These standard uncertainties were combined with the standard uncertainty for predicted values from the regression analysis (described above) to yield the combined standard uncertainty ($k = 1$) of 0.00 025 $W\ m^{-1}\ K^{-1}$.

The expanded uncertainties of the certified thermal resistance values are not expected to exceed 0.013 $m^2\ K\ W^{-1}$ (see Table 1). This estimate is based on the experimental data and includes both material variability and measurement uncertainties.

SUPPLEMENTAL INFORMATION

The following conversion table is provided for convenience only.

Table 2. Unit Conversion Factors

Conversions			
Parameters	SI Units	Factors to Convert (Multiply SI Units)	Conventional Units
Density, p	$kg{\cdot}m^{-3}$	0.062 43	$lb{\cdot}ft^{-3}$
Thermal Conductivity, λ	$W{\cdot}m^{-1}{\cdot}K^{-1}$	6.9335	$Btu{\cdot}in{\cdot}h^{-1}{\cdot}ft^{-2}{\cdot}(°F)^{-1}$
Thermal Resistance, R	$m^2{\cdot}K{\cdot}W^{-1}$	5.6783	$h{\cdot}ft^2{\cdot}°F{\cdot}Btu^{-1}$
Temperature, T	K	1.8(T – 273.15) + 32	°F

REFERENCES

[1] ASTM C 177-93; *Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus*; Annu. Book ASTM Stand., Vol. 04.06.

[2] ASTM C 518-91; *Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus*; Annu. Book of ASTM Stand., Vol. 04.06.

[3] JCGM 100:2008; *Evaluation of Measurement Data — Guide to the Expression of Uncertainty in Measurement* (ISO GUM 1995 with Minor Corrections); Joint Committee for Guides in Metrology (2008); available at http://www.bipm.org/utils/common/documents/jcgm/JCGM_100_2008_E.pdf (accessed Jun 2010); see also Taylor, B.N.; Kuyatt, C.E.; *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*; NIST Technical Note 1297; U.S. Government Printing Office: Washington, DC (1994); available at http://www.nist.gov/physlab/pubs/index.cfm (accessed Jun 2010).

Certificate Revision History: 16 June 2010 (This revision includes a change in regression parameters for the thermal conductivity model [equation 3], correction of certified values in Table 1, and updates of the certificate to current NIST standards.); 05 March 1997 (Original certificate date).

Users of this SRM should ensure that the certificate in their possession is current. This can be accomplished by contacting the SRM Program at: telephone (301)-975-2200; fax (301) 926-4751; e-mail srminfo@nist.gov; or via the Internet at http://www.nist.gov/srm.