

# **National Insulation Association's Insulation Science Glossary**

## **Abatement**

To reduce or make void any substance such as the removal of noise, asbestos or lead.  
See asbestos abatement definition as one form of removal.

## **Abrasion Resistance**

The ability of a material to withstand abrasion without appreciative erosion.

## **Absolute Humidity**

The ratio of the mass of water vapor to total volume of an air sample. The I-P units are pounds of moisture per pound of cubic foot of air and the SI units are grams or kilograms of moisture per cubic meter of air.

## **Absorptance**

The ratio of the radiant flux absorbed by a body to that incident upon it.

## **Absorption**

Transformation of radiant energy to a different form of energy by interaction with matter.

## **Adsorption**

Adsorption is the physical adherence or bonding of ions and molecules onto the surface of another molecule.

## **Acoustical Treatment**

Application of absorbing insulation for sound control.

## **Adhesive**

A substance used to bond materials by surface attachment.

## **Aerogel**

A homogeneous, low-density solid state material derived from a gel, in which the liquid component of the gel has been replaced with a gas. The resulting material has a porous structure with an average pore size below the mean free path of air molecules at standard atmospheric pressure and temperature.

## **Air Conditioning**

See conditioned air.

## **Alkalinity**

The quality of a material to be basic or alkaline when exposed to moisture or water producing a blue reaction to litmus paper. A pH measure greater than 7.0.

**Ambient**

Surrounding-encompassing (Generally applied to temperature, humidity and atmospheric conditions).

**Ambient Temperature**

The average temperature of the medium, usually air, surrounding the object under consideration.

**Annular Space (Annulus)**

The distance between a penetrating item and the surrounding opening.

**Anti-Abrasive Coating**

Cushioning material applied where insulation contacts the pipe, duct, vessel or adjacent insulation to prevent eroding of either or both.

**Anti-Sweat**

Any application that prevents condensation.

**Apparent Thermal Conductivity**

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).

**Apparent Thermal Resistivity**

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, R-value).

**Appearance Covering**

Materials used to improve the aesthetics of the finished insulation.

**Application Temperature Limits**

Minimum and maximum temperatures between which it is usually safe to service finishes, adhesives and sealants without endangering the integrity of the material.

**Area Weight**

Weight per unit area for a specified sample, in units of lbs/ft<sup>2</sup> (kg/m<sup>2</sup>).

**Asbestos Abatement**

A procedure for the removal, enclosure or encapsulation of asbestos containing materials from buildings or areas.

**ASJ**

All Service Jacket, otherwise described as a laminate facing or covering constructed with a white kraft paper, fiber glass scrim and a thin aluminum foil.

**Asphalt Cut-Back**

Petroleum asphalt coating with mineral solvents. (This is a vapor-retarder mastic).

**Asphalt Emulsion**

A colloidal dispersion of petroleum asphalt coating with water. (This is a breather mastic).

**ASTM International**

ASTM International provides a global forum for the development and publication of international voluntary consensus standards for materials, products, systems, and services.

**Attenuation**

The limiting of sound propagation from one area to another.

**Bands**

Strapping used to fasten insulation and/or jacketing in place.

**Batt**

Blanket insulation manufactured to dimensions as required by a specific application.

**Beading**

Process of curling the edge of metal jacketing to accommodate sealing.

**Bedding Compound**

A plastic material (mastic) used to imbed insulation. Acts as a cushion, anti-abrasive and adhesive.

**Bends (Tube Turns)**

Pipe, factory or field formed, to pre-determined radii.

**Binder**

Substance contained in insulation material that stabilizes the fibers (sometimes called a thermal setting resin).

**Blackbody**

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.

**Blanket Insulation**

A relatively flat and flexible insulation in coherent sheet form furnished in units of substantial area.

**Blanket Insulation, Metal Mesh**

Blanket insulation covered by flexible metal-mesh facings attached on one or both sides.

**Bleeding**

The diffusion of coloring through a coating from its base or substrate (such as bleeding of asphalt mastic through a paint top coat).

**Blister**

Rounded elevation of the surface of a mastic resembling a blister on the human skin, usually the entrapment of air or vapor.

**Block Insulation**

Rigid insulation preformed into rectangular units.

**Board Insulation**

Semi-rigid insulation preformed into rectangular units having a degree of suppleness, particularly related to their geometrical dimensions.

**BOCA**

Building Officials and Code Administrators.

**Body**

The viscosity or consistency of a mastic or coating.

**Bond Strength**

The force in tension, compression, cleavage or shear required to break an adhesive assembly.

**Bonding Time**

The time required for an adhesive to reach its optimum bonding strength.

**Box Rib**

Aluminum sheet formed to have alternating parallel grooves and ridges with a cross section approximating a square wave.

**Box Trench**

Built-up enclosure either in a shallow trench or buried underground.

**Branch**

Distribution piping or ductwork, same as a main duct except, smaller and from or returning to the main, serving two or more runouts.

**Breather Coating**

A weather barrier coating designed to prevent water (rain, snow, sleet, spillage, wash water, etc.) from entering the insulation system, while still allowing the escape of small quantities of water vapor resulting from heat applied to the moisture entrapped in the insulation.

**British Thermal Unit (Btu)**

The amount of heat required to raise one pound of water one degree Fahrenheit at 59 F., specifically 778.26 ft. lbs.

**Built-Up Roof**

A composition roof composed of layers of roofing felt mopped with hot asphalt and usually topped with gravel.

**Butt Joints**

The end joints of pipe insulation.

**Butt Strip**

Strips of similar jacket material applied around pipe insulation butt joints to either seal joints or for aesthetics.

**C-Value (Thermal Conductance)**

See Conductance, thermal.

**Calcium Silicate**

Insulation composed principally of hydrous calcium silicate, and which usually contains reinforcing fibers.

**Canvas**

A plain-weave cotton fabric used for jacketing or covering.

**Capillarity**

The ability of a cellular, fibrous or granular material to diffuse water into its structure.

**Caulk**

To seal and make water and/or airtight.

**Cellular Elastomeric**

Insulation composed principally of natural or synthetic elastomers, or both, processed to form a flexible, semi-rigid or rigid foam that has a closed-cell structure.

**Cellular Glass**

Insulation composed of glass processed to form a rigid foam having a predominately closed-cell structure.

**Cellular Insulation**

Insulation composed of small, individual cells separated from each other. The cellular material may be glass or plastic such as polystyrene, polyurethane, polyisocyanurate or elastomeric.

**Cellular Plastic Expanded**

Beads of plastic expanded by chemical or thermal means and bonded together chemically or thermally.

**Cellular Plastic Extruded**

Extruded plastic with cells formed by thermal or chemical means.

**Cellular Polyimide**

Insulation composed of the reaction product in which the bonds formed between monomers during polymerization are essentially imide units forming a cellular structure.

**Cellular Polystyrene**

Insulation composed principally of polymerized styrene resin processed to form a rigid foam having a predominately closed-cell structure.

**Cellular Polyurethane**

Insulation composed principally of the catalyzed reaction product of polyisocyanate and polyol compounds, processed usually with fluorocarbon or hydrocarbon gas to form a rigid foam having a predominately closed-cell structure.

**Cellulosic Fiber**

Insulation composed principally of cellulose fibers usually derived from paper, paperboard stock or wood, with or without binders.

**Cement, Finishing**

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, smooth protective surface.

**Cement, Insulating**

A mixture of dry granular, fibrous or powdery (or both) 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.

**Ceramic Fibers**

Pure silica heated and expanded to produce fibers from which high-temperature insulation can be made. Sometimes called Refractory Ceramic Fibers.

**Chalking**

A soft white or gray appearance on the surface of a weathered finish.

**Checking**

Openings of a coated surface characterized by the appearance of fine cracks in all directions.

**Chemical Resistance**

Capability of a material to withstand exposure to acids, alkalis, salts and their solutions.

**Chicken Wire**

Hexagonal wire netting (poultry mesh) used as reinforcement or as a metal-mesh facing.

**Cladding (as related to insulation jacketing)—synonymous with jacketing**

*Discussion*—The three terms “jacketing”, “lagging”, and “cladding” are considered synonymous in most metal jacket related applications and geographies. However, in some cases in the power industry in North America the term “lagging” has a different meaning than “jacketing” or “cladding” and refers specifically to a heavier gauge of jacketing.

**Clearance**

Adequate space allowed for installation of insulation materials.

**Closed Cell Foam**

A material comprised predominantly of individual non-interconnecting cellular voids.

**Coating**

A liquid or semi-liquid that dries or cures to form a protective finish, suitable for application to thermal insulation or other surfaces in a dry thickness of 30 mils or less per coat.

**Code (Building)**

A set of construction and materials standards, usually statutory. Model building codes are adopted by each municipality from the major code organizations. The major code authorities are BOCA, (Building Officials and Code Administrators, primarily Midwest), ICBO (International Council of Building Code Officials, West and Indiana) and SBCCI (Southern Building Code Congress, International, South). The local municipality or state can choose which major building code is adopted.

**Coefficient of Linear Expansion/Contraction**

The change in a unit length of a material corresponding to a unit change in the temperature of the material.

**Combustible**

Provides enough fuel to make insulation capable of burning.

**Compaction Resistance**

The property of a fibrous or loose-fill material that resists compaction under load or vibratory conditions.

**Compatible Materials**

Two or more substances that can be mixed or used together without separating, reacting, or adversely affecting the materials.

### **Compressive Strength**

The property of an insulation material that resists any change in dimensions when acted upon by a compaction force.

### **Concealed Spaces**

Spaces not generally visible after the project is completed such as furred spaces, pipe spaces, pipe and duct shafts, spaces above ceilings, unfinished spaces, crawl spaces, attics and tunnels.

### **Condensate Drain**

Piping carrying condensed water from air conditioning or refrigeration drip pans to a point of discharge.

### **Condensate Return**

The liquid formed by condensation of vapor. In steam heating it is water condensed from steam. In air conditioning it is the water extracted from the air by cooling.

### **Condensation**

The act of water vapor turning into liquid upon contact with a cold surface.

### **Conditioned Space**

Building area supplied with conditioned air that is heated or cooled to a certain temperature and may be mechanical controlled to provide a certain humidity level.

### **Conductance, Air Film,**

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.

### **Conductance, Thermal, C-value**

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.

### **Conduction**

The transfer of heat energy within a body or between two bodies in physical contact.

### **Conductivity, Thermal (k-value)**

The measure of heat that pass through a unit area of a homogeneous substance, through a unit thickness, in a unit of time, for each unit temperature difference. The lower the k-value, the higher the insulating value.

Note: I-P units are Btu – in / hr – ft<sup>2</sup> - °F and typical SI units are Watts / m - °C.

Textbook definition: The time rate of steady heat flow through a unit area of a homogeneous material induced by a unit temperature gradient in a direction perpendicular to that unit area.

**Contact Adhesive**

An adhesive that when tacky to the touch will adhere to itself instantaneously on contact.

**Convection**

The transfer of heat by movement of fluids.

**Corrosion**

Deterioration by chemical action such as rust on steel.

**Corrosion Retarder (as Related to Insulation Jacketing)**

See Moisture Barrier (as related to insulation jacketing)

**Couplings**

Screwed, soldered, welded or mechanical/grooved connections between links of pipe.

**Cover**

To place insulation and/or finish materials on, over or around a surface so as to insulate, protect or seal.

**Coverage**

The area to be covered per unit volume of coating to obtain specified dry thickness and desired performance.

**Covering Capacity, Dry**

The area covered to a dry thickness of 1 inch (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**

The area covered to a wet thickness of 1 inch (25 mm) by 100 lb. (45.4 kg) of dry cement when mixed with the recommended amount of water and molded.

**Crevice Corrosion**

Localized corrosion of metal jacketing surface at, or immediately adjacent to, an area that is shielded from full exposure to the environment because of close proximity between the metal and the surface of another material.

**Crimping**

Corrugating of the metal edge to reduce diameter or facilitate bending. Used on fitting gores to mate with beaded edge of adjacent segment or on end caps for tanks and vessels.

**Cross Crimped**

Synonymous with  $\frac{3}{16}$  in. corrugated.

**Cryogenic Insulation**

Insulation for extremely low-temperature processes surfaces from –100 F to –459 F (absolute zero).

**Cupped Head Pin**

Capacitor discharge welded insulation fastener pin with a fixed washer.

**Cure**

To change the properties of a plastic or resin by chemical reaction, usually accomplished by the action of either heat or a catalyst.

**Damming**

The use of a substance to support firestopping materials until cured.

**Decibel (Db)**

A logarithmic measure of the ratio of like power quantities as used in describing levels of sound pressure or sound power.

**Decomposition**

The separating or breaking down of a substance into its component compounds or basic elements.

**Deep Corrugated**

Aluminum sheet formed to have alternating parallel grooves and ridges with a cross section approximating a sine wave.

**Delamination**

The separation of the layers of material in a laminate.

**Density, Apparent (of Applied Insulation)**

The mass per unit volume of in-place mass thermal insulation.

**Dew Point**

Saturation temperature where water vapor and liquid occur simultaneously.

**Dewpoint Temperature**

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.

**Diatomaceous Silica**

Insulation composed principally of diatomaceous earth with or without binders, and which usually contains reinforcing fibers.

**Diffusivity, Thermal**

The ratio of thermal conductivity of a substance to the product of its density and specific heat.

**Dimensional Stability**

That property of a material that enables it to maintain its original size, shape and dimensions.

**Dry**

To change the physical state of a substance by the loss of solvent constituents by evaporation, absorption, oxidation or a combination of these factors.

**Dual Temperature**

Systems of equipment that operate as cold condition and hot application.

**Duct**

A passageway made of sheet metal or other suitable material used for conveying air or other gas.

**Duct Flange (Stiffener)**

A structural or fabricated angle iron shape, attached to the exterior surfaces of a duct at specified intervals for the purpose of reinforcing the metal and assembly of the ducts.

**Efflorescence**

A white powdery substance occurring on the surface of coated insulation products caused by the migration of soluble salts from the insulation, followed by precipitation and carbonation.

**Elastomeric**

A closed-cell foam insulation containing elastomers that provide the property of high elasticity.

**Emissivity**

Emissivity is for pure materials that are perfectly smooth. The ratio of the radiant flux given off (emitted) by a surface to that given off (emitted) by a blackbody at the same temperature and under the same conditions.

**Emittance**

Emittance is for rough and contaminated surfaces (practical surfaces). The ratio of the radiant flux given off (emitted) by a surface to that given off (emitted) by a blackbody at the same temperature and under the same conditions.

**Emittance, Directional**

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**

The average directional emittance over a hemispherical envelope covering a surface.

**Emittance, Spectral**

An emittance based on the radiant energy emitted per unit wavelength interval (monochromatic radiant energy).

**Emittance, Total**

An emittance that is an integrated average over all wavelengths of radiant energy emitted.

**Emulsion**

Insoluble fine solids or liquids dispersed in another liquid, usually water.

**Epoxy Resins**

A two-part compound of an epoxy and catalyst that cures at ambient temperatures to form finishes which are highly resistant to solvents and chemicals. A high bond adhesive.

**Exhaust Duct**

A duct carrying air from a conditioned space to an outlet outside the building.

**Expanded Metal Lath**

See lath—expanded metal.

**Exposed Spaces**

Those spaces not referred to as concealed or as defined by the specifier.

**FDA Approval**

Compliance with the Food and Drug Administration's regulations for food handling operations.

**Facing**

A thin covering adhered to the surface of insulation prior to field installation.

**Fan**

A mechanical air-moving device.

**Fiber Glass**

See fibrous glass.

**Fibrous Glass**

A synthetic vitreous fiber insulation made by melting predominantly silica sand and other inorganic materials, and then physically forming the melt into fibers. To form an insulation product, there are often other materials applied to the mineral wool such as binders, oils, etc. Commonly referred to as either fiber glass or fiberglass.

**Fibrous Insulation**

Insulation composed of small diameter fibers that finely divide the air space. Fibers used are silica, rock wool, slag wool or alumina silica.

**Film (Wet)**

The applied layer of mastic or coating before curing or drying.

**Finish** (*as related to insulation metal jacketing*)

The texture of the metal surface.

**Finishes**

Jackets, mastics or strong films used for aesthetics or to protect insulation from at least one or more of the following: weather, mechanical, and/or personnel abuse.

**Finishing Cement**

A mixture of various insulating fibers, fillers and binders with water, with or without hydraulic cement, to form a smooth trowelable paste insulation for smooth application over insulating cement or unfinished block insulation.

**Fire Resistance**

The property of a material or assembly to withstand fire or give protection. It is characterized by the ability to confine a fire and to continue to perform a given structural function.

**Fire Retardance (FR)**

The property of a material that retards the spread of fire.

**Firestopping**

Furnishing and installing a material or a combination of materials to form an effective barrier against the spread of flame, smoke, gases and moisture. It is to maintain the integrity of the fire-rated construction.

**Fish-Mouth**

A gap between layers of sheet materials caused by warping or bunching of one or both layers.

**Fitting Cover**

The insulation for a pipe fitting composed of the specified thickness of insulation material, which may be preformed. Also, a preformed jacketing.

**Fittings**

Items used to change size, direction of flow, level or assembly of piping, except for unions, grooved couplings, flanges, valves or strainers.

**Fixture Connection**

Final piping connections to plumbing fixtures (usually exposed and chrome-plated).

**Flame Retardant**

The quality of a material to limit the flame spread across its surface.

**Flame Spread**

The index rate expressed in distance and time at which a material will propagate flame on its surface.

**Flange**

A projecting collar attached to a pipe for the purpose of connecting to another pipe, valve or fitting.

**Flange Cover**

The insulation for a pipe flange composed of the specified thickness of insulation material, may be preformed. Also, a preformed jacketing.

**Flash Point**

The temperature at which combustion is initiated.

**Flashing**

The arrangement of metal or other weather barrier

**Flexibility**

That property of a material that allows it to be bent (flexed) without loss of strength or integrity.

**Foamed Plastic**

Plastic expanded to a cellular form by thermal or chemical means.

**F-Rating**

A rating usually expressed in hours indicating a specific length of time that a fire resistive barrier can withstand fire before being consumed or permits the passage of flame through an opening in the assembly, as determined by ASTM E 814 (UL 1479).

**Freeze/Thaw Stability**

The property of a product that allows it to be subjected to temperatures below freezing and still be useable when returned to room temperature.

**Fresh Air**

Air taken from outdoors.

**Fresh Air Duct (Make-Up Air)**

A duct used to convey outdoor air to a point within the building, terminating at the mixing plenum, air handling unit or discharge grill.

**FSK**

Foil scrim Kraft. This is a laminate composed of a thin layer of aluminum foil, glass fiber reinforcing scrim, and Kraft paper.

**Fuel Contribution**

Combustible by-products from a substance generated or emitted in a burning environment.

**Galvanic Corrosion (Electrolysis)**

Effect of two dissimilar metals in the presence of an electrolyte to produce a weak voltaic cell causing depleting or pitting of the more soluble metal.

**Glass Cloth**

Closed-weave glass fiber used as a finish jacket.

**Glass Fabric**

Open-weave glass fiber used as a reinforcing membrane.

**Glass Fiber**

An inorganic fiber manufactured as continuous filament from molten glass or silica, normally used for reinforcement, tissue or textiles.

**Glass Scrim**

See glass fabric.

**Gore**

Jacketing for elbows, fittings, or other non-straight portions of the piping system made from a multitude of similar overlapping pieces.

**Granular Insulation**

Insulation composed of small nodules that contain voids or hollow spaces. The material may be calcium silicate, diatomaceous earth, expanded vermiculite, perlite, cellulose or microporous insulations.

**Graybody**

A body having the same spectral emittance at all wavelengths.

**Handicapped Fixtures**

Exposed fixture connections located in facilities for the handicapped. Waste and hot piping exposed connections in these areas are usually insulated for personnel protection.

**Hanger (Pipe)**

Devices used to support piping.

**Heat Flow, Heat Flow Rate**

The quantity of heat transferred to or from a system in unit time.

**Heat Flux**

The heat flow rate through a surface of unit area perpendicular to the direction of heat flow.

**Heat Flux Transducer (HFT)**

A device containing a thermopile (or equivalent) that produces an output that is a function of the heat flux.

**Heated Space**

Building area supplied directly with heat.

**Heel**

The outside of an elbow.

**Hertz (Hz)**

A measurement of sound frequency measured in cycles per second.

**High Pressure Condensate**

That condensate directly received from high-pressure steam lines.

**High Pressure Steam**

Steam at or above 75 pounds per square inch gauge pressure.

**High Rib Lath**

A metal lath with a built-in rib used to provide air space under insulation applications.

**High Velocity Duct**

A duct designed with air flow at more than 2,000 feet per minute velocity with a static pressure exceeding 6 inches.

**Homogeneous Material**

A material in which relevant properties are not a function of the position within the material.

**Horizontal Piping**

Any piping up to and including 45° from the horizontal plane.

**Housings (Built-Up)**

Assembled or fabricated at the construction site.

**Housings (Casings)**

Enclosures of sheet metal or other material to house fans, coils, filters or other components of air handling equipment.

**Hubs**

Caulking or cement connections between pipe joints.

**Humidity**

A measure of the amount of water vapor in the ambient air.

**Humidity, Absolute**

The ratio of the mass of water vapor to total volume of an air sample. The I-P units are pounds of moisture per pound of cubic foot of air and the SI units are grams or kilograms of moisture per cubic meter of air.

**Humidity, Ratio**

The ratio of the mass of water vapor to the mass of dry air in an air sample. The I-P units are either pounds of moisture per pound of dry air or grains of moisture per pound of dry air; the SI units are grams of moisture per gram of dry air.

**Humidity, Relative**

One of the following ratios (a) the mole fraction of water vapor in a given moist air sample to the mole fraction in the air sample saturated at the same temperature and pressure; (b) the vapor pressure in a given moist air sample to the vapor pressure in the air sample saturated at the same temperature and pressure and (c) the humidity ratio in a given moist air sample to the humidity ratio in the air sample saturated at the same temperature and pressure. There are no units.

**IARC**

International Agency for Research on Cancer

**ICBO**

International Council of Building Code Officials.

**ICC**

International Code Council.

**Impact Resistance**

Capability of an insulation material and/or finish to withstand mechanical or physical abuse.

**Impale**

To pierce or fix by piercing on a sharp point or pin.

**Insulate**

To cover with a material of low thermal conductivity in order to reduce the passage or leakage of heat.

**Insulating Cement**

A mixture of various insulating fibers and binders with water to form a moldable paste insulation for application to fittings, irregular surfaces or voids.

**Insulation**

Those materials or combination of materials that retard the flow of heat.

**Insulation Hanger**

A device such as a welded pin, stud or adhesive secured fastener that carries the weight of insulation.

**Intumescent**

A characteristic of certain firestop products that when exposed to heat, expand to seal and fill any void in the penetration. When exposed to fire, intumescent products will form a hard char.

**Jacket (as Related to Insulation Jacketing)**

A protective covering installed over thermal insulation.

**Joint**

The place where two adjacent pieces of material or jacketing meet. They may be overlapped, sealed, filled (pointed) or finished by the application of tape, cement, mastic, coatings, additional layer of insulation materials or other compounds.

**k-Value (Thermal Conductivity)**

See Conductivity, thermal.

**Lacing**

A method of joining or securing insulation materials, reinforcements, or finishes for insulation materials using eyelets, hooks, wire, cord, etc.

**Lag**

(v.) To apply lagging. (n.) A single piece of covering material.

**Lagging (as related to insulation jacketing) synonymous with jacketing**

*Discussion*—The three terms “jacketing”, “lagging”, and “cladding” are considered synonymous in most metal jacket related applications and geographies. However, in some cases in the power industry in North America the term “lagging” has a different meaning than “jacketing” or “cladding” and refers specifically to a heavier gauge of jacketing.

**Lagging Adhesive**

Water based resin emulsion products that are used to adhere lagging cloth to the insulation and to itself at the lap joints. They also seal and size the fabric and shrink it tightly to the surface. They can be brushed or sprayed.

**Lagging—Insulation**

Definition 1: A block material for insulating tanks and boilers, usually curved or tapered and can be made from any of several insulation materials.

Definition 2: Insulation used on pipe, tanks, ducts, vessels, or other mechanical equipment

Discussion - lagging-insulation is usually applied in the form of cut, pieced together or mitered parts.

**Lagging—Jacketing**

Jacketing installed over insulation. Also see “Jacket.”

**Laminate**

A product made by bonding together two or more layers of material or materials.

**Lap Adhesive**

The adhesive used to seal the butt joints and laps of insulation jackets.

**Lath—Expanded Metal**

A lattice type of material of various gauges and sizes, used to provide reinforcement for insulation materials. Also used as a facing for metal-mesh insulation.

**Lath—High Rib**

A metal lath with a built-in rib used to provide air space under insulation applications.

**Log Mean (Radius)**

The equivalent value of insulation thickness for pipe (curved surfaces) to produce the same resistance to heat flow as per flat areas.

**Loose-Fill Insulation**

Insulation in granular, nodular, fibrous, powdery or similar form designed to be installed by pouring, blowing or hand placement.

**Loose or Fill Insulation**

Insulation consisting of loose granules, fibers, beads, flakes, etc., which must be contained and are usually placed in cavities.

**Low-Pressure Condensate**

Condensate directly received from low-pressure steam.

**Low-Pressure Steam**

Steam at or below 15 pounds per square inch gauge.

**Low-Velocity Duct**

A duct designed with air flow at not more than 2,000 feet per minute velocity with static pressure not above 2 inches.

**Main**

Piping or ductwork from a source to the last branch connection or from the last branch connection returning to the source or to a termination point.

**Mastic**

A protective coating applied by spray or trowel to weatherproof or otherwise prevent deterioration of the insulation to which it is applied.

**Mat**

A piece of insulation of the semi-flexible type, composed of fibers of one or more kinds in which the fibers are in random arrangement, used to support another material.

**Mean Specific Heat**

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).

**Mean Temperature**

Sum of the cold surface temperature and the hot surface temperature divided by two. (Thermal conductivity charts are calculated to use mean temperatures).

**Mechanical Couplings**

Bolting devices used in assembly of piping.

**Medium Pressure Condensate**

Condensate directly received from medium-pressure steam.

**Medium Pressure Steam**

Steam under 75 pounds per square inch gauge, but above 15 pounds psig.

**Medium Velocity Duct**

A duct designed with airflow over 2000 feet per minute velocity with a static pressure below 6 inches.

**Membrane Reinforcement**

Woven or non-woven fabrics used for saturation and embedment in mastic and coating applications to provide strength, continuity and impact resistance. See glass fabric.

**Metal Lagging**

See jacket.

**Microporous Insulation**

Material in the form of compacted powder with an average interconnecting pore size comparable to or below the mean free path of air molecules at standard atmospheric temperature and pressure. Microporous insulation may contain fibers to add integral strength and opacifiers to reduce the amount of radiant heat transmitted.

**Mineral Fiber**

Insulation composed principally of fibers manufactured from rock, slag, or glass, with or without binders.

**Mineral Wool**

A synthetic vitreous fiber insulation made by melting predominantly igneous rock, and or furnace slag, and other inorganic materials, and then physically forming the melt into fibers. To form an insulation product, there are often other materials applied to the mineral wool such as binders, oils, etc.

**Mixed Air Duct (Plenum)**

A duct or plenum located at a point where air returned from a space inside the building, and fresh air are mixed or metered by dampers for redistribution through the air handling unit.

**Moisture Barrier (as related to Insulation Jacketing)**

A polymeric film or coating applied to the inner surface of metal jacketing for the primary purpose of reducing electrolytic, pitting, or crevice corrosion of the jacketing

Discussion – moisture barriers are not water vapor barriers or water vapor retarders

**Moisture Retarder (as related to Insulation Jacketing)**

A layer of plastic film or other material applied to the inner side of metal jacketing to inhibit jacket corrosion by interfering with the formation of a galvanic cell between the dissimilar metals of the pipe and jacket or by preventing crevice corrosion

*Discussion*—A moisture retarder is not an insulation system water vapor retarder and does not perform the same function.

**Mold and Mildew Resistance**

The property of a material that enables it to resist the formation of fungus growth.

**NFPA**

National Fire Protection Association.

**Noise Reduction Coefficient (NRC)**

A single number rating that is the arithmetic average of the individual sound absorption coefficients at 250, 500, 1000 and 2000 Hz to the nearest 0.05.

**Noncombustible**

A material that will not contribute fuel or heat to support a fire to which it is exposed.

**Nonflammable**

A material that will release very little heat when exposed to fire or flame.

**Octave Band**

A frequency band with an upper frequency limit equal to twice the lower limit.

**Offset**

A change in location or direction of a main, branch or runout. It may be located in a riser or horizontal run of piping or duct.

**One-coat Cement**

A mixture of various insulation fibers, fillers and binders with hydraulic-setting cement. The material can be applied directly to fittings to match adjacent insulation thickness in one application and smoothed to provide a hard finish.

**Open Cell Foam**

A material comprised predominantly of interconnecting cellular voids.

**Panel**

A prefabricated unit of insulation and lagging.

**Patching**

Repair or restoration of damaged existing insulation. See Reinsulate.

**Perlite**

Insulation composed of natural perlite ore expanded to form a cellular structure.

**Perm**

The unit measure of vapor transmission consisting of one grain of water through one square foot of a membrane in an hour at 1-inch mercury vapor pressure difference.

**Personnel Protection**

Insulation installed for the purpose of protecting personnel from hot surfaces.

**pH**

A measure of the acidity or alkalinity of a solution, numerically equal to 7 for neutral solutions, increasing with increasing alkalinity and decreasing with increasing acidity (potential of hydrogen).

**Phenolic Foam**

A foamed insulation made from resins of phenols condensed with aldehydes.

**Pin Weld**

Attachment of insulation anchor pins to ductwork or equipment usually by capacitor discharge welding.

**Pinhole**

Very small hole through a mastic or coating.

**Pipe**

A circular conduit for the conveyance of liquids or semisolids.

**Pipe Insulation**

Insulation in a form suitable for application to cylindrical surfaces.

**Plenums**

A compartment or chamber to which one or more ducts are connected, that forms a part of the air distribution system, and that is not used for occupancy or storage. A plenum is often formed in part or in total by portions of the building.

**Pointing**

Applying or shaping cements or mastic with a small pointed trowel.

**Polyfilm**

A multilayer film used as a moisture retarder on metal jacketing consisting of at least one layer of ethylene/methacrylic acid copolymer and one or more layers of other polymers, usually polyethylene.

**Polyethylene**

A closed-cell, thermoplastic material used for insulation.

**Polyimide**

See cellular polyimide.

**Polyisocyanate**

A closed-cell, thermoset, plastic foam formed by combining isocyanurate, polyol, surfactants, catalysts and blowing agents.

**polykraft**

A multilayer composite film used as a moisture retarder on metal jacketing consisting of at least one layer of minimum 40 lb kraft paper and one or more layers of plastic film, usually polyethylene at a minimum thickness of 1.5 mils.

**Polymer**

A long chain molecule resulting from the chemical attachment of short molecules (monomers) of the same product. For example, when ethylene (a gas) is polymerized, the synthetic resin polyethylene is produced.

**Polyolefin**

A closed-cell thermoplastic material used for insulation, typically polyethylene.

**Polyvinyl Chloride (PVC)**

A polymerized vinyl compound using chloride.

**Polyvinyl Fluoride (PVF)**

A polymerized vinyl compound using fluoride.

**Pressure Sensitive Tape**

A tape with adhesive pre-applied.

**Pumped Condensate (Discharge)**

Condensate in liquid state from condensate receivers to feed water heaters, deaerators or boilers.

**Puncture Resistance**

That property of a material that enables it to resist punctures or perforations under blows or pressure from sharp objects.

**Punking**

An exothermic reaction that occurs inside insulation material, on a hot surface, and usually is the result of the combustion of gasses resulting from chemically decomposed binder or resin.

**R-Value (Resistance)**

See Resistance, thermal.

**Radiance**

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).

**Radiant Flux Density**

The rate of radiant energy emitted from unit area of a surface in all radial directions of the overspreading hemisphere.

**Radiation**

The passage of heat from one object to another without warming the space between.

**Reflectance**

The fraction of the incident radiation upon a surface that is reflected from the surface.

**Reflective Insulation**

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.

**Refractory Insulation**

Insulation for extremely high temperatures, applications usually above 1500°F.

**Refractory Materials**

Materials, usually fibers, that do not significantly deform or change chemically at very high temperatures. Manufactured in blanket, block, brick or cement form.

**Reinforcing Cloth or Fabric**

A woven cloth or fabric of glass or resilient fibers used as reinforcement to a mastic.

**Reinsulate**

To repair insulation to its former condition. (If insulation is to be removed and replaced, it should be so stated.)

### **Relative Humidity**

One of the following ratios (a) the mole fraction of water vapor in a given moist air sample to the mole fraction in the air sample saturated at the same temperature and pressure; (b) the vapor pressure in a given moist air sample to the vapor pressure in the air sample saturated at the same temperature and pressure and (c) the humidity ratio in a given moist air sample to the humidity ratio in the air sample saturated at the same temperature and pressure. There are no units.

### **Removable and Reusable Covers**

Insulation materials or pads, enclosed in a fabric or metal (mesh, or sheet), designed to be readily removed and reinstalled.

### **Resiliency**

The property of a material that enables it to recover its original shape and thickness after compression.

### **Resistance to Acids, Caustics, and Solvents**

The ability of a material to resist decomposition by various acids, caustics and solvents to which it may be subjected.

### **Resistance to Air Erosion**

The ability of an insulation material to resist erosion by air currents over its surface.

### **Resistance, Abrasion**

The ability to withstand scuffing, scratching, rubbing or wind-scouring.

### **Resistance, Freeze-Thaw**

Resistance to cycles of freezing and thawing that could affect application, appearance or performance.

### **Resistance, Impact (Toughness)**

Ability to withstand mechanical blows or shock without damage seriously affecting the effectiveness of the material or system.

### **Resistance, Thermal, (R-value)**

A measure of the ability to retard heat flow rather than the ability to transmit heat. R-value is the numerical reciprocal of “U” or “C,” thus  $R = 1/U$  or  $1/C$ . Thermal resistance R-value is used in combination with numerals to designate thermal resistance values: R-11 equals 11 resistance units. The higher the “R,” the higher the insulating value. The I-P units are  $^{\circ}\text{F} - \text{ft}^2 - \text{hr} / \text{Btu}$ ; the SI units are  $^{\circ}\text{C} - \text{m}^2 / \text{W}$ .

### **Resistivity, Thermal, r**

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:  $\text{m K/W}$ .) (r in inch-pound units:  $\text{h ft F/Btu}$  or,  $\text{h ft}^2 \text{ F/Btu in.}$ )

**Retrofit**

The application of additional insulation over existing insulation, new insulation after old insulation has been removed, or new insulation over existing, previously uninsulated surfaces.

**Return Air**

Air returned from conditioned spaces to an air-handling unit.

**Return Air Duct**

A duct carrying air from a conditioned space to the mixing air duct or plenum unit.

**Rigid Wrap-around Insulation**

Segments of insulation material that have been adhered to a facing giving rigid insulation materials flexibility of application.

**Rigidity**

The property of a material that opposes any tendency for it to bend (flex) under load.

**Riser**

The vertical portion of a main, branch or runout.

**Rock Wool (Mineral Wool)**

A synthetic vitreous fiber insulation made by melting predominantly igneous rock and other inorganic materials, and then physically forming the melt into fibers.

See Mineral Wool.

**Run-Out**

Piping or duct work from or to a branch or main serving one: a) plumbing unit or fixture connection. b) heating and/or cooling unit, coil, convactor, unit heater, fin tube, equipment connection, etc. c) HVAC diffuser or register or d) process equipment connection.

**Saddle**

Rigid support for piping or equipment with allowance for insulation.

**Sample**

A group of items, observations, test results, or portions of material, taken from a large collection of items, observations, test results, or quantities of material, which serves to provide information that may be used as a basis for making a decision concerning the larger collection.

**Safety Edge**

A n edge of metal jacketing that has been de-burred or rounded by a rolling operation

**Safety Hem**

A rounded edge of metal jacketing created by folding the edge of sheet jacketing completely back upon itself using a roll former or a brake

*Discussion*– The fold is made toward the underside of the jacketing so that the original edge is hidden and the external appearance of the jacketing is preserved

### **SBCCI**

Southern Building Code Congress, International.

### **S-Clip**

A device (in the shape of an “S”) for supporting insulation, bands or jacketing.

### **Scrim**

A woven, nonwoven or knitted fabric composed of continuous strands of material used for reinforcing or strengthening materials like ASJ or FSK insulation facers.

### **Score**

To cut grooves in rigid insulation so that it may be cracked and fitted to round or irregular surfaces.

### **Seal**

To make water-tight or airtight.

### **Sealant**

Sealants in insulation function primarily as water and vapor seals. They may also be used as adhesives, and for expansion joints for metal, masonry, cellular glass, etc. They must exhibit low shrinkage, excellent adhesion and permanent flexibility.

### **Sealer**

A liquid coating used to prevent excessive absorption of finish coats into porous surfaces.

### **Securements**

Any device, wire, strap or adhesive used to fasten insulation into its service position and hold it there.

### **Self-Extinguishing**

The property of a material that enables it to stop its own ignition after external ignition sources are removed.

### **Service Temperature Limits**

The temperature to which the jacket or coating may be subjected when applied over insulation. It does not refer to the operating temperature of the equipment, vessel or pipe.

### **Shear Strength**

The ability of a material to resist cleavage.

**Shelf Life**

The period of time during which a material, especially packaged adhesive, coating or sealant, can be stored under specified temperature conditions and remain suitable for use.

**Shield**

Metal protector to prevent crushing of insulation at pipe hangars.

**Shrinkage**

That property of a material that indicates its proportionate loss in dimensions or volume due to temperature changes or aging.

**Slag Wool**

A mineral wool made usually from molten blast-furnace slag by the action of jets of steam under high pressure.

**Smoke Density**

The amount of smoke given off by the burning material compared to the amount of smoke given off by the burning of a standard material.

**Soaking Heat**

A test condition in which the specimen is completely immersed in an atmosphere maintained at a controlled temperature.

**Solar Resistance**

The property of a material to resist decomposition by the ultraviolet rays from the sun or the passage of radiant heat from the sun.

**Solids Content**

The percentage of the non-volatile matter in adhesives, coatings or sealants. It may be based on weight or volume.

**Solvent**

Any substance, usually a liquid, that dissolves another substance.

**Sorption**

Sorption refers to the process in which one substance takes up or holds another (by either absorption or adsorption)

**Sound Absorption Coefficient (SAC)**

The percentage of sound energy incident on the surface of a material that is absorbed by the material.

**Sound Transmission Class (STC)**

A single number rating based on sound transmission loss measurements of a partition between adjacent closed rooms.

**Sound Transmission Loss (STL)**

The reduction in level measured in decibels as sound energy passes through a material or composite construction.

**Specific Heat**

The ratio of the amount of heat required to raise a unit mass of a material 1 degree, to that required to raise a unit mass of water 1 degree at some specified temperature.

**splice roll**

Metal jacketing sold in roll form where the package contains two separate pieces of metal jacketing rolled approximately end to end.

*Discussion*—A splice roll occurs when the metal coil being used to form the roll jacketing reaches its end before the required roll length is obtained.

**split roll**

Synonymous with splice roll.

**Sprayed-on Insulation**

Insulation of the fibrous or foam type that is applied to a surface by means of power spray devices.

**SSL**

Self-sealing lap, as in the overlap on pipe insulation jacket.

**Standing Seam**

Folded configuration of jacketing to achieve watershed for the top flat surfaces of ductwork, vessels, or tanks. Also used to provide rigidity.

**Steady State (Thermal)**

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.

**Stiffener (Duct Flange)**

A structural or fabricated angle iron shape, attached to the exterior surfaces of a duct or bulkhead at specified intervals for the purpose of reinforcing the metal and to prevent vibration.

**Stone Wool**

See Rock Wool.

**Strainer**

A filter or sieve used in fluid piping to trap scale and other entrained particles.

**Strength, Transverse (or Flexural)**

The breaking load applied normal to the neutral axis of a beam.

**Stud**

Used to hold heavy insulation and/or panels in place. Applied with arc welder, studs differ from pins in that they are generally 1/4-inch or greater in diameter.

**Stud Weld**

Attachment of insulation anchors to tanks or vessels by means of drawn arc welding.

**Supply Air Duct**

A duct that carries conditioned air from air supply units to room diffusers or grilles.

**Support (Insulation)**

A mechanical device that carries the weight of insulation.

**Surface Coefficient**

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 surrounding (air or other fluid and other visible surfaces) to the temperature difference between the surface and its surroundings.

(See conductance, film).

**Surface Temperature (TA)**

The surface temperature of finished insulation.

**Tack**

The property of an adhesive that enables it to form a measurable bond immediately after adhesive and adherent are brought into contact under low pressure.

**Tear Strength**

The property of a material that enables it to resist being pulled apart by opposing forces.

**Temperature Limits**

The upper and lower temperatures at which a material will experience no change in its physical properties.

**Test Specimen**

The portion of a test unit needed to obtain a single test determination.

**Thermal Conductivity (k-Value)**

See Conductivity, thermal (k-value)

### **Thermal Capacity**

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.)

### **Thermal Insulation**

Definition One: Insulation applicable within the general temperature range of –300 F to 1800 F.

Definition Two: A material or assembly of materials used to provide resistance to heat flow.

### **Thermal Insulation System**

Applied or installed thermal insulation complete with any accessories, vapor retarder, and facing required.

### **Thermal Properties of Insulation**

Usually expressed as C-value, K-value, R-value and U-value.

### **Throat**

Inside radius of an elbow.

### **Traced**

The supplying of auxiliary heat to a pipe or piece of equipment by means of a companion line containing a hot fluid or electric resistance. It can be thermally or mechanically bonded to the pipe or equipment.

### **Transference, Thermal**

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**

The quantity of heat flowing through unit area due to all modes of heat transfer induced by the prevailing conditions.

### **Transmittance, Thermal (U-value)**

The combined thermal value of all the materials in a insulation system, air spaces, and surface air films. The heat transmission in unit time through unit area of a material or construction and boundary air films, induced by unit temperature difference between the environments on each side. The I-P units are Btu / (hr – sq ft – deg F temperature difference) and the SI units are W / (sq m – deg C temperature difference). Note: This heat transmission rate has been called the overall coefficient of heat transfer.

**T-Rating**

A rating usually expressed in hours indicating the length of time that the temperature on the non-fire side of a fire-rated assembly exceeds 325°F above its ambient temperature as determined by ASTM E-814 (UL-1479).

**Tube Turn (Bend)**

Pipe, factory or field formed, to pre-determined radii.

**UL**

Underwriters Laboratories. An independent materials testing company. UL provides testing, evaluation, and listing services for products having specific safety-related features. UL test standards generally are similar to ASTM International standards when both exist.

**Underground**

Insulation applied on piping and equipment located below grade and in direct contact with the surrounding soil.

**Union**

A coupling device for connecting pipes.

**Urethane**

Plastic foam of rigid polyurethane closed-cell insulation in board, pipe insulation or foamed-in-place form.

**U-Value (Transmittance)**

See Transmittance, Thermal (U-value)

**Valve**

Any of various devices that regulate liquid or gas flow by opening, closing or obstructing its passage.

**Ventilating Air**

Air supplied to or removed from any space by natural or mechanical means.

**Ventilating Duct**

Duct supplying or removing air by natural or mechanical means.

**Vermiculite**

Insulation composed of natural vermiculite ore expanded to form an exfoliated structure.

**Vertical Piping**

Any piping that is less than 45° from the vertical plane.

**Vibration Resistance**

The property of a material that indicates its ability to resist mechanical vibration without wearing away, setting or dusting.

**Vinyl**

The name of a class of resins or sheeting.

**Warpage**

The change in the flatness of a material caused by differences in the temperature and/or humidities applied to opposite surfaces of the material.

**Washer (Insulation Clip)**

Self-locking flat metal device applied to anchor pins to secure the insulation in place.

**Water Absorption**

The increase in weight of a material expressed as a percentage of its dry weight or volume after immersion in water for a specified time.

**Water Resistant**

Capable of withstanding limited exposure to water.

**Water Vapor Diffusion**

The process by which water vapor spreads or moves through permeable materials caused by a difference in water vapor pressure.

**Water Vapor Permeability**

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. Water vapor permeability is measured in the IP system in perm inches.

**Water Vapor Permeance**

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. Water vapor permeance is measured in IP system in units of perm.

**Water Vapor Pressure**

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**

The steady state 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.

**Water Vapor Resistivity**

The steady state 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.

**Water Vapor Retarder (Barrier)**

A material or system that significantly impedes the transmission of water vapor under specified conditions.

**Water Vapor Retarder Jacket**

Any material or composite meeting the requirements of a water vapor retarder and used for the jacketing of insulation material. It may be factory furnished or field applied and may or may not be adhered to the insulation material.

**Water Vapor Transmission Rate (WVTR)**

The steady state 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. The I-P units are lbs / hr – ft<sup>2</sup>; the SI units are grams / hr – m<sup>2</sup>.

**Waterproof**

Impervious to prolonged exposure to water or water entry.

**Weather/Vapor-Retarder (barrier)**

A vapor retarder that also protects from atmospheric conditions.

**Weather Barrier**

A breather jacket or coating which allows passage of water vapor yet protects from atmospheric conditions.

**Weld Pin**

Made of carbon steel, stainless steel or aluminum in various lengths for attaching insulation to metal surfaces. Applied by welding, usually with a weld gun.

**Wetting and Adhesion, Surface**

The mutual affinity of and bonding between finish and the surface to which it is applied.

**Wicking**

Action of absorbing by capillary action.

**Wood Fiber**

Insulation composed of wood/cellulosic fibers, with or without binders.

THIS REVISION AND CORRECTIONS DATED: **August 7, 2015**

**2015 REVISION**

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