Designation: C 168 – 97

AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Terminology Relating to Thermal Insulating Materials[1]

This standard is issued under the fixed designation C 168; 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 standard provides definitions, symbols, units, and abbreviations of terms used in ASTM standards pertaining to thermal insulating materials, and to materials associated with them.

1.2 The definitions appear in alphabetical order in the following sections:

THERMAL INSULATION MATERIALS (PRINCIPAL MATERIAL TYPES)

calcium silicate
cellular elastomeric
cellular glass
cellular polystyrene
cellular polyurethane
cellulosic fiber
diatomaceous silica
homogeneous material
mineral fiber
perlite
vermiculite
wood fiber

THERMAL INSULATION FORMS

blanket insulation
blanket insulation, metal mesh
block insulation
board insulation
cement, finishing
cement, insulating
loose fill insulation
pipe insulation
reflective insulation

THERMAL INSULATION PROPERTIES

absorptance
absorption
conductance, film
conductance, thermal
conductivity, thermal
density, apparent (of applied insulation)
diffusivity, thermal
emittance
emittance, directional
emittance, hemispherical
emittance, spectral
emittance, total
radiance
radiant flux density
reflectance
resistance, abrasion
resistance, freeze-thaw
resitance, impact (toughness)
resistance, thermal
resistivity, thermal
strength, transverse (or flexural)
surface coefficient
transference, thermal
transmission, heat
transmittance, thermal
water vapor
water vapor diffusion
water vapor permeability
water vapor permeance
water vapor pressure
water vapor resistance
water vapor resistivity
water vapor transmission rate
wetting and adhesion, surface

THERMAL INSULATION (GENERAL TERMS)

apparent thermal conductivity
apparent thermal resistivity
blackbody
coating
coverage
covering capacity, dry
covering capacity, wet
dewpoint temperature
facing
graybody
heat flow, heat flow rate
heat flux
heat flux transducer
humidity
humidity, absolute
humidity, relative
jacket
mastic
perm
soaking heat
steady state thermal
thermal insulation
thermal insulation system
water vapor retarder (barrier)

2. Referenced Documents

2.1 *ISO Standard:*

[1] This terminology is under the jurisdiction of ASTM Committee C-16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.94 on Terminology.

Current edition approved Nov. 10, 1997. Published June 1998. Originally published as C 168 – 41 T. Last previous edition C 168 – 90.

ISO 7345 Thermal Insulation—Physical Quantities and Definitions[2]

3. Terminology

3.1 *Definitions Relating to Thermal Insulation Materials (Principal Material Types):*

calcium silicate, *n*—insulation composed principally of hydrous calcium silicate, and which usually contains reinforcing fibers.

cellular elastomeric, *n*—insulation composed principally of natural or synthetic elastomers, or both, processed to form a flexible, semirigid, or rigid foam which has a predominantly closed-cell structure.

cellular glass, *n*—insulation composed of glass processed to form a rigid foam having a predominantly closed-cell structure.

cellular polystyrene, *n*—insulation composed principally of polymerized styrene resin processed to form a rigid foam having a predominantly closed-cell structure.

cellular polyurethane, *n*—insulation composed principally of the catalyzed reaction product of polyisocyanate and polyhydroxy compounds, processed usually with fluorocarbon gas to form a rigid foam having a predominantly closed-cell structure.

cellulosic fiber, *n*—insulation composed principally of cellulose fibers usually derived from paper, paperboard stock, or wood, with or without binders.

diatomaceous silica, *n*—insulation composed principally of diatomaceous earth with or without binders, and which usually contains reinforcing fibers.

homogeneous material, *n*—a material in which relevant properties are not a function of the position within the material.

DISCUSSION—Homogeneity depends on the scale of the volume element used to examine the material. The purposes of Committee C-16 are best suited if a macroscopic viewpoint is taken such that the standard insulating materials are considered homogeneous (for example, fibrous and cellular insulations), at least in the heat flow direction and time frame involved in a thermal test.

DISCUSSION—Relevant properties may be a function of such variables as time, direction, or temperature.

mineral fiber, *n*—insulation composed principally of fibers manufactured from rock, slag, or glass, with or without binders.

perlite, *n*—insulation composed of natural perlite ore expanded to form a cellular structure.

vermiculite, *n*—insulation composed of natural vermiculite ore expanded to form an exfoliated structure.

wood fiber, *n*—insulation composed of wood fibers, with or without binders.

DISCUSSION—This is a type of cellulosic fiber insulation.

3.2 *Definitions Relating to Thermal Insulation Forms:*

blanket insulation, *n*—a relatively flat and flexible insulation in coherent sheet form furnished in units of substantial area.

blanket insulation, metal mesh, *n*—blanket insulation covered by flexible metal-mesh facings attached on one or both sides.

block insulation, *n*—rigid insulation preformed into rectangular units.

board insulation, *n*—semirigid insulation preformed into rectangular units having a degree of suppleness particularly related to their geometrical dimensions.

cement, finishing, *n*—a mixture of dry fibrous or powdery materials, or both, that when mixed with water develops a plastic consistency, and when dried in place forms a relatively hard, protective surface.

cement, insulating, *n*—a mixture of dry granular, flaky, fibrous, or powdery materials that when mixed with water develops a plastic consistency, and when dried in place forms a coherent covering that affords substantial resistance to heat transmission.

loose fill insulation, *n*—insulation in granular, nodular, fibrous, powdery, or similar form designed to be installed by pouring, blowing, or hand placement.

pipe insulation, *n*—insulation in a form suitable for application to cylindrical surfaces.

reflective insulation, *n*—insulation depending for its performance upon reduction of radiant heat transfer across air spaces by use of one or more surfaces of high reflectance and low emittance.

3.3 *Definitions Relating to Thermal Insulation Properties:*

absorptance, *n*—the ratio of the radiant flux absorbed by a body to that incident upon it.

absorption, *n*—transformation of radiant energy to a different form of energy by interaction with matter.

conductance, film, *n*—the time rate of heat flow from a unit area of a surface to its surroundings, induced by a unit temperature difference between the surface and the environment.

DISCUSSION—The environment is a fluid (liquids or gases). h depends on the nature of fluid motion past the surface (laminar or turbulent). (h in SI units: $W/m^2 \cdot K$).

conductance, thermal, *C*, *n*—the time rate of steady state heat flow through a unit area of a material or construction induced by a unit temperature difference between the body surfaces.

$$C = q/\Delta T$$

A conductance (C) associated with a material shall be specified as a material C. A conductance (C) associated with a system or construction of materials shall be specified as a system C. (C in SI units: W/m^2K.) (C in inch-pound units: $(Btu/h)/ft^2/F = Btu/h\ ft^2F$.)

DISCUSSION—The average temperature of a surface is the area-weighted temperature of that surface.

DISCUSSION—When the surfaces of a mass type thermal insulation are not of equal areas, as in the case of thermal transmission in the radial direction, or are not of uniform separation (thickness), the surface area and thickness to which the conductance is assigned must be defined.

DISCUSSION—"Total'' or "areal'' thermal conductance are often used as synonyms for thermal conductance.

DISCUSSION—Thermal conductance and thermal resistance are reciprocals of one another.

DISCUSSION—See Discussion under **resistance, thermal.**

[2] Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

conductivity, thermal, λ or *k*, *n*—the time rate of steady state heat flow through a unit area of a homogeneous material induced by a unit temperature gradient in a direction perpendicular to that unit area. (λ or *k* in SI units: $(W/m^2)/(K/m) = W/m\ K$.) (λ or *k* in inch-pound units: $(Btu/h)/ft^2/(F/ft) = Btu/h\ ft\ F$) or $(Btu/h)/ft^2/(F/in.) = Btu\ in./h\ ft^2\ F$.) (See discussion under **apparent thermal conductivity** in paragraph 3.3.)

DISCUSSION—Thermal conductivity testing is usually done in one of two apparatus/specimen geometries: flat-slab specimens with parallel heat flux lines, or cylindrical specimens with radial heat flux lines. The operational definitions of thermal conductivity for these two cases are given as follows:

$$\text{Flat-slab geometry } \lambda = \frac{Q}{A}\frac{L}{\Delta T} \tag{1}$$

where:
Q = heat flow rate,
A = area through which Q passes, and
L = thickness of the flat-slab specimen across which the temperature difference ΔT exists.

The $\Delta T/L$ ratio approximates the temperature gradient.

$$\text{Cylindrical geometry } \lambda = \frac{Q}{2\pi l \Delta T}\log_e\frac{r_2}{r_1} \tag{2}$$

where:
1 = length,
r_2 = the outer radius, and
r_1 = the inner radius of the cylinder.

Eq 1 and Eq 2 are actually special-case simplifications of the more general definition:

thermal conductivity, λ—a tensor property defined by the tensor equation:

$$q = -\lambda \Delta T \tag{3}$$

where q is the heat flux vector, and $\Delta\ T$ (grad T) is the temperature gradient vector. Except in theoretical discussions, this generalized form of the definition is seldom used. For experimental situations, the geometry of the testing apparatus and the specimen are chosen such that Eq 3 reduces to the one-dimensional scalar equation:

$$Q = -A\lambda\frac{dT}{du} \tag{4}$$

where:
Q = heat flow rate,
A = area through which Q passes,
λ = thermal conductivity, and
dT/du = the temperature gradient in the direction of heat flow.

At steady state, Eq 1 and Eq 2 are consistent with Eq 4 if $\Delta\ T$ is sufficiently small. If ΔT is not sufficiently small, then Eq 1 and Eq 2 define a mean thermal conductivity over the ΔT range, and this range in addition to the mean temperature should be stated.

DISCUSSION—If the measured thermal property indicates that other than conductive heat flows are present, as evidenced by dependence on specimen thickness, air flow, or emittance of bounding surfaces, then this definition does not apply. See also, **apparent thermal conductivity.**

DISCUSSION—Thermal conductivity and thermal resistivity are reciprocals of one another.

DISCUSSION—As an additional reference and discussion along similar lines, see the International Standard ISO 7345 Annex.

density, apparent (of applied insulation), *n*—the mass per unit volume of in-place mass thermal insulation.

diffusivity, thermal, *n*—the ratio of thermal conductivity of a substance to the product of its density and specific heat. (In SI units: $(W/(m\bullet K))/((kg/m^3)\bullet(J/(kg\bullet K))) = m^2/s$.) (In inch-pound units: $(Btu/(hr\bullet ft)\ F)/((lb/ft^3)(Btu/(lb\bullet F)) = ft^2/hr)$)

emittance, ε, *n*—the ratio of the radiant flux emitted by a specimen to that emitted by a blackbody at the same temperature and under the same conditions.

emittance, directional ε(θ; φ), *n*—the ratio of the radiance from a surface in a particular direction to the radiance from a blackbody at the same temperature under the same conditions.

emittance, hemispherical ϵ_H or ε(2π), *n*—the average directional emittance over a hemispherical envelope covering a surface.

emittance, spectral ϵ_λ or ε(λ; θ;φ), *n*—an emittance based on the radiant energy emitted per unit wavelength interval (monochromatic radiant energy).

DISCUSSION—Where necessary to avoid confusion, emittances should be designated by subscripts, for example: ϵ_{HT}, $\epsilon_{H\lambda}$, $\epsilon_{N\lambda}$, $\epsilon_{\theta\lambda}$, ϵ_{HT}. For most engineering purposes, the hemispherical total emittance ϵ_{HT} suffices.

emittance, total ϵ_T or ε(t), *n*—an emittance that is an integrated average over all wavelengths of radiant energy emitted.

overall coefficient of heat transfer—See **transmittance, thermal**.

permeability, water vapor— See **water vapor permeability**.

permeance, water vapor— See **water vapor permeance**.

radiance, *n*—the rate of radiant emission per unit solid angle and per unit projected area of a source in a stated angular direction from the surface (usually the normal).

DISCUSSION—The term "intensity of radiation'' is often used as a synonym for radiance.

radiant flux density, *n*—the rate of radiant energy emitted from unit area of a surface in all radial directions of the overspreading hemisphere.

reflectance, *n*—the fraction of the incident radiation upon a surface that is reflected from the surface.

DISCUSSION—For an opaque surface, the sum of the reflectance and the absorptance is unity at equilibrium.

DISCUSSION—Absorptances and reflectances are of various types, as are emittances. For most engineering purposes, the counterparts of the hemispherical total emittance suffice. Further, the terms absorptivity and reflectivity, like emissivity, are restricted to apply to materials having opaque, optically flat surfaces.

resistance, abrasion, *n*—the ability to withstand scuffing, scratching, rubbing, or wind-scouring.

resistance, freeze-thaw, *n*—resistance to cycles of freezing and thawing that could affect application, appearance, or performance.

resistance, impact (toughness), *n*— ability to withstand mechanical blows or shock without damage seriously affecting the effectiveness of the material or system.

resistance, thermal, *R*, *n*—the quantity determined by the temperature difference, at steady state, between two defined surfaces of a material or construction that induces a unit heat flow rate through a unit area.

$$R = \Delta T/q \tag{5}$$

A resistance (*R*) associated with a material shall be specified as a material *R*. A resistance (*R*) associated with a system or construction of materials shall be specified as a system *R*. (*R* in SI units: $K/(W/m^2) = K\ m^2/W$.) (*R* in inch-pound units: $F/(Btu/h/ft^2) = F\ ft^2\ h/Btu$.)

Discussion—Thermal resistance and thermal conductance are reciprocals of one another.

Discussion—See first and second discussions under **conductance, thermal.** For insulation applied to cylinders, thermal resistance is expressed in terms of unit linear length or unit area of the cylindrical surface.

Discussion—For the case where the heat flow rate depends upon air flow within the system, moisture content and migration, or radiant energy transparency, the situation must be fully described.

resistivity, thermal, *r*, *n*—the quantity determined by the temperature difference, at steady state, between two defined parallel surfaces of a homogeneous material of unit thickness, that induces a unit heat flow rate through a unit area. (*r* in SI units: m K/W.) (*r* in inch-pound units: h ft F/Btu or, h ft^2 F/Btu in.)

Discussion—Thermal resistivity and thermal conductivity are reciprocals of one another.

Discussion—See the definition and discussions under **conductive, thermal**. Also, see the definition of **apparent thermal resistivity.**

resistivity, water vapor— See **water vapor resistivity**.

strength, transverse (or flexural), *n*— the breaking load applied normal to the neutral axis of a beam.

surface coefficient, *n*—the ratio of the steady-state heat exchange rate (time rate of heat flow per unit area of a particular surface by the combined effects of radiation, conduction, and convection) between a surface and its external surroundings (air or other fluid and other visible surfaces) to the temperature difference between the surface and its surroundings. (See **conductance, film**.)

surface wetting and adhesion—See **wetting and adhesion, surface**.

toughness—See **resistance, impact (toughness)**.

transference, thermal, *n*—the steady-state heat flow from (or to) a body through applied thermal insulation and to (or from) the external surroundings by conduction, convection, and radiation. It is expressed as the time rate of heat flow per unit area of the body surface per unit temperature difference between the body surface and the external surroundings.

transmission, heat, *n*—the quantity of heat flowing through unit area due to all modes of heat transfer induced by the prevailing conditions.

Discussion—Heat transfer may be by solid conduction, mass transfer, gas conduction, convection and radiation, either separately or in any combination.

transmission rate, water vapor—See **water vapor transmission rate**.

transmittance, thermal, *n*—the heat transmission in unit time through unit area of a material or construction and the boundary air films, induced by unit temperature difference between the environments on each side.

Discussion—This heat transmission rate has been called the overall coefficient of heat transfer.

water vapor diffusion, *n*—the process by which water vapor spreads or moves through permeable materials caused by a difference in water vapor pressure.

water vapor permeability, *n*—the time rate of water vapor transmission through unit area of flat material of unit thickness induced by unit vapor pressure difference between two specific surfaces, under specified temperature and humidity conditions.

Discussion—Permeability is a property of a material, but the permeability of a body that performs like a material may be used. Permeability is the arithmetic product of permeance and thickness.

water vapor permeance, *n*—the time rate of water vapor transmission through unit area of flat material or construction induced by unit vapor pressure difference between two specific surfaces, under specified temperature and humidity conditions.

Discussion—Permeance is a performance evaluation and not a property of a material.

water vapor pressure, *n*—the pressure of water vapor at a given temperature; also the component of atmospheric pressure contributed by the presence of water vapor.

water vapor resistance, *n*—the steady vapor pressure difference that induces unit time rate of vapor flow through unit area of a flat material (or construction that acts like a homogeneous body) for specific conditions of temperature and relative humidity at each surface.

Discussion—Vapor resistance is the reciprocal of vapor permeance. It is the arithmetic product of the resistivity and thickness.

water vapor resistivity, *n*—the steady vapor pressure difference that induces unit time rate of vapor flow through unit area and unit thickness of a flat material (or construction that acts like a homogeneous body), for specific conditions of temperature and relative humidity at each surface.

Discussion—Vapor resistivity is the reciprocal of vapor permeability.

water vapor transmission rate, *n*—the steady water vapor flow in unit time through unit area of a body, normal to specific parallel surfaces, under specific conditions of temperature and humidity at each surface.

wetting and adhesion, surface, *n*—the mutual affinity of and bonding between finish and the surface to which it is applied.

3.3 *Definitions Relating to Thermal Insulation (General Terms):*

apparent thermal conductivity, $\boldsymbol{\lambda}_a$, k_a, *n*—a thermal conductivity assigned to a material that exhibits thermal transmission by several modes of heat transfer resulting in property variation with specimen thickness, or surface emittance. See **conductivity, thermal**.

DISCUSSION—Thermal conductivity and resistivity are normally considered to be intrinsic or specific properties of materials and, as such, should be independent of thickness. When nonconductive modes of heat transfer are present within the specimen (radiation, free convection) this may not be the case. To indicate the possible presence of this phenomena (for example, thickness effect) the modifier "apparent" is used, as in apparent thermal conductivity.

DISCUSSION—Test data using the "apparent" modifier must be quoted only for the conditions of the measurement. Values of thermal conductance (material *C*) and thermal resistance (material *R*) calculated from apparent thermal conductivity or resistivity, are valid only for the same conditions.

DISCUSSION—Test data labeled with "apparent" shall not include any equipment related measurement errors induced due to measurement attempts beyond an apparatus range or calibration.

DISCUSSION—Use of the "apparent" modifier with system *C* or system *R* measurements is not permitted.

apparent thermal resistivity, r_a, *n*—a thermal resistivity assigned to a material that exhibits thermal transmission by several modes of heat transfer resulting in property variation with specimen thickness, or surface emittance. See **resistivity, thermal**.

DISCUSSION—See entire discussion under **apparent thermal conductivity.**

blackbody, *n*—the ideal, perfect emitter and absorber of thermal radiation. It emits radiant energy at each wavelength at the maximum rate possible as a consequence of its temperature, and absorbs all incident radiance.

coating, *n*—a liquid or semiliquid that dries or cures to form a protective finish, suitable for application to thermal insulation or other surfaces in thickness of 30 mils (0.76 mm) or less, per coat.

coverage, *n*—the area to be covered per unit volume of coating to obtain specified dry thickness and desired performance.

covering capacity, dry, *n*—the area covered to a dry thickness of 1 in. (25 mm) by 100 lb (45.4 kg) of dry cement when mixed with the recommended amount of water, molded and dried to constant weight.

covering capacity, wet, *n*—the area covered to a wet thickness of 1 in. (25 mm) by 100 lb (45.4 kg) of dry cement when mixed with the recommended amount of water, and molded.

dewpoint temperature, *n*—the temperature at which condensation of water vapor in a space begins for a given state of humidity and pressure as the vapor temperature is reduced; the temperature corresponding to saturation (100 % relative humidity) for a given absolute humidity at constant pressure.

facing, *n*—a protective or decorative (or both) surface applied as the outermost layers of an insulation system.

graybody, *n*—a body having the same spectral emittance at all wavelengths.

heat flow; heat flow rate, *Q*, *n*—the quantity of heat transferred to or from a system in unit time. (*Q* in SI units: *W*.) (*Q* in inch-pound units: Btu/h.)

DISCUSSION—See **heat flux** for the areal dependence.

DISCUSSION—This definition is different than that given in some textbooks, which may use $\dot{Q}$, or *q* to represent heat flow rate. The ISO definition uses Φ.

heat flux, *q*, *n*—the heat flow rate through a surface of unit area perpendicular to the direction of heat flow.
(*q* in SI units: W/m^2)
(*q* in inch-pound units: Btu/h/ft^2 = Btu/h ft^2)

DISCUSSION—This definition has been used as heat flux density, or density of heat flow rate (defined as areal density of heat flow rate by ISO).

heat flux transducer, HFT, *n*—a device containing a thermopile (or equivalent) that produces an output which is a function of the heat flux.

DISCUSSION—In the past this device may also have been known as a heat flow meter, heat flux meter, heat flow sensor, or heat flux sensor.

DISCUSSION—The HFT output may also be a function of mean temperature, attachment, application, and environmental situation.

humidity, absolute, *n*—the mass of water vapor per unit volume.

humidity, relative, *n*—the ratio of the mol fraction of water vapor present in the air to the mol fraction of water vapor present in saturated air at the same temperature and barometric pressure. Approximately, it equals the ratio of the partial pressure or density of the water vapor in the air to the saturation pressure or density, respectively, at the same temperature.

jacket, *n*—a form of facing applied over insulation.

DISCUSSION—It may be integral with the insulation, or field-applied using sheet materials.

mastic, *n*—a material of relatively viscous consistency that dries or cures to form a protective finish, suitable for application to thermal insulation in thickness greater than 30 mils (0.76 mm) per coat.

mean specific heat, *n*—the quantity of heat required to change the temperature of a unit mass of a substance one degree, measured as the average quantity over the temperature range specified. (It is distinguished from true specific heat by being an average rather than a point value.) (In SI units: J/kg•K) (In inch-pound units: Btu/lb•F)

perm, *n*—the mass rate of water vapor flow through one square foot of a material or construction of one grain per hour induced by a vapor pressure gradient between two surfaces of one inch of mercury or in units that equal that flow rate.

DISCUSSION—This emperically derived permeance unit was developed by cooperation of eight laboratories in the United States and Canada to delineate the moisture migration rate below which there would be low probability for induced moisture problems in ordinary constructions, such as houses, apartments, and conventional buildings in climates that are not greater than 5 000 degree heating-days or are hot and humid for which continual air conditioning would be recommended. Perms are not limited to buildings.

DISCUSSION—Evaluations in perms can be made in multiple or fractional perms. However, no combination of SI units will express the same flow rate without a numerical coefficient. A perm defines the same flow rate, regardless of units, world-wide.

1 perm	= 1 gr/h·ft^2·in·Hg	I-P units
	= 57.2·10^{-12} kg/s·m^2·Pa	SI fundamental
	= 57.2·10^{-12} s/m	SI reduced
	= 57.2 ng/s·m^2·Pa	SI modified
	= 0.66 g/24 h·m^2·mm Hg	SI obsolete

soaking heat, *n*—a test condition in which the specimen is completely immersed in an atmosphere maintained at a controlled temperature.

steady state (thermal), *n*—a condition for which all relevant parameters in a region do not vary over two consecutive steady-state time periods by more than the steady-state tolerance, and no long-term monotonic drifts are present.

Where, the steady-state time period is the time constant of the apparatus-specimen system with additional time necessary if physical phenomena are present, such as moisture transport, which could cause a long-term monotonic drift.

Steady-state tolerance consists of (possibilities in order of increasing magnitude):

(*1*) The imprecision of the mean of a set of data points. This can be defined as twice the standard deviation of a set of N independent data points divided by the square root of N, $2\sigma/\sqrt{N}$,

(*2*) The scatter of the data. This would be 2σ, or,

(*3*) Some larger value may be chosen resulting in less precision.

DISCUSSION—The time constant of an apparatus-specimen system will depend on the response time of the control system, and the heat capacity of the specimen and the apparatus parts in contact with it. One way to estimate the time constant is to initiate a step change in the hot surface temperature and measure the time required for the change in the measured heat flux across the specimen to reach $1/e$ of the eventual total heat flux change, where e is the natural logarithm base (2.718).

DISCUSSION—At times it may be necessary for a point to be averaged over a period of time of the order of the steady-state time period to qualify as being independent, otherwise $2\sigma/ \; - - > \sqrt{N}$ would not be a correct estimate of the apparatus precision.

DISCUSSION—In some measurements (especially in situ), the data may vary with time in a seemingly erratic manner. However, if there are no monotonic trends then this may be termed a "quasi-steady-state'' and the variations can be averaged out.

thermal capacity, *n*—the quantity of heat required to change the temperature of the body one degree. For a homogeneous body, it is the product of mass and specific heat. For a nonhomogeneous body, it is the sum of the products of mass and specific heat of the individual constituents. (May also be seen as heat capacity.) (In SI units: J/K) (In inch-pound units: Btu/F)

thermal insulation, *n*—a material or assembly of materials used to provide resistance to heat flow.

thermal insulation system, *n*—applied or installed thermal insulation complete with any accessories, vapor retarder, and facing required.

vapor barrier—See **water vapor retarder (barrier)**.

water vapor retarder (barrier), *n*— a material or system that adequately impedes the transmission of water vapor under specified conditions.