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# AEROSPACE INFORMATION REPORT

**SAE** AIR4844

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Submitted for recognition as an American National Standard

## COMPOSITES AND METAL BONDING GLOSSARY

### 1. SCOPE:

The following terminology has been generated by the ATA/IATA/SAE Commercial Aircraft Composite Repair Committee (CACRC) and provides terminology for design, fabrication, and repair of composite and bonded metal structures.

#### 1.1 Purpose:

The purpose of this AIR is to provide terminology that should be used when developing CACRC repair documents or repair documents produced by airlines or airframe and engine manufacturers. It is intended to develop this AIR into an AS.

### 2. REFERENCES:

- 2.1 Engineering Materials Handbook, Engineering Plastics, Volumes 1 & 2.
- 2.2 Producibility Guidelines for Thermoplastic Composites, Lockheed Aeronautical Systems Company, Volume 1, Steve E. Watkins.
- 2.3 Composite and Bonding Glossary. Boeing Commercial Airplane Group.
- 2.4 Advanced Composite Materials Glossary of Terms. Boeing Company - Customer Training and Flight Operations Support.
- 2.5 Douglas Glossary.
- 2.6 Structural Adhesives - Chemistry and Technology. Edited by S. R. Hartshorn. Plenum Press, 1986, ISBN 0 - 306 - 42121 - 6.
- 2.7 Handbook of Adhesive Bonding. Charles V. Cagle, Henry Lee and Kris Neville. Consulting Editors. Published by McGraw-Hill 1973.

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- 2.8 ASM Engineered Materials Handbook, Vol. 3, Adhesives and Sealants.
- 2.9 ASTM D 907.
- 2.10 ISO 472.
- 2.11 MIL-HDBK-17.
- 2.12 Boeing Drafting Standard BDS 1330.
- 2.13 "Composite Airframe Structures," ISBN 962-7128-06-6, Michael C. Y. Niu, Published Conmilit Press Ltd., P.O. Box 38251, Hing Fat Street Post Office, Hong Kong.
- 2.14 Composites Glossary from Great Lakes Composites Consortium.
- 2.15 Handbook of Adhesion, Edited D. E. Packham, Published Longman Scientific and Technical, Polymer Science and Technology Series, 1992. ISBN 0-470-21870-3.
- 2.16 ASTM C 274.

## 3. COMPOSITES GLOSSARY:

This is a modified version of a glossary originally produced by Scott W. Horstman - Composites Development Center, Lockheed Aeronautical Systems Company. Considerable modifications have been made together with switching from American to English terminology. See References.

## 3.1 A:

**A-BASIS:** The "A" mechanical property value is the value above which at least 99% of the population of values is expected to fall, with a confidence of 95%. Also called A-allowable. See also B-basis, S-basis, and typical basis.

**A-SCAN:** A scope presentation in which time or distance is related to amplitude. A nondestructive inspection technique for finding voids, delaminations, and defects in laminates.

**A-STAGE:** The initial state of the resin as produced by the manufacturer. An early stage in the polymerization reaction of certain thermosetting resins (especially phenolics) in which the material is still linear in structure, soluble in some liquids and fusible. The A-stage is usually considered to be a point where little or no reaction has occurred. Prepreg in an A-stage condition would be extremely sticky, lumpy and have little integrity. Also called resole. See also B-stage and C-stage. See ASTM D 907 and ISO 472.

**ABHESIVE:** A material that resists adhesion. A film or coating applied to surfaces to prevent sticking, heat sealing, etc., for example a parting agent or mold release agent.

**ABL BOTTLE:** An internal pressure test vessel about 460 mm (18 in) in diameter and 610 mm (24 in) long used to determine the quality and properties of the filament-wound material in the vessel.

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## 3.1 (Continued):

**ABLATION:** The degradation, decomposition, and erosion of a material caused by high temperature, pressure, time, percent oxidizing species, and velocity of gas flow. A controlled loss of material to protect the underlying structure.

**ABLATIVE PLASTIC:** A material that absorbs heat (with low material loss and char rate) through a decomposition process (pyrolysis) that takes place at or near the surface exposed to the heat. This mechanism essentially provides thermal protection (insulation) of the subsurface materials and components by sacrificing the surface layer. Ablation is an exothermic process.

**ABRASION:** The wearing away of a portion of the surface by either natural (rain, wind, etc.), mechanical (misfit, etc.), or man-made (oversanding, etc.) means; penetrates only the surface finish. In a composite, does not damage the first ply.

**ABRASIVES:** Special hard mineral ingredients employed to impart abrasive power to rubber articles used for abrading, grinding, or polishing such as rubber erasers or hard or soft rubber grinding wheels. Also used with paper or fabric backings and as abrasive discs or flapper wheels. Pumice, Silica, Tripoli sand, Carborundum, Silicon Carbide, Cerium Oxide and Diamond powder may be used as abrasives. The surface finish in microinches can be related directly to the grit size of the abrasive.

**ABS:** Acrylonitrile-butadiene-styrene

**ABSOLUTE HUMIDITY:** Absolute humidity is the weight of water vapor present in a unit volume of air, such as grams per cubic foot or grams per cubic meter. The amount of water vapor is also reported in terms of weight per unit weight of dry air, such as grams per pound of dry air, but this value differs from values calculated on a volume basis and should not be referred to as absolute humidity. It is designated as humidity ratio, specific humidity, or moisture content.

**ABSOLUTE VISCOSITY:** Of a fluid adhesive, the tangential force on unit area of either of two parallel plates at unit distance apart when the space between the plates is filled with the fluid in question and one of the plates moves with unit differential velocity in its own plane. The unit of measurement is the centipoise.

**ABSORBATE:** A material which is absorbed by another.

**ABSORBENT:** A material that takes in, or absorbs another.

**ABSORPTION:** (i) The penetration into the mass of one substance by another. (ii) The process whereby energy is dissipated within a specimen placed in a field of radiant energy. (iii) The capillary or cellular attraction of adherent surfaces to draw off the liquid adhesive film into the substrate. (iv) A process in which one material (the absorbent) takes in or absorbs another (the adsorbate). See MIL-HDBK-17.

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## 3.1 (Continued):

**ACCELERATED TEST:** A test procedure in which conditions are increased in magnitude to reduce the time required to obtain a result. To reproduce in a short time the deteriorating effect obtained under normal service conditions.

**ACCELERATOR:** A material that, when mixed with a catalyst or a resin, will speed up the chemical reaction between the catalyst and the resin either in polymerizing of resins or vulcanization of rubbers. Also called promoter. See ISO 472.

**ACCEPTANCE TEST:** A test or series of tests, called out in a material specification, conducted by the supplier, procuring agency, or an agent thereof, to determine whether an individual lot of material conforms to the purchase order or contract or to determine the degree of uniformity of the material supplied by the vendor or both.

**NOTE:** Specifications usually state sampling techniques, test procedures, and minimum requirements for acceptance. See ASTM D 907.

**ACCURACY:** The degree of conformity of a measured or calculated value to some recognized standard or specified value. Accuracy involves the systematic error of an operation. (MIL-HDBK-17).

**ACETONE:** Commonly used wipe solvent. Also known as 2-propanone and Dimethylketone. Used for cleaning composite surfaces prior to bonding and also metal surfaces prior to other treatments. Can also be used to remove uncured epoxy resin from tools and other items. Classed as "Seriously Flammable" with a flash point of  $-4^{\circ}\text{F}$  ( $-20^{\circ}\text{C}$ ). Has a high evaporation rate. May be procured to U.S. Federal Specification O-A-51H or ASTM D 329.

**ACID:** A chemical compound containing one or more hydrogen atoms available for reaction with active metals or alkaline solutions.

**ACOUSTIC EMISSION:** A measure of integrity of a material, as determined by sound emission when a material is stressed. Ideally, emissions can be correlated with defects and/or incipient failure.

**ACRYLIC PLASTIC:** Any of a family of synthetic resins made by the polymerization of esters of acrylic acid and its derivatives. See also polymethyl methacrylate. See ISO 472.

**ACTIVATION:** The (usually) chemical process of making a surface more receptive to bonding to a coating or an encapsulating material.

**ACTIVATOR:** An additive used to promote the curing of matrix resins and reduce curing time. See accelerator. See ISO 472.

**ADDITION POLYMERIZATION.** A chemical reaction in which simple molecules (monomers) are added to each other to form long-chain molecules (polymers) without forming by-products. The small molecules, monomers, add together to form the polymer molecule. The polymer is usually linear.

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## 3.1 (Continued):

**ADDITIVE:** Any substance added to another substance, usually to improve properties, such as plasticizers, initiators, light stabilizers, and flame retardants. See also filler.

**ADHERE:** To cause two surfaces to be held together by adhesion.

**ADHEREND:** See adherent.

**ADHERENT:** A body that is held to another body, usually by an adhesive. A detail or part prepared for bonding.

**ADHESION:** The state in which two surfaces are held together at an interface by mechanical or chemical forces or interlocking action or both.

**ADHESION, MECHANICAL:** Adhesion due to the physical interlocking of the adhesive with the substrate irregularities.

**ADHESION PROMOTER:** A coating applied to a substrate before it is coated with an adhesive, to improve the adhesion of the adhesive. Also called primer. A primer may and should improve the durability of a joint in the long-term but does not always increase joint strength.

**ADHESION, SPECIFIC:** Adhesion due to valence forces at the adhesive-substrate surface interface. Such valence forces are of the same type that give rise to cohesion.

**ADHESIVE:** A substance capable of holding two materials together by surface attachment. Adhesive can be in film, liquid, or paste form. In this context, the term is used to denote structural adhesives, i.e., those which create attachments capable of transmitting significant structural loads.

**ADHESIVE AGE:** The age of the material from the date of shipment by the manufacturer to the present date.

**ADHESIVE BATCH:** One production mixture of adhesive by a manufacturer with the batch number assigned by the manufacturer.

**ADHESIVE BONDING:** A materials joining process in which an adhesive, placed between facing surfaces, solidifies to bond the surfaces together.

**ADHESIVE FAILURE:** Rupture of an adhesive bond such that the separation appears to be at the adhesive-adherent interface.

**ADHESIVE FILM:** A synthetic resin adhesive, with or without a carrier fabric, usually of the thermosetting type, in the form of a thin film of resin, used under heat and pressure in the production of bonded structures. A convenient form of adhesive for production because it is easy to handle and already mixed. Requires refrigerated storage.

**ADHESIVE FLASH:** The cured adhesive squeezed out around the edges of doublers, at butt splices and at the ends of the assembly.

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## 3.1 (Continued):

**ADHESIVE, INTERMEDIATE TEMPERATURE SETTING:** See intermediate temperature setting adhesive.

**ADHESIVE JOINT:** The location at which two adherents or substrates are held together with a layer of adhesive. The general area of contact for a bonded structure.

**ADHESIVE LOT:** One batch of adhesive or a portion of one batch, submitted for acceptance at one time. The adhesive lot number is assigned by the manufacturer.

**ADHESIVE, SUPPORTED:** An adhesive film which has a woven or nonwoven carrier cloth.

**ADHESIVE SYSTEM:** A compatible primer and film adhesive for system bonding metal-to-metal assemblies and a primer, pourcoat and film adhesive for bonding sandwich assemblies.

**ADHESIVE, UNSUPPORTED:** A film adhesive which has no carrier cloth.

**ADK:** Notation used for the k-sample Anderson-Darling statistic, which is used to test the hypothesis that k batches have the same distribution. See MIL-HDBK-17.

**ADMIXTURE:** The addition and homogeneous dispersion of discrete components, before cure.

**ADSORPTION:** The adhesion of the molecules of gases, dissolved substances, or liquids in more or less concentrated form, to the surfaces of solids or liquids with which they are in contact. A concentration of a substance at a surface or interface of another substance.

**ADVANCED COMPOSITES:** Composite materials applicable to aerospace or other high-performance component construction and made by imbedding high-strength and/or high modulus fibers within an essentially homogeneous matrix. See filamentary composites.

**ADVANCED FILAMENTS:** Continuous filaments made from high-strength, high-modulus materials for use as constituents of advanced composites.

**AFRP (OR ARP):** Aramid Fiber Reinforced Plastic

**AFTERBAKE:** See postcure.

**AGGLOMERATION:** The act or condition whereby minute particles dispersed in a liquid or viscous medium become united into larger groups.

**AGGREGATE:** A hard, coarse material usually of mineral origin used with an epoxy binder (or other resin) in plastic tools. Also used in flooring or as a surface medium.

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## 3.1 (Continued):

**AGEING:** The effect on materials of exposure to an environment for an interval of time. The process of exposing materials to an environment for an interval of time. See ISO 472.

**AIR-BUBBLE VOID:** Air entrapment within and between the plies of reinforcement or within a bondline or encapsulated area: localized, non interconnected, spherical in shape.

**AIR DRYING:** A material is said to be air drying when it can be dried at ordinary room temperature without the use of artificial heat.

**AIR LOCKS:** Surface depressions on a molded part, caused by trapped air between the mold surface and the plastic.

**AIR VENT:** Small outlet to prevent entrapment of gases in a molding or tooling fixture.

**ALCOHOL:** A hydrocarbon derivative in which one or more hydroxyl (OH) groups have replaced a corresponding number of hydrogen atoms. Some are produced by fermentation and others synthetically. Ethyl grain is the best known and is described as "alcohol". Commercial alcohol generally contains a de-naturant to render it unfit for human consumption and exempt from taxation. This solvent group is relatively expensive and is usually considered to be among the more harmless industrial solvents.

**ALDEHYDE:** (i) Acetaldehyde  $\text{CH}_3\text{-CHO}$  reacts with aniline to give an accelerator. One of the first known antioxidants. (ii) Aldehydes are volatile liquids with sharp, penetrating odors that are slightly less soluble in water than are corresponding alcohols. (iii) A broad class of organic compounds having the generic formula  $\text{RCHO}$  and characterized by an unsaturated carbonyl group ( $\text{C=O}$ ). They are formed from alcohols by either dehydrogenation or oxidation, and thus occupy an intermediate position between primary alcohols and the acids obtained from them by further oxidation.

**ALIPHATIC:** Organic compounds (hydrocarbons) in which carbon atoms are arranged in an open or straight chain. More commonly known as naphthas, they are prepared by straight-run, overhead distillation of petroleum. Familiar examples include gasoline, kerosene, paraffin, and natural gas. Of the common solvents, they are the lowest in price and the least toxic.

**ALIQOT:** A small, representative portion of a larger sample. See MIL-HDBK-17.

**ALKALI:** Substance that neutralizes acids to form a salt and water. Yields hydroxyl ( $\text{OH}^-$ ) ions in water solution. Proton acceptor. Turns Litmus paper blue.

**ALKALINITY:** The condition of having or containing hydroxyl ( $\text{OH}^-$ ) ions. Containing alkaline substances. The opposite of acidic. The property of turning red litmus paper blue and of neutralizing acids to form salts.

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## 3.1 (Continued):

**ALKYD PLASTIC:** Thermoset plastic based on resins composed principally of polymeric esters, in which the recurring ester groups are an integral part of the main polymer chain, and in which ester groups occur in most cross-links that may be present between chains.

**ALLOTROPY:** The existence of a substance and especially an element in two or more forms (as in crystals). See also graphite.

**ALLOY:** In plastics, a blend of polymers or copolymers with other polymers or elastomers under selected conditions: for example, styrene-acrylonitrile. Also called polymer blend. In metals, a substance having metallic properties and being composed of two or more chemical elements of which at least one is a metal.

**ALLYL PLASTIC:** A thermoset plastic based on resins made by addition polymerization of monomers containing allyl groups: for example, diallyl phthalate (DAP).

**ALTERNATING STRESS:** (i) A stress varying between two maximum values which are equal but with opposite signs, according to a law determined in terms of time. (ii) This term is sometimes used to define changes between stresses of different levels, i.e., not necessarily equal levels. It can also be used for stresses alternating between two levels of tension only or two levels of compression only.

**ALTERNATING STRESS AMPLITUDE:** A test parameter of a dynamic fatigue test: one-half the algebraic difference between the maximum and minimum stress in one cycle.

**AMBIENT:** The surrounding environmental conditions, such as pressure, temperature, or relative humidity.

**AMINE RESIN:** A synthetic resin derived from the reaction of urea, thiourea, melamine or allied compounds with aldehydes, particularly formaldehyde. (See amino.)

**AMINO:** Indicates the presence of an  $\text{NH}_2$  or  $\text{NH}$  group.

**AMINO PLASTICS:** Plastics based on resins made by the condensations of amines, such as urea and melamine, with aldehydes. (See amine resin.)

**AMINO-SILANE FINISH:** Applied to glass fibers to give a good bond to epoxide, phenolic and melamine resins. Must be used in glass-fiber for use with wet lay-up phenolic resins.

**AMM:** Aircraft Maintenance Manual. Provided by aircraft manufacturers.

**AMORPHOUS PLASTIC (AMORPHOUS PHASE):** A plastic that has no crystalline component. There is no order or pattern to the distribution of the molecules.

## SAE AIR4844

## 3.1 (Continued):

**AMPHOTERIC:** Having the property of behaving as an acid or a base according to the condition of the reaction. Zinc hydroxide is a well known example. It dissolves in alkalis as well as in acids. Albumen is an example of an amphoteric organic colloid.

**ANAEROBIC ADHESIVE:** An adhesive that cures only in the absence of air after being confined between assembled parts (absence of oxygen).

**ANELASTICITY:** A characteristic exhibited by certain materials in which strain is a function of both stress and time, such that while no permanent deformations are involved, a finite time is required to establish equilibrium between stress and strain in both the loading and unloading directions.

**ANGLE-PLY LAMINATE:** (i) A laminate having fibers of adjacent plies oriented at alternating angles. Any filamentary laminate which is not uniaxial. (ii) A laminate built from orthotropic plies that is symmetrical with respect to the laminate mid-plane and the ply orientations of adjacent plies are alternating. Such laminates have a special stress/strain behavior.

**ANGLE WRAP:** Tape fabric wrapped on a starter dam mandrel at an angle to the centerline.

**ANGSTROM UNIT:** The unit used to define the short wavelengths of the electromagnetic spectrum such as visible light, ultraviolet light and X-rays. One angstrom unit is  $10^{-10}$  meter or 1/250,000,000 inch.

**ANHYDRIDE:** Usually an acid from which water has been removed, practically or theoretically. (e.g. acetic anhydride).

**ANHYDROUS:** Term used to describe a compound or mixture which has lost all its water, in particular, water of crystallization or absorbed water.

**ANION:** In solutions of electrolytes, the negatively charged ion which, during electrolysis, travels towards the positive electrode or anode. When rubber is deposited from aqueous solutions, the colloidal rubber particles behave as anions and deposit at the anode.

**ANISOTROPIC:** Not isotropic. Exhibiting different properties along axes in different directions. See also anisotropy of laminates.

**ANISOTROPIC LAMINATE:** One in which the properties are different in different directions along the laminate plane.

**ANISOTROPY OF LAMINATES:** The difference of the properties along the directions parallel to the length or width of the lamination planes and perpendicular to the lamination.

**ANNEALING:** In plastics, heating to a temperature at which the molecules have significant mobility, permitting them to reorient to a configuration having less residual stress.

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## 3.1 (Continued):

**ANODE:** The positive anode in a solution of electrolytes (or in a vacuum tube) at which electrons leave the solution and at which oxidation occurs. It is also the positive pole of a battery.

**ANODIZING:** The application of a protective oxide film on aluminum, magnesium and other light metals by passing an electric current through an acid bath in which the metal is suspended. The metal serves as the anode. The most common acids used are sulfuric, chromic and phosphoric.

**ANTIOXIDANT:** A substance that, when added in small quantities to the resin during mixing, prevents its oxidative degradation and contributes to the maintenance of its properties. See ISO 472.

**ANTISTATIC AGENTS:** Agents that, when added to a molding material or applied to the surface of the molded object, hinder the fixation of dust or the buildup of electrical charge.

**ANTISYMMETRIC LAMINATE:** (i) A special laminate type that is balanced but unsymmetric, i.e., (+ 0, - 0, + 0, - 0) and  $A_{16} = A_{26} = D_{16} = D_{26} = 0$   $B_{ij} \neq 0$ . (ii) A laminate is said to be antisymmetric when for a given ply configuration (that is a ply with certain elastic properties and thickness) in the lower half of a laminate there is an identical ply configuration in the upper half, but with an alternating ply angle. Note that for an antisymmetric laminate, the corresponding plies in the lower and upper half of the laminate do not have to be placed at their corresponding equal distances from the laminate midplane.

Antisymmetric laminates, by definition, are possible only with orthotropic plies. It is not possible to have an antisymmetric laminate made from isotropic plies as there are no directional properties in the isotropic plies.

An antisymmetric laminate made from specially orthotropic plies is called a cross-ply, whereas one made from generally orthotropic plies is known as an angle-ply.

**API's:** Addition-reaction polyimides

**AQUEOUS:** Water-containing or water-based

**ARAC:** Aviation Rulemaking Advisory Committee

**ARAMID:** A type of highly oriented organic material derived from polyamide (nylon) but incorporating aromatic ring structure. Used primarily as a high-strength, high modulus fiber. Kevlar and Nomex are examples of aramids.

**ARC RESISTANCE:** Ability to withstand exposure to an electric voltage. The total time in seconds that an intermittent arc may play across a plastic surface without rendering the surface conductive.

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## 3.1 (Continued):

**AREAL WEIGHT:** The weight of fiber per unit area (width X length) of tape or fabric.

**AROMATIC:** Unsaturated hydrocarbon with one or more benzene ring structures in the molecule.

**ARTIFICIAL WEATHERING:** The exposure of plastics to cyclic laboratory conditions, consisting of high and low temperatures, high and low relative humidities, and ultraviolet radiant energy, with or without direct water spray and moving air (wind), in an attempt to produce changes in their properties similar to those observed in long-term continuous exposure outdoors. The laboratory exposure conditions are usually intensified beyond those encountered in actual outdoor exposure, in an attempt to achieve an accelerated effect. Also called accelerated ageing.

**ASH CONTENT:** Proportion of the solid residue remaining after a reinforcing substance has been incinerated (charred or intensely heated).

**ASPECT RATIO:** (i) The ratio of length to diameter of a fiber. (ii) In an essentially two-dimensional rectangular structure (e.g., a panel), the ratio of the long dimension to the short dimension. (iii) In compression loading, it is sometimes considered to be the ratio of the load direction dimension to the transverse dimension. (iv) In aircraft design it is the ratio of the wingspan to the chord (or width) of the wing. See also MIL-HDBK-17.

**ASSEMBLY:** A group of materials or parts, including adhesives, which has been placed together for bonding or which has been bonded in place.

**ASSEMBLY TIME:** The time interval between the spreading of the adhesive on the adherent and the application of pressure and/or heat to the assembly. See ASTM D 907.

**ASTM:** American Society for Testing and Materials

**ATACTIC:** A molecular chain in which the methyl groups are more or less in random order.

**ATLAS (acronym):** Automated tape lay-up systems.

**ATTENUATION:** The diminution of vibrations or energy over time or distance. The process of making thin and slender, as applied to the formation of fiber from molten glass.

**AUDREY:** The trade name of some equipment used for dynamic dielectric analysis (DDA).

**AUTOCLAVE:** A closed vessel for producing an environment of fluid pressure, with or without heat, to an enclosed object while it undergoes a chemical reaction or other process.

## SAE AIR4844

## 3.1 (Continued):

**AUTOCLAVE MOLDING:** A process in which, after lay-up, winding, or wrapping, an entire assembly is placed in a heated autoclave, usually at 340 to 1380 kPa (50 to 200 psi). Additional pressure permits higher density and improved removal of volatiles from the resin. Lay-up is usually vacuum bagged with a bleeder and release cloth. The vacuum bag is normally vented to atmosphere, after establishing that it does not leak.

**AUTOMATIC MOLD:** A mold for injection or compression molding that repeatedly goes through the entire cycle, including ejection, without human assistance.

**AUTOMATIC PRESS:** An hydraulic press for compression molding or an injection machine that operates continuously, being controlled mechanically, electrically, hydraulically, or by a combination of any of these methods.

**AVERAGE (ARITHMETIC MEAN):** The sum of a group of test values divided by the number of test values summed.

**AXIAL STRAIN:** A linear strain in a plane parallel to the longitudinal axis of the specimen.

**AXIAL WINDING:** In filament-wound reinforced plastics, a winding with the filaments parallel or at a small angle to the axis ( $0^\circ$  helix angle). See also polar winding.

## 3.2 B:

**B-BASIS:** The "B" mechanical property value is the value above which at least 90% of the population of values is expected to fall, with a confidence of 95%. See also A-basis, S-basis, and typical-basis.

**B-STAGE:** An intermediate stage in the reaction of certain thermosetting resins in which the material softens when heated and is plastic and fusible but may not entirely dissolve or fuse. Helps facilitate handling and processing. Also called resitol. The resin in an uncured prepreg is usually in this stage. See also A-stage and C-stage. See ISO 472.

**BACK DRAFT:** An area of interference in an otherwise smooth-drafted encasement; an obstruction in the taper which would interfere with the withdrawal of the model from the mold.

**BACK PRESSURE:** (i) Resistance of a material because of its viscosity, to continued flow when mold is closing. (ii) In autoclave molding, the pressure under the vacuum bag after the bag has been vented to atmosphere and the autoclave is at operating pressure.

**BADGE:** Bisphenol "A" diglycidylether. See DGEBA, another way of saying the same thing.

**BAGGING:** Applying an impermeable layer of film over an uncured part and sealing edges so that a vacuum can be drawn.

## SAE AIR4844

## 3.2 (Continued):

**BAG MOLDING:** A process in which the consolidation of the material in the mold is effected by the application of fluid or gas pressure through a flexible membrane. See ISO 472 and ASTM D 907.

**BAG SIDE:** The side of the part that is cured against the vacuum bag.

**BALANCED CONSTRUCTION:** Equal parts of warp and fill in fiber fabric. Construction in which reactions to tension and compression loads result in extension or compression deformations only and in which flexural loads produce pure bending of equal magnitude in axial and lateral directions.

**BALANCED DESIGN:** In filament-wound reinforced plastics, a winding pattern so designed that the stresses in all filaments are equal.

**BALANCED-IN-PLANE CONTOUR:** In a filament-wound part, a head contour in which the filaments are oriented within a plane and the radii of curvature are adjusted to balance the stresses along the filaments with the pressure loading.

**BALANCED LAMINATE:** A composite laminate in which all the laminae at angles, other than 0 and 90 degrees, occur only in plus and minus pairs (not necessarily adjacent) and are symmetrical around the centerline. This type of laminate will have the least tendency to bow after cure. See also Symmetrical Laminate. A laminate may be balanced but not symmetrical or symmetrical but not balanced. See textbooks on composite laminate design. (See Figure 1).

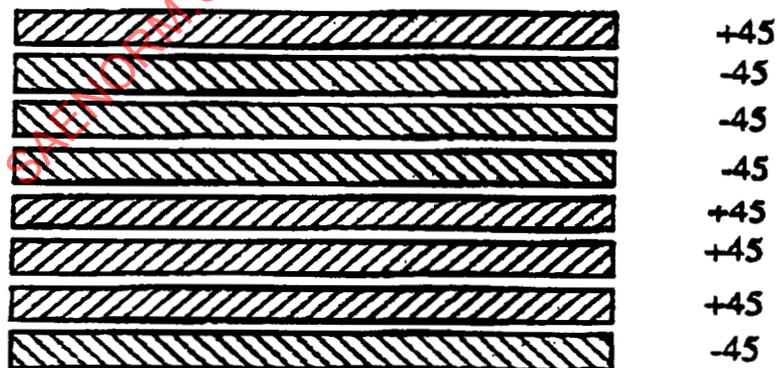
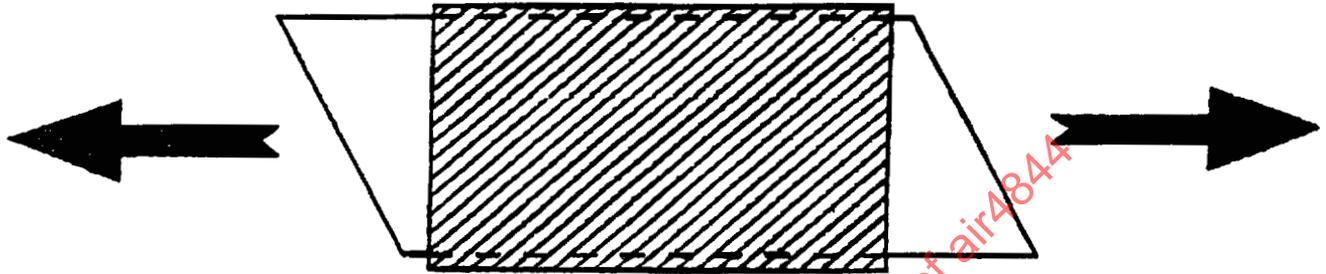


FIGURE 1

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## 3.2 (Continued):

A laminate which does not possess this balance will have the  $A_{16}$  and  $A_{26}$  terms in the in-plane stiffness matrix not equal to zero, that is to say, there is shear coupling in the laminate (a unique property of composite laminates). Hence, under in-plane loading, the laminate deforms in both normal and shear, see Figure 2.



NOTE: Flexural behavior is rarely balanced.

FIGURE 2

**BALANCED TWIST:** An arrangement of twists in a combination of two or more strands that does not cause kinking or twisting on themselves when the yarn produced is held in the form of an open loop.

**BALLISTIC DAMAGE:** Damage resulting from armament projectile strikes.

**BAND DENSITY:** In filament winding, the quantity of fiberglass reinforcement per inch of bandwidth, expressed as strands (or filaments) per inch or per centimeter.

**BAND THICKNESS:** In filament winding, the thickness of the reinforcement as it is applied to the mandrel.

**BANDWIDTH:** In filament winding, the width of the reinforcement as it is applied to the mandrel.

**BARCOL HARDNESS:** A hardness value obtained by measuring the resistance to penetration of a sharp steel point under a spring load. The instrument, called the Barcol impresser, gives a direct reading on a 0 to 100 scale. The hardness value is often used as a measure of the degree of cure of a plastic.

**BARE GLASS:** Glass, such as yarns, rovings, and fabrics, from which the sizing or finish has been removed. Also, such glass before the application of sizing or finish.

**BARRIER COAT:** An exterior coating applied to a composite wound structure to provide protection.

**BARRIER FILM:** The layer of film used to permit removal of air and volatiles from a composite lay-up during cure while minimizing resin loss.

## SAE AIR4844

## 3.2 (Continued):

**BARRIER PLASTICS:** A general term applied to a group of lightweight, transparent impact-resistant plastics, usually rigid copolymers of high acrylonitrile content. Barrier plastics are generally characterized by gas, aroma, and flavor barrier characteristics approaching those of metal and glass.

**BASE:** The reinforcing material (glass fiber, paper, cotton, asbestos etc.) which is impregnated with resin in the forming of laminates.

**BATCH:** (i) In general, a quantity of material formed during the same process or in one continuous process and having identical characteristics throughout. Also called a lot. A discrete quantity of material with a total commonality of raw materials and process history. (ii) (Resins, adhesives, fabrics). Resins or adhesives that are made in one mixer load and fabric woven from one warp loom setup. A batch may be a large or small amount of resin, adhesive, or woven fabric. See ASTM D 907. (iii) (Prepreg material). A production run of prepreg material that is preimpregnated using one batch of resin and fabric, all in one continuous operation. A batch of prepreg may consist of one or more rolls of material.

**BATT:** Felted fabrics. Structures built by the interlocking action of compressing fibers, without spinning, weaving, or knitting.

**BEARING AREA:** The diameter of the hole times the thickness of the material. The cross-section area of the bearing load member on the sample.

**BEARING LOAD:** A compressive load on an interface.

**BEARING STRAIN:** The ratio of the deformation of the bearing hole, in the direction of the applied force, to the pin diameter. Also the stretch or deformation strain for a sample under bearing load.

**BEARING STRENGTH:** The maximum bearing stress that can be sustained. Also, the bearing stress at that point on the stress-strain curve where the tangent is equal to the bearing stress divided by  $n\%$  of the bearing hole diameter.

**BEARING STRESS:** The applied load divided by the bearing area. Maximum bearing stress is the maximum load sustained by the specimen during the test, divided by the original bearing area.

**BEARING YIELD STRENGTH:** The bearing stress at which a material exhibits a specified limiting deviation from the proportionality of bearing stress to bearing strain. Usually obtained using an offset. (MIL-HDBK-17)

**BEND TEST:** A test of ductility by bending or folding, usually with steadily applied forces. In some instances the test may involve blows to a specimen having a cross section that is essentially uniform over a length several times as great as the largest dimension of the cross section. See MIL-HDBK-17.

## SAE AIR4844

## 3.2 (Continued):

**BENDING STIFFNESS:** The sandwich property which resists bending deflections. ASTM C 274.

**BENDING-TWISTING COUPLING:** A property of certain classes of laminates that exhibit twisting curvatures when subjected to bending moments. Also occurs with in-plane loading in certain laminates.

**BENZENE:** A hydrocarbon of the composition  $C_6H_6$ ; the initial member of the benzene or aromatic series. Its molecular structure is conceived as a six sided ring with double linkages between each alternating pair of the carbon atoms and a hydrogen atom attached to each carbon atom. It is produced commercially by the distillation of the light oils produced from coal tar. It is considered to be very toxic. Benzol is an industrial (less pure) grade of benzene. Toluene and Xylene are related, less toxic compounds.

**BENZENE RING:** The basic structure of benzene, the most important aromatic chemical. It is an unsaturated, resonant, six carbon ring, having three double bonds. One or more of the six hydrogen atoms of benzene may be replaced by other atoms or groups.

**BINOMIAL RANDOM VARIABLE:** The number of successes in independent trials where the probability of success is the same for each trial. MIL-HDBK-17.

**BISPHENOL 'A':** A condensation product formed by the reaction of two molecules of phenol with acetone. This polyhydric phenol is the standard intermediate resin that is reacted with epichlorohydrin in the production of epoxy resins.

**BIAS FABRIC:** Warp and fill fibers at an angle to the length of the fabric.

**BIAXIAL LOAD:** A loading condition in which a laminate is stressed in two perpendicular directions. A loading condition of a pressure vessel under internal pressure and with unrestrained ends.

**BIAXIAL WINDING:** In filament winding, a type of winding in which the helical band is laid in sequence, side by side, with crossover of the fibers eliminated.

**BIDIRECTIONAL LAMINATE:** A reinforced plastic laminate with the fibers oriented in two directions in its plane. A cross laminate. See also unidirectional laminate.

**BILLET:** A small ingot of nonferrous metal.

**BINDER:** (i) The resin or cementing constituent (of a plastic compound) that holds the other components together. (ii) The agent applied to fiber mat or preforms to bond fibers before laminating or molding. See ASTM D 907 and ISO 472.

## SAE AIR4844

## 3.2 (Continued):

**BIREFRINGENCE:** The difference between the two principal refractive indices (of a fiber) or the ratio between the retardation and thickness of a material at a given point. (MIL-HDBK-17)

**BISMALEIMIDE (BMI):** A type of polyimide that cures by an addition rather than a condensation reaction, thus avoiding problems with volatiles formation, and which is produced by a vinyl-type polymerization of a prepolymer terminated with two maleimide groups. Intermediate in temperature capability between epoxy and polyimide.

**BLADDER:** An elastomeric lining for the containment of hydroproof or hydroburst pressurization medium in filament-wound structures.

**BLANKET:** Fiber or fabric plies that have been laid up in a complete assembly and placed on or in the mold all at one time (flexible bag process). Also, the form of bag in which the edges are sealed against the mold.

**BLEED:** (1) To give up color when brought into contact with water or solvents.  
 (2) An undesired movement of certain materials in adhesives (sometimes plasticizers) to the surface of the bonded article (especially plastics) or into adjacent materials.  
 (3) To evacuate excess resin from an assembly during the curing cycle.

**BLEEDER:** See bleeder cloth.

**BLEEDER CLOTH:** A nonstructural layer of material used in the manufacture or repair of composite parts to allow the escape of excess gas and resin during the cure. The bleeder cloth is removed after curing and is not part of the final composite. MIL-HDBK-17.

**BLEEDING:** (i) The removal of excess resin from a laminate during cure.  
 (ii) The diffusion of color out of a plastic part into the surrounding surface or part.

**BLEEDOUT:** (i) The excess liquid resin that migrates to the surface of a winding. Primarily occurs in filament winding. (ii) The spread of adhesive away from the bond area.

**BLIND FASTENER:** A fastener that is installed with access from one side only.

**BLIND HOLE:** A hole that is not drilled entirely through.

**BLISTER:** (i) Debond of paint or other coating from part surface. Undesirable rounded elevation of the surface of a plastic with boundaries that are more or less sharply defined, resembling in shape a blister on the human skin.  
 (ii) The blister may burst and become flattened. See ASTM D 907 and ISO 472.

## SAE AIR4844

## 3.2 (Continued):

**BLOOM:** A visible local exudation or finish change on the surface of a plastic. Bloom can be caused by a lubricant or plasticizer or by atmospheric contamination. See ISO 472.

**BLOWING AGENT:** A substance used to cause expansion in the manufacture of hollow or cellular articles. See ISO 472.

**BMC:** See bulk molding compound.

**BMI:** See bismaleimide.

**BODY PUTTY:** A paste like mixture of plastic resin (polyester or epoxy) and talc used in repair of metal surfaces, such as auto bodies.

**BOILING POINT:** The temperature at which the vapor pressure of a liquid is equal to the pressure of the atmosphere.

**BOLTED TYPE REPAIR:** A repair attached with mechanical fasteners. The fasteners may be rivets or bolts of various types and the repair plate and/or angled sections may be either of precured composite construction or made from sheet metal or extrusions. The parts used in the repair may additionally be adhesively bonded.

**BOND:** (i) The adhesion of one surface to another, with or without the use of an adhesive as a bonding agent. The sticking together of two or more surfaces with or without glue. See ASTM D 907. (ii) To join together with an adhesive and/or by fusing the resins of preimpregnated materials. (BDS 1330)

**BOND FACE:** The part or surface of an adherend that serves as a substrate for an adhesive.

**BOND LINE:** The layer of adhesive that attaches two adherends. Synonym for glue line. See ASTM D 907.

**BOND PLY:** The ply of a prepreg material that is placed against the fluted core of a radome.

**BONDED PART:** (i) See bonded structure. (ii) See composite part.

**BONDED STRUCTURE:** The structure resulting when a combination of parts is assembled and intimately attached to each other by applying a structural adhesive to the faying surfaces, followed by curing of the adhesives by pressure, heat or both.

**BONDLINE CRACKS:** Cracking in the adhesive layer as a result of strain.

**BOND STRENGTH:** The unit load applied in tension, compression, flexure, peel, impact or shear required to break an adhesively bonded assembly with the failure occurring either within the adhesive or at the adhesive/adherent interface. See also adhesion and bond.

## SAE AIR4844

## 3.2 (Continued):

**BORON FIBER:** A fiber produced by vapor deposition of elemental boron, usually on to a tungsten filament core, to impart strength and stiffness.

**BOSS:** Small projection from surface of a part designed to add strength, facilitate alignment with another part during assembly, or permit attachment to another part.

**BOTTOM PLATE:** A steel plate fixed to the lower section of a mold, often used to join the lower section of the mold to the platen of the press.

**BRAID:** A fabric structure made by interlacing textile yarns in such a manner that all yarns lie at an angle other than  $0^\circ$  or  $90^\circ$  to the length direction of the fabric. See ISO 472.

**BRAIDING:** Weaving of fibers into a tubular shape instead of a flat fabric, as for graphite fiber reinforced golf club shafts.

**BRANCHED POLYMER:** In molecular structure of polymers, a main chain with attached side chains, in contrast to a linear polymer.

**BREAKING EXTENSION:** The elongation necessary to cause rupture of a test specimen. The tensile strain at the moment of rupture.

**BREAKING FACTOR:** The breaking load divided by the original width of a test specimen, expressed in lb/in.

**BREAKING LENGTH:** A measure of the breaking strength of yarn. The length of a specimen whose weight is equal to the breaking load.

**BREAKOUT:** Fiber separation or break on surface plies at drilled or machined edges.

**BREATHER (BREATHING CLOTH):** A loosely woven material such as glass fabric or Osnaburg cloth that will serve as a continuous vacuum path over a part or the repair area but is not in direct contact with the part or the repair area.

**BREATHING:** (i) The opening and closing of a mold to allow gas to escape early in the molding cycle. Also called degassing; sometimes called bumping in phenolic molding. (ii) Permeability to air of plastic sheeting. (iii) The removal of air or gases from an assembly during autoclave molding by use of a breather.

**BRIDGING:** (i) Condition in which fibers do not move into or conform to radii and corners during molding, resulting in voids and dimensional control problems. (ii) A condition where one or more plies of a prepreg span a radius step of the fluted core of a radome without full contact.

**BRISTLE:** A relatively thick, short section cut from a monofilament. See ISO 472.

## SAE AIR4844

## 3.2 (Continued):

**BROADGOODS:** (i) Fiber woven to form fabric up to 1270 mm (50 in) wide. It may or may not be impregnated with resin and is usually furnished in rolls of 25 to 140 kg (50 to 300 lb). (ii) A term loosely applied to prepreg material greater than about 12 inches in width usually furnished by suppliers in continuous rolls. The term is currently used to designate both collimated uniaxial tape and woven fabric prepreps.

**BUBBLE:** A spherical internal void; globule of air or other gas trapped in a plastic.

**BUCKLING (COMPOSITE):** A mode of failure generally characterized by an unstable lateral material deflection due to compressive action on the structural element involved. In advanced composites, buckling may take the form not only of conventional general instability and local instability, but also a micro instability of individual fibers.

**BUCKLING:** Crimping of fibers in a composite material, often occurring in glass-reinforced thermoset due to resin shrinkage during cure.

**BUCKLE LINE:** A line of collapsed honeycomb cells, two to three cells wide with undistorted cells on either side. (Buckle lines generally appear on the inner radius of the formed core).

**BUILDUP:** An area within a laminate made thicker by addition of more plies or layers of material.

**BULK DENSITY:** The density of a molding material in loose form (granular, nodular, etc.), expressed as a ratio of weight to volume.

**BULK FACTOR:** The ratio of the volume of a raw molding compound or powdered plastic to the volume of the finished solid piece produced therefrom. The ratio of the density of the solid plastic object to the apparent or bulk density of the loose molding powder.

**BULK MODULUS:** The ratio of the hydrostatic pressure to the volume strain.

**BULK MOLDING COMPOUND (BMC):** Thermosetting resin mixed with strand reinforcement, fillers, and so on, into a viscous compound for compression or injection molding. See also premix and sheeting molding compound.

**BUNDLE:** A general term for a collection of essentially parallel filaments or fibers.

**BURNED:** Showing evidence of thermal decomposition or charring through some discoloration, distortion, destruction, or conversion of the surface of the plastic, sometimes to a carbonaceous char.

**BURST STRENGTH (BURSTING STRENGTH):** Measure of the ability of a material to withstand internal hydrostatic or gas dynamic pressure without rupture. Hydraulic pressure required to burst a vessel of given thickness. Commonly used in testing filament-wound composite structures.

## SAE AIR4844

## 3.2 (Continued):

**BUSHING:** (i) An electrically heated alloy container encased in insulating material, used for melting and feeding glass in the forming of individual fibers or filaments. (ii) Also, special extra heavy load-carrying short cylinder inserted in bolt or pin holes.

**BUTT JOINT:** A type of edge joint in which the edge faces of the two adherents are a right angles to the other faces of the adherents.

**BUTT WRAP:** Tape wrapped around an object in an edge-to-edge fashion.

## 3.3 C:

**CAA:** Civil Aviation Authority (UK)

**CAD:** Computer aided design

**CAM:** Computer aided manufacture

**CALENDER:** To produce a smooth finish and a desired dimensional thickness for sheet material by passing it between sets of pressure rollers.

**CARBON:** The element that provides the backbone for all organic polymers. Graphite is a more ordered form of carbon. Diamond is the densest crystalline form of carbon.

**CARBON-CARBON:** A composite material consisting of carbon or graphite fibers in a carbon or graphite matrix.

**CARBON FIBER:** Fiber produced by the pyrolysis of organic precursor fibers, such as rayon, polyacrylonitrile (PAN), and pitch in an inert environment. The term is often used interchangeably with the term graphite: however, carbon fibers and graphite fibers differ. The basic differences lie in the temperature at which the fibers are made and heat treated, and in the amount of elemental carbon produced. Carbon fibers typically are carbonized in the region of 1315 °C (2400 °F) and assay at 93 to 95% carbon, while graphite fibers are graphitized at 1900 to 2480 °C (3450 to 4500 °F) and assay at more than 99% elemental carbon. See also pyrolysis (of fibers).

**CARBONIZATION:** The process of pyrolysis in an inert atmosphere at temperatures ranging from 800 to 1600 °C (1470 to 2910 °F) and higher, usually at about 1315 °C (2400 °F). Range is influenced by precursor, individual manufacturer's process, and properties desired.

**CARTRIDGE HEATER:** Cylindrical-bodied, electrical heater for providing heat for injection, compression, and transfer molds; injection nozzles; runnerless mold system; hot stamping dies; sealing; etc.

**CAST:** To form material into a certain shape by pouring it into a mold and letting it harden without applying external pressure.

## SAE AIR4844

## 3.3 (Continued):

**CASTING RESIN:** A resin in liquid form that can be poured or otherwise introduced into a mold and shaped without pressure into solid articles. See ISO 472.

**CATALYST:** A substance that changes the rate of a chemical reaction without itself undergoing permanent change in composition or becoming a part of the molecular structure of the product. A substance that markedly speeds up the cure of a compound when added in minor quantity as compared to the amounts of primary reactants. See also accelerator, curing agent, hardener, inhibitor, and promoter. See ASTM D 907 and ISO 472.

**CATASTROPHIC FAILURES:** (i) Totally unpredictable failures of a mechanical, thermal, or electrical nature causing total failure/malfunction of the part, component, or system. (ii) Major failures causing loss of life or serious financial loss or secondary damage. In aeronautical terminology a Primary structure is defined as one where failure could cause loss of the aircraft. A Secondary structure is one which although not causing loss of the aircraft, failure could result in disturbances to aircraft control, damage to primary structure or engines, or reduced life between overhauls and increased maintenance cost.

**CATENARY:** (i) A measure of the difference in length of the strands in a specified length of roving as a result of unequal tension. (ii) The tendency of some strands in a taut horizontal roving to sag more than the others. (iii) Curve formed by a uniform chain hanging freely from two points not in one vertical line. (From Latin catena = a chain). (iv) Name given to the curve assumed by a perfectly flexible string suspended at each end and hanging under the action of gravity.

**CAUL PLATES:** (i) Smooth metal plates, free of surface defects, the same size and shape as a composite lay-up, used immediately in contact with the lay-up during the curing process to transmit normal pressure and temperature, and to provide a smooth surface on the finished laminate. See ASTM D 907. (ii) Discussion. A caul is used to protect either the faces of the assembly or the press platens, or both, against marring and staining, to prevent sticking; to facilitate press loading; to impart a desired surface texture or finish; and to provide a uniform pressure distribution. (iii) Discussion. A caul may be of any suitable material such as aluminum, stainless steel, hardboard, fiberboard or plastic, the length and width dimensions generally being the same as those of the plates of the press where it is used. Sometimes plates the same size as the part are used.

**CAVITY:** The space inside a mold in which a resin or molding compound is poured or injected. The female portion of mold. That portion of the mold that encloses the molded article (often referred to as the die). Depending on the number of such depressions, molds are designated as single cavity or multiple cavity.

**CC:** Carbonaceous heat-shield composites (C-C is carbon-carbon).

## SAE AIR4844

## 3.3 (Continued):

**CELL:** (i) In honeycomb core, a cell is a single honeycomb unit, usually in a hexagonal shape. (ii) (In cellular plastics) A single small cavity surrounded partially or completely by its walls. See ISO 472.

**CELL SIZE:** The diameter of an inscribed circle within a cell of honeycomb core.

**CELLULAR PLASTIC:** (Expanded plastic, foamed plastic) A plastic whose density is reduced by the presence of numerous small cavities (cells), interconnecting or not, dispersed throughout the mass. See ISO 472.

**CENSORING:** Data is right (or left) censored at M, if, whenever an observation is less than or equal to M (or greater than or equal to M), the actual value of the observation is recorded. If the observation exceeds (or is less than) M, the observation is recorded as M. See MIL-HDBK-17.

**CENTRIFUGAL CASTING:** A production technique for fabricating cylindrical composites, such as pipes, in which composite material is positioned inside a hollow mandrel designed to be heated and rotated as resin is cured.

**CERAMIC:** A rigid, frequently brittle material made from clay and other inorganic, nonmetallic substances and fabricated into articles by forming followed by sintering or densification of the article at high temperature.

**CERMET:** Composite materials consisting of two constituents, one being either an oxide, carbide, boride, or similar inorganic compound, and the other a metallic binder.

**CERTIFICATION:** Written testimony of qualification.

**CERTIFYING AGENCY:** (i) The training organization of the person being certified. (ii) The FAA, JAA, or CAA for Repair Stations. (iii) Any recognized authority with the power to act as a "Certifying Agency" for a particular activity.

**CFRP:** Carbon Fiber Reinforced Plastic

**C-GLASS:** A glass with a soda-lime-borosilicate composition that is used for its chemical stability in corrosive environments.

**CHAIN GROWTH POLYMERIZATION:** A chemical reaction in which polymer formation is initiated by a reactive species  $R^*$  produced from some compound I termed an initiator. The reactive species may be a free radical, cation or anion. The reactive center, once produced, adds monomer units in a chain reaction and grows rapidly to a large size. High molecular weight polymer forms immediately with the molecular weight changing slightly, if at all, as the monomer concentration decreases steadily during the reaction. (MIL-HDBK-17)

**CHAIN LENGTH:** The length of the stretched linear macromolecule, most often expressed by the number of identical links.

## SAE AIR4844

## 3.3 (Continued):

**CHALKING:** Dry, chalklike appearance of deposit on the surface of a plastic. See ISO 472.

**CHARGE:** The measurement or weight of material (liquid, preformed or powder) used to load a mold at one time or during one cycle.

**CHARPY IMPACT TEST:** A test for shock loading in which a centrally notched sample bar is held at both ends and broken by striking the back face in the same plane as the notch.

**CHARRING:** The heating of a composite in air to reduce the polymer matrix to ash, allowing the fiber content to be determined by weight.

**CHEMICAL ATTACK:** Damage to the resin matrix by accidental contact with, or unauthorized use of chemical products.

**CHEMICAL VAPOR DEPOSITED (CVD) CARBON:** Carbon deposited on a substrate by pyrolysis of a hydrocarbon, such as methane.

**CHEMICAL VAPOR DEPOSITION (CVD):** Process used in manufacture of several composite reinforcements, especially boron and silicon carbide, in which desired reinforcement material is deposited from vapor phase on to a continuous core, for example, boron on tungsten wire (core).

**CHEMICALLY FOAMED PLASTIC:** A cellular plastic in which the cells are formed by gases generated from thermal decomposition or chemical reaction of the constituents. See ISO 472.

**CHOPPED STRAND MAT:** A mat formed of strands cut to a short length, randomly distributed, without intentional orientation, and held together by a binder. See ISO 472.

**CHOPPED STRANDS:** Short strands cut from continuous filament strands, not held together by any means. See ISO 472.

**CHROMATOGRAM:** A plot of detector response against peak volume of solution (eluate) emerging from the system for each of the constituents which have been separated. (MIL-HDBK-17)

**CHROMATOGRAPHY:** See thin-layer chromatography.

**CHROME FINISH:** (Volan 'A') - Applied to glass fibers to give good bonding to polyester and epoxy resins.

**CIRCUIT:** In filament winding, one complete traverse of a winding band from one arbitrary point along the winding path to another point on a plane through the starting point and perpendicular to the axis. One complete traverse of the fiber-feed mechanism of a winding machine.

## SAE AIR4844

## 3.3 (Continued):

**CIRCUIT BOARD:** A sheet of insulating material laminated to foil that is etched to produce a circuit pattern on one or both sides. Also called printed circuit board or printed wiring board.

**CIRCUMFERENTIAL ("CIRC") WINDING:** In filament wound reinforced plastics, a winding with the filaments essentially perpendicular to the axis (90° or level winding).

**CLAMPING AREA:** Largest molding area an injection molding machine can hold closed under full pressure.

**CLAMPING PLATE:** A mold plate fitted to the mold and used to fasten the mold to the machine.

**CLAMPING PRESSURE:** (i) In injection molding and transfer molding, the pressure that is applied to the mold to keep it closed, in opposition to the fluid pressure of the compressed molding material. (ii) May also refer to the pressure on two plates in a bolted joint after the bolts are tightened either to a specific torque loading or generally. (iii) May also refer to the pressure applied when clamps are used instead of a press or vacuum to apply pressure to a composite or bonded joint or repair during curing.

**CLAMP TONNAGE:** Rated clamping capacity of an injection or transfer molding machine.

**CLEAN ROOM:** A special room where composite or bonded metal components are assembled prior to bonding in a clinical atmosphere. The room is sealed as far as possible, kept scrupulously clean at all times, temperature and humidity controlled and has a positive air pressure inside so that airflow is always outwards to minimize contamination. Operators wear clean overalls, clean gloves and caps, and visitors are generally discouraged. When allowed into a clean room they also have to wear clean outer garments to prevent contamination. No cutting, drilling, or sanding operations are permitted in a clean room, it is for the assembly of clean, dry components and materials only, immediately prior to bonding.

**CLIMBING DRUM PEEL TEST:** For details see ASTM D 1781 and Reference 2.15. This test is used where the bonded members are not flexible enough to be peeled in a more usual manner. The less rigid of the two members is peeled by winding it round a rigid cylinder - the "climbing drum". This is a practical test used to assess the quality of adhesive bonds between thin skins and honeycomb or other core materials for lightweight sandwich panels and also for testing adhesives by peeling a thin sheet from a much thicker one.

**CLOSED CELL:** A cell totally enclosed by its walls and hence noninterconnecting with other cells. See ISO 472.

**CLOSED-CELL CELLULAR PLASTIC:** A cellular plastic in which almost all the cells are noninterconnecting. See ISO 472.

## SAE AIR4844

## 3.3 (Continued):

**CLOSURE:** The complete coverage of a mandrel with one layer (two plies) of fiber. When the last tape circuit that completes mandrel coverage lays down adjacent to the first without gaps or overlaps, the wind pattern is said to have "closed."

**CLOTH:** See woven fabric and nonwoven fabric.

**CMM:** Component Maintenance Manual. (i) Provided by aircraft manufacturers. (ii) May also mean Coordinate Measuring Machine.

**COBONDING:** The curing together of two or more elements, of which at least one has already been fully cured and at least one is uncured. This requires film adhesive between any precured and uncured interface. (BDS 1330)

**CO-CONSOLIDATION:** A processing step where two or more thermoplastic preformed parts are joined by properly locating in a fixture or tool and reheating to melt under pressure.

**CO-CURING:** (i) The act of curing a composite laminate and simultaneously bonding it to some other prepared surface, or curing together an inner and outer tube of similar or dissimilar fiber-resin combination after each has been wound or wrapped separately. See also secondary bonding. (ii) The simultaneous curing together of two or more uncured elements. (BDS 1330)

**COEFFICIENT OF ELASTICITY:** The reciprocal of Young's modulus in a tension test. See also compliance.

**COEFFICIENT OF EXPANSION:** A measure of the change in length or volume of an object, specifically measured by the increase in length or volume of an object per unit length or volume.

**COEFFICIENT OF FRICTION:** A measure of the resistance to sliding of one surface in contact with another surface. The coefficient of friction  $f = F/W$  where  $F$  is the force to cause sliding and  $W$  is the weight being moved. Each material has its own value of coefficient  $f$ . See ISO 472.

**COEFFICIENT OF THERMAL EXPANSION (CTE):** The change in length or volume per unit length or volume produced by a 1° rise in temperature. See ISO 472.

**COEFFICIENT OF VARIATION:** The ratio of the population (or sample) standard deviation to the population (or sample) mean. (MIL-HDBK-17)

**CO-FAB:** Fabrication process where close-outs and inserts are bonded into the panel at the same time as the facings are bonded to the core. ASTM C 274.

**COHESION:** The propensity of a single substance to adhere to itself. The internal attraction of molecular particles toward each other. The ability to resist partition of itself. The force holding a single substance together. See ASTM D 907.

## SAE AIR4844

## 3.3 (Continued):

**COHESIVE FAILURE:** Failure of an adhesive joint occurring primarily in an adhesive layer. See ASTM D 907.

**COHESIVE STRENGTH:** Intrinsic strength of an adhesive.

**COIN TEST:** Using a coin to tap a laminate in different spots, listening for a change in sound, which would indicate the presence of a defect. A surprisingly accurate test in the hands of experienced personnel. Also called Tap Test.

**COKE:** Carbonaceous residue resulting from the pyrolysis of pitch.

**COLD FLOW:** The distortion that takes place in materials under continuous load at temperatures within the working range of the material without a phase or chemical change. See also creep.

**COLD-SETTING ADHESIVE:** A synthetic resin adhesive capable of hardening at normal room temperature in the presence of a hardener. See ASTM D 907.

**COLLET:** (i) A rigid, lateral container for the mold-forming material. A dam, a restriction box. (ii) The drive wheel that pulls glass fibers from the bushing. A forming tube is placed on the collet, and a package of strands is wound up on the tube. (iii) A metal band, ferrule, collar, or flange often used to hold a tool or workpiece.

**COLLIMATED:** Rendered parallel.

**COLLIMATED ROVING:** Roving that has been made using a special process (usually parallel wound), so that the strands are more parallel than in standard roving.

**COLLOIDAL:** A state of suspension in a liquid medium in which extremely small particles are suspended and dispersed but not dissolved.

**COMMINGLING:** The random mixing of fibers of different materials.

**CO-MINGLED FIBER FABRIC:** Thermoplastic and reinforcing fibers precisely intermingled in a single yarn which can be woven into fabrics that are easy to handle and can drape over and into complex molds.

**CO-MINGLED YARN:** A hybrid yarn made with two types of materials intermingled in a single yarn; for example, thermoplastic filaments intermingled with carbon filaments to form a single yarn.

**COMPACTION:** The application of a temporary vacuum bag and vacuum to remove trapped air and compact the lay-up. Sometimes called "de-bulking".

## SAE AIR4844

## 3.3 (Continued):

**COMPATIBILITY:** (i) The ability of two or more substances combined with one another to form a homogeneous composition of useful plastic properties; for example, the suitability of a sizing or finish for use with certain general resin types. (ii) Compatibility is a measure of the ability of two substances to mix. (iii) On the principle that "like generally dissolves like", solubility parameters are often used to predict the compatibility of solvents and plastics. (iv) The ability of different resin systems to be processed in contact with each other without degradation of end product properties. MIL-HDBK-17. (v) Nonreactivity or negligible reactivity between materials in contact. In this case compatibility means that the two materials in contact DO NOT react with each other. In the other four cases it means that they DO REACT with each other.

**COMPLEX CURVATURE:** Describing a surface which curves in more than one direction, such as a saddle or spherical shape. The surface may have both concave and convex areas. May also be described as "double curvature".

**COMPLEX DIELECTRIC CONSTANT:** The vectorial sum of the dielectric constant and the loss factor.

**COMPLEX SHEAR MODULUS:** The vectorial sum of the shear modulus and the loss modulus.

**COMPLEX YOUNG'S MODULUS:** The vectorial sum of Young's modulus and the loss modulus. Analogous to the complex dielectric constant.

**COMPLIANCE:** Tensile compliance: the reciprocal of Young's modulus. Shear compliance: the reciprocal of shear modulus. Also, a term used in the evaluation of stiffness and deflection.

**COMPOSITE:** See composite material.

**COMPOSITE CLASS:** A major subdivision of fibrous composite materials in which a class is defined by the geometric characteristic of the fiber arrangement. Examples of composite classes are filamentary laminates (q.v.), random chopped-fiber composites, whisker composites, and woven fabric.

**COMPOSITE MATERIAL:** A combination of two or more materials (reinforcing elements, fillers, and composite matrix binder), differing in form or composition on a macro scale. The constituents retain their identities; that is, they do not dissolve or merge completely into one another although they act in concert. Normally, the components can be physically identified and exhibit an interface between one another. See ISO 472.

**COMPOSITE PART:** An individual part that is either of the following:

(i) An inseparable assembly of composite materials cured, consolidated, cobonded or secondary bonded together, alone or in combination with other composite or noncomposite parts.

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## 3.3 (Continued):

(ii) An uncured assembly of composite materials that have been stacked up and compacted together alone or in combination with other composite or noncomposite parts. (BDS 1330)

**COMPOUND:** The intimate admixture of a polymer with other ingredients, such as fillers, softeners, plasticizers, reinforcement, catalysts, pigments, or dyes. A thermoset compound usually contains all the ingredients necessary for the finished product, while a thermoplastic compound may require subsequent addition of pigments, blowing agents, etc. See ISO 472.

**COMPRESSION AFTER IMPACT (CAI) STRENGTH:** (i) The compression strength of a laminate when tested after impact damage (primarily delaminations) has been caused by a controlled impact. (ii) The actual compression strength of a component in service after impact of unknown severity has occurred. The purpose of the testing in (i) is to assess this from the damage size and type.

**COMPRESSION MOLD:** A mold that is open when the material is introduced and that shapes the material by the pressure of closing and by heat.

**COMPRESSION MOLDING PRESSURE:** The unit pressure applied to the molding material in the mold.

**COMPRESSION TEST (COMPOSITES):** See ASTM D 3410. Compressive properties of unidirectional or crossply fiber-resin composites. This gives two methods, one using a specially designed fixture to give true compressive failure and the other using a sandwich beam specimen.

**COMPRESSIVE MODULUS:** Ratio of compressive stress to compressive strain below the proportional limit. Theoretically equal to Young's modulus determined from tensile experiments.

**COMPRESSIVE STRENGTH:** The ability of a material to resist a force that tends to crush or buckle. The maximum compressive load sustained by a specimen divided by the original cross-sectional area of the specimen.

**COMPRESSIVE STRESS:** The normal stress caused by forces directed toward the plane on which they act. The compressive load per unit area of original cross section carried by the specimen during the compression tests.

**COMPUTER AIDED DESIGN (CAD):** The use of a computer to develop the design of a product to be manufactured. The use of a computer to develop the design and necessary NC programs for use by the manufacturing equipment which will produce a product.

**CONDENSATION POLYMERIZATION:** A chemical reaction in which two or more molecules combine, with the separation of water or some other simple substance. If a polymer is formed, the process is called polycondensation. See also polymerization.

## SAE AIR4844

## 3.3 (Continued):

**CONDENSATION REACTION:** A chemical reaction in which two different molecules react to form a new compound of greater complexity, with the formation of water, alcohol, ammonia etc., as a by-product

**CONDITIONING:** Subjecting a material to a prescribed environmental and/or stress history before testing. See ISO 472.

**CONDUCTIVITY:** Reciprocal of volume resistivity. The electrical or thermal conductance of a unit cube of any material (conductivity per unit volume).

**CONSISTENCY:** That property of a liquid adhesive by virtue of which it tends to resist deformation. Consistency is not a fundamental property but is composed of viscosity, plasticity, and other phenomena. See ASTM D 907 and also viscosity.

**CONSOLIDATION:** (i) In metal matrix or thermoplastic composites, a processing step in which fiber and matrix are compressed by one of several methods to reduce voids and achieve desired density. (ii) The joining together under heat and pressure of multiple plies of thermoplastic composite materials, which may be resoftened without undergoing a chemical change when heated. This is a reversible process with some limitations on the number of reprocessing cycles possible, depending on the thermoplastic. (iii) A process that fuses each ply together by tacking and flowing the matrix between the plies. Usually involves heat and pressure.

**CONSTITUENT:** In general, an element of a larger grouping. In advanced composites, the principal constituents are the fibers and the matrix.

**CONTACT ADHESIVE:** An adhesive that is apparently dry to the touch and which will adhere to itself simultaneously upon contact. An adhesive applied to both adherents and allowed to become dry, which develops a bond when the adherents are brought together without sustained pressure.

**CONTACT ANGLE:** When a drop of liquid is placed on a surface it will either retract into a ball, like a drop of mercury, or spread out like water on a clean, high energy surface. The contact angle is the angle made between the surface and a tangent to the surface of the drop at the point of contact with the surface. Low contact angles mean good "wetting" of a surface and high contact angles mean poor "wetting". A major purpose of surface treatments prior to adhesive bonding is to ensure good "wetting" of the bonding faces when the adhesive is applied.

**CONTACT CORROSION (CREVICE CORROSION):** Corrosion of a metal at an area where contact is made with a material, usually nonmetallic.

**CONTACT MOLDING:** A process for molding reinforced plastics in which reinforcement and resin are placed on a mold. Cure is either at room temperature using a catalyst-promoter system or by heating in an oven, without additional pressure.

## SAE AIR4844

## 3.3 (Continued):

**CONTACT PRESSURE RESINS:** Liquid resins that thicken or polymerize on heating, and, when used for bonding laminates, require little or no pressure.

**CONTAMINANT:** An impurity or foreign substance present in a material or environment that affects one or more properties of the material, particularly adhesion.

**CONTINUOUS FILAMENT:** (i) An individual flexible rod of small diameter of great or indefinite length. (ii) A yarn or strand in which the individual filaments are substantially the same length as the strand. MIL-HDBK-17.

**CONTINUOUS-FILAMENT YARN:** Yarn formed by twisting two or more continuous filaments into a single, continuous strand.

**CONTINUOUS ROVING:** Parallel filaments coated with a sizing (finish), gathered together into single or multiple strands. It may be used to provide continuous reinforcement in woven roving, filament winding, pultrusion, prepregs, or high strength molding compounds, or it may be used chopped.

**CONTROL:** A product of known characteristics which is included in a series of similar service or bench tests to provide a basis for evaluation of one or more unknown products (e.g., a carefully stored specimen for comparison with other specimens that have been subjected to environmental exposure).

**COOLING FIXTURE:** A fixture used to maintain the shape or dimensional accuracy of a molding or casting after it is removed from the mold and until the material is cool enough to hold its own shape.

**COPOLYMER:** A long-chain molecule formed by the reaction of two or more dissimilar monomers. See also polymer. See ISO 472.

**COPOLYMERIZATION:** Polymerization in which a copolymer is formed. See ISO 472.

**CORE:** (i) The central member, usually foam or honeycomb, of a sandwich construction to which the faces of the sandwich are attached or bonded. (ii) The central member of a plywood assembly. (iii) A channel in a mold for circulation of heat transfer media. (iv) Part of a complex mold that forms undercut parts. (v) A device on which prepreg is wound.

**CORE CORROSION:** Oxidation or other chemical or electrolytic attack that adversely affects the core.

**CORE CRUSH:** A collapse, distortion, or compression of the core.

**CORE DEPRESSION:** A localized indentation or gouge in the core.

**CORE NODES:** The points at which honeycomb cells are bonded to each other.

**CORED MOLD:** A mold incorporating passages for electrical heating elements, steam, or water.

## SAE AIR4844

## 3.3 (Continued):

**CORE NODE SEPARATION:** A partial or complete breaking of the core node bond.

**CORE SPLICING:** The joining of segments of a core by bonding, or by overlapping each segment and then driving them together.

**CORE STABILIZATION:** A process to rigidize honeycomb core materials to prevent distortion during machining.

**CORONA RESISTANCE:** Resistance to an ionizing process. When an electric current passes through a conductor, it induces a surrounding electrostatic field. When voids exist in the insulation near the conductor, the high voltage electrostatic field may ionize and rapidly accelerate some of the air molecules in the void. These ions can then collide with the other molecules and ionize them, thereby eating a hole in the insulation. Resistance to this process is called corona resistance.

**CORROSION:** The deterioration of a metal by chemical or electrochemical reaction resulting from exposure to weathering, moisture, chemicals or other agents or media. See electrolytic corrosion, galvanic corrosion.

**CORROSION FATIGUE:** The formation of fatigue cracks due to the conjoint action of alternating mechanical loading and corrosion. The presence of corrosion reduces the stress required to cause cracking.

**CORROSION RESISTANCE:** The ability of a material to withstand contact with ambient natural factors or those of a particular artificially created atmosphere, without degradation or change in properties. For metals this could be pitting, general surface corrosion or in the case of iron and steel, rusting.

**COUNT:** For fabric, number of warp and filling yarns per inch in woven cloth. For yarn the size based on relation of length and weight. Basic unit is a "tex".

**COUPLANT:** See liquid couplant.

**COUPLING AGENT:** A double-ended molecule, one end of which bonds to the substrate and the other to the resin or adhesive to assist both strength and especially the durability of bonding, e.g., silane coatings on fiber glass.

**COUPON:** Usually a specimen for a specific test, as a tensile coupon.

**CO-WOVEN FABRIC:** A reinforcement fabric woven with two different types of fibers in separate yarns; for example, thermoplastic fibers woven side by side with carbon fibers.

**CP:** Cross ply

**CPI's:** Condensation reaction polyimides

## SAE AIR4844

## 3.3 (Continued):

**CRACK:** Fractures in either matrix or both matrix and fibers. An actual separation of material. Does not necessarily extend through the thickness of the composite but can be stopped by differently oriented plies.

**CRACK GROWTH:** Rate of propagation of a crack through a material due to a static or dynamic applied load.

**CRAZING:** Region of ultrafine cracks, which may extend in a network on or under the surface of a resin or plastic material. May appear as a white band. Often found in a filament-wound pressure vessel or bottle. In plastics crazing occurs where a crack is bridged by fibrils that still carry significant load. Crazing becomes cracking when the fibrils break and no load is transmitted. Crazing appears as cracking to the naked eye. A craze is a narrow zone of highly deformed and voided polymer resembling a true crack. Crazing occurs at a critical strain, or stress and these can be greatly reduced in the presence of active environments (notably organic solvents in the case of polymeric glasses). See ASTM D 907 and ISO 472.

**CREASE or WRINKLE:** A break or line in a fabric usually caused by a sharp fold.

**CREEL:** A device for holding the required number of roving balls (spools) or supply packages in desired position for unwinding on to the next processing step, that is, weaving, braiding, or filament winding.

**CREEP:** The change in dimension of a material under load over a period of time, not including the initial instantaneous elastic deformation. (Creep at room temperature is called cold flow.) The time-dependent part of strain resulting from an applied stress. See ISO 472.

**CREEP, RATE OF:** The slope of the creep-time curve at a given time. Deflection with time under a given static load.

**CRIMP:** The waviness of a fiber or fabric, which determines the capacity of fibers to cohere under light pressure. Measured by the number of crimps or waves per unit length or by the percent increase in length of the fiber on removal of the crimp.

**CRITICAL LENGTH:** The minimum fiber length required for shear loading to its ultimate strength by the matrix.

**CRITICAL LONGITUDINAL STRESS:** Applied to fibers, the longitudinal stress necessary to cause internal slippage and separation of a spun yarn. The stress necessary to overcome the interfiber friction developed as a result of twist.

**CRITICAL STRAIN:** The strain at the yield point.

**CROSS LAMINATED:** Material laminated so that some of the layers are oriented at various angles to the other layers with respect to the laminate reference axis. A cross-ply laminate usually has plies oriented only at 0 and 90°.

## SAE AIR4844

## 3.3 (Continued):

**CROSSLINK (verb):** To form multiple intermolecular covalent or ionic bonds between polymer chains. See ISO 472.

**CROSSLINKING AGENT:** A substance that promotes or regulates intermolecular covalent or ionic bonding between polymer chains. See ISO 472.

**CROSS-LINKING:** Applied to polymer molecules, the setting-up of chemical links between the molecular chains. When extensive, as in most thermosetting resins, cross-linking makes one infusible super molecule of all the chains. See ISO 472.

**CROSS-LINKING, DEGREE OF:** The fraction of cross-linked polymeric units in the entire system.

**CROSS PLY:** The laminae are at right angles to each other.

**CROSS-PLY LAMINATE:** (i) A laminate with plies usually oriented at 0° and 90° only. See ISO 472. (ii) A laminate built from orthotropic plies that is symmetrical with respect to the laminate mid-plane and the ply orientation is either 0° or 90°. Such laminates have a special stress/strain behavior.

**CROSSWISE DIRECTION:** Crosswise refers to the cutting of specimens and to the application of load. For rods and tubes, crosswise is any direction perpendicular to the long axis. For other shapes or materials that are stronger in one direction than in another, crosswise is the direction that is weaker. For materials that are equally strong in both directions, crosswise is an arbitrarily designated direction at right angles to the lengthwise direction. See ISO 472.

**CRT:** Cathod Ray Tube

**CRUSH SPLICING:** The joining of segments of core by overlapping each segment two to four cells and then driving them together.

**CRYSTALLINE PLASTIC:** A polymeric material having an internal structure in which the atoms are arranged in an orderly three-dimensional configuration.

**CRYSTALLINITY:** In polymers, a microstructure in which the linear molecular chains are arranged in an orderly fashion. Branched or network polymers are not crystalline, but have pockets of order within their bulk. They are, therefore, said to be "semi-crystalline".

**C-SCAN:** In a basic C-Scan system, the search unit is moved over the surface of the test piece in a search pattern. A nondestructive inspection technique for finding voids, delaminations, defects in fiber distribution, etc., using ultrasonics. The part must be placed in a tank of water and scanned in "through-transmission mode" to produce a picture of the damage. C-Scan results are easier to interpret than A-Scan signals, but C-Scan is usually limited to flat or mildly curved parts which will fit into the tank. See also A-Scan and NDI.

## SAE AIR4844

## 3.3 (Continued):

**C-STAGE:** The final stage in the reaction of certain thermosetting resins in which the material is practically insoluble and infusible. Sometimes referred to as resite. The resin in a fully cured thermoset molding is in this stage. See also A-stage and B-stage. See ASTM D 907 and ISO 472.

**CULL:** Material remaining in a transfer chamber after the mold has been filled. (Unless there is a slight excess in the charge, the operator cannot be sure that the cavity has been filled).

**CURE:** To irreversibly change the properties of a thermosetting resin by chemical reaction, that is condensation, ring opening, or addition. Cure may be accomplished by addition of curing (cross-linking) agents, with or without heat and pressure. To permanently change the state of an epoxy material from the B-stage to the C-stage by the controlled action of heat and pressure. See ASTM D 907.

**CURE CYCLE:** The time/temperature/pressure cycle used to cure a thermosetting resin system or prepreg.

**CURE MONITORING, ELECTRICAL:** Use of electrical techniques to detect changes in the electrical properties and/or mobility of the resin molecules during cure. A measuring of resin cure.

**CURE STRESS:** A residual internal stress produced during the curing cycle of composite structures. Normally, these stresses originate when different components of a lay-up have different thermal coefficients of expansion.

**CURING AGENT:** A catalytic or reactive agent that, when added to a resin, causes polymerization. Also called hardener. See ISO 472.

**CURING TEMPERATURE:** Temperature at which a cast, molded or extruded product, a resin-impregnated reinforcement, an adhesive etc. is subjected to curing. The temperature at which the chemical reaction required to cure a particular material will be activated and run to completion. In some cases the cure temperature needs to be fairly closely controlled. See data sheet for each material.

**CURING TIME:** The length of time necessary for a part to be subjected to heat or pressure (or both) in order to fully cure a resin. The interval of time between the instant at which relative movement between the moving parts of a mold ceases and the instant pressure is released. Further cure may take place after removal of the assembly from the conditions of heat and pressure.

**CUT OR TEAR:** Adjacent yarns which have been cut or broken.

**CUT-OFF:** The line where the two halves of a compression mold come together.

**CVD CARBON:** See chemical vapor deposited (CVD) carbon.

## SAE AIR4844

## 3.3 (Continued):

**CYCLE:** One full sequence in a molding operation, from a point in the process to the same point in the next sequence. The complete, repeating sequence of operations in a process or part of a process.

## 3.4 D:

**DAM:** Boundary support or ridge used to prevent excessive edge bleeding or resin runout of a laminate and to prevent crowning of the bag during cure.

**DAMAGE TOLERANCE:** (i) A design measure of crack growth rate. Cracks in damage tolerant designed structures are not permitted to grow to critical size during expected service life. (ii) The ability of a structure to withstand damage, as by impact, and still perform acceptably.

**DAMPING:** The decay with time of the amplitude of free vibrations of a specimen. See also hysteresis and attenuation.

**DAYLIGHT:** The distance, in the open position, between the moving and fixed tables or the platens of an hydraulic press. In the case of a multiplaten press, daylight is the distance between adjacent platens. Daylight provides space for removal of the molded part from the mold.

**DDM:** Diaminodiphenyl methane. An aromatic amine curing agent for epoxy resins. Requires elevated temperature cure.

**DDS:** Diaminodiphenyl sulphone. An aromatic amine curing agent for epoxy resins. Requires elevated temperature cure.

**DEBOND:** A deliberate separation of a bonded joint or interface, usually for repair or rework purposes. Also an unbonded or nonadhered region; a separation at the fiber-matrix interface due to strain incompatibility. In the United Kingdom, the term often refers to accidental damage. See also disbond and delamination.

**DEBULKING:** Compacting of a thick laminate under moderate heat and pressure, i.e., noncuring conditions and/or vacuum to remove most of the air, to ensure seating on the tool and to prevent wrinkles.

**DECOMPOSITION:** A chemical and physical material breakdown due to an excess exposure to heat and oxidation or due to the effects of bacterial contamination of the adhesive.

**DEEP-DRAW MOLD:** A mold having a core that is long in relation to the wall thickness.

**DEFIBRILLATE:** To divide longitudinally into fibers of smaller diameter.

**DEFLASHING:** A finishing technique used to remove the flash (excess, unwanted material) on a plastic molding.

## SAE AIR4844

## 3.4 (Continued):

**DEFLECTION TEMPERATURE UNDER LOAD:** The temperature at which a simple cantilever beam deflects a given amount under load. Formerly called heat distortion temperature.

**DEFORMATION UNDER LOAD:** The dimensional change of a material under load for a specified time following the instantaneous elastic deformation caused by the initial application of the load. See also cold flow and creep.

**DEGASSING:** Removal of air or gases from an adhesive usually accomplished by subjecting the material to a vacuum.

**DEGRADATION:** A deleterious change in the chemical structure, physical properties, or appearance of a plastic adhesive or any other material.

**DEGREASE:** To remove oil and grease from adherend surfaces.

**DEGREE OF POLYMERIZATION:** Number of structural units, or mers, in the average polymer molecule in a sample measure of molecular weight. In most adhesives the degree of polymerization must reach several thousand if worthwhile physical properties are to be obtained. See ISO 472.

**DEHYDRATION:** Removal of water as such from a substance, or after formation from a hydrogen and hydroxyl group in a compound, by heat or a dehydrating substance.

**DELAMINATE:** To split a laminated plastic material along the plane of its layers.

**DELAMINATION:** Separation of the layers of material in a laminate, either local or covering a wide area. Can occur in the cure or subsequent life. See ASTM D 907 and ISO 472.

**DELIQUESCENT:** The absorption of atmospheric water vapor by a crystalline solid until the crystal eventually dissolves into a saturated solution.

**DENATURANT:** A substance which renders alcohol unfit to use as a beverage.

**DENIER:** A yarn and filament numbering system in which the yarn number is numerically equal to the weight in grams of 9000 m. Used for continuous filaments. The lower the denier, the finer the yarn.

**DENSIFICATION PROCESS:** Consolidation of a loose or bulky material. Compaction of a complex assembly with the use of vacuum (minimum 22 in Hg) and heat (150 + 10 °F, rise rate 1 °F/min) for a specified time. Autoclave pressure of 25 psi ± 5 psi may be used to increase the amount of compaction.

**DENSITY:** Weight per unit of volume. Commonly expressed in grams per cubic centimeter, pounds per cubic inch and pounds per cubic foot or kilograms per cubic meter. Pounds per cubic foot and kilograms per cubic meter are usually used for sandwich filler materials, foams and honeycomb core, while the other units are used more generally.

## SAE AIR4844

## 3.4 (Continued):

**DENT:** A concave depression which does not rupture plies or debond the composite structure.

**DEPOLYMERIZATION:** Separation of a more complex molecule into two or more simpler molecules chemically similar to and having the same empirical composition as the original. Reverse of polymerization.

**DEPOSITION:** The process of applying a material to a base by means of vacuum, electrical, chemical, screening, or vapor methods, often with the assistance of a temperature and pressure container.

**DESICCANT:** Substance which can be used for drying purposes because of its affinity for water.

**DESIGN ALLOWABLES:** Material property allowable strengths, usually referring to stress or strain, for design purposes based on a sufficient number of tests to be statistically significant and to give values with specified levels of confidence. See also A-basis, B-basis, S-basis, and typical basis. A limiting value for a material property that can be used to design a structural or mechanical system to a specified level of success.

**DESIZING:** The process of eliminating sizing, which is generally starch, from gray (also greige) goods before applying special finishes or bleaches (for yarn such as glass or cotton). Also, removing lubricant size following weaving of a cloth.

**DESORPTION:** A process in which an absorbed or adsorbed material is released from another material. Desorption is the reverse of absorption, adsorption, or both.

**DESTRUCTIVE TESTS:** Actual destruction of a bonded assembly or test pieces for the purpose of evaluating the bond properties. Destructive tests are usually made initially for qualification of materials and tools and periodically for tool, process and material control.

**DETA:** Diethylene triamine. A curing agent for room temperature curing epoxies.

**DETERIORATION:** A permanent change in the physical properties of a plastic evidenced by impairment of these properties. See ISO 472.

**DEVIATION:** Variation from a specified dimension or requirement, usually defining the upper and lower limits. MIL-HDBK-17.

## SAE AIR4844

## 3.4 (Continued):

**DEVITRIFICATION:** The formation of crystals (seeds) in a glass melt, usually occurring when the melt is too cold. These crystals can appear as defects in glass fibers. Glasses behave as they do because, while they are cooling, they are so viscous that the molecules do not have time to sort themselves out into crystals and so cool glass is a solidified liquid, not a crystalline solid. However, the tendency to crystallize is there and given time some glasses will in fact crystallize. This is known as devitrification. The material can still be amorphous below the devitrification temperature. Devitrification occurs when the melt is maintained in the crystallization temperature range for too long.

**DEVITRIFY:** To deprive of vitreous quality. To make glass or vitreous rock opaque and crystalline.

**DEW POINT:** The temperature to which water vapor must be reduced to obtain saturation vapor pressure, that is, 100% relative humidity. As air is cooled the amount of water vapor it can hold decreases. If air is cooled sufficiently, the actual water vapor pressure becomes equal to the saturation water vapor pressure, and any further cooling normally results in the condensation of moisture.

**D-GLASS:** A high boron content glass made especially for laminates requiring a precisely controlled dielectric constant.

**DGEBA:** Di-glycidylether of Bisphenol "A", the basic epoxy resin.

**DICY:** Dicyandiamide. A curing agent for epoxy resins. Used with 180 °C curing systems and with an accelerator is also used with 120 °C curing systems.

**DIELECTRIC:** A nonconductor of electricity. The ability of a material to resist the flow of an electrical current.

**DIELECTRIC CONSTANT:** The ratio of the capacitance of an assembly of two electrodes separated solely by a plastic insulating material to its capacitance when the electrodes are separated by air. See also complex dielectric constant. A measure of the electrical charge stored per unit volume at unit potential.

**DIELECTRIC CURING:** The curing of a synthetic thermosetting resin by the passage of an electric charge (produced from a high frequency generator) through the resin.

**DIELECTRIC HEATING:** The heating of materials by dielectric loss in a high-frequency electrostatic field.

**DIELECTRIC LOSS:** A loss of energy evidenced by the rise in heat of a dielectric placed in an alternating electric field. It is usually observed as a frequency-dependent conductivity.

## SAE AIR4844

## 3.4 (Continued):

**DIELECTRIC LOSS ANGLE:** The difference between  $90^\circ$  and the dielectric phase angle. Also called the dielectric phase difference. See ISO 472.

**DIELECTRIC LOSS FACTOR:** The product of the dielectric constant and the tangent of the dielectric loss angle for a material. Also called the dielectric loss index.

**DIELECTRIC MONITORING:** A means of tracking the cure of thermosets by changes in their electrical properties during material processing.

**DIELECTRIC PHASE ANGLE:** The angular difference in phase between the sinusoidal alternating potential difference applied to the dielectric and the component of the resulting alternating current having the same period as the potential difference.

**DIELECTRIC POWER FACTOR:** The cosine of the dielectric phase angle (or sine of the dielectric loss angle).

**DIELECTRIC STRENGTH:** The property of an insulating material that enables it to withstand electric stress. The average potential per unit thickness at which failure of the dielectric material occurs. See ISO 472.

**DIELECTROMETRY:** Use of electrical techniques to measure the changes in loss factor (dissipation) and in capacitance during cure of the resin in a laminate.

**DIFFERENTIAL SCANNING CALORIMETRY (DSC):** Measurement of the energy absorbed (endotherm) or produced (exotherm) as a resin system is cured. Also detects loss of solvents and other volatiles. May be applied to melting, crystallization, resin curing, loss of solvents, and other processes involving an energy change. May also be applied to processes involving change in heat capacity such as the glass transition. See ISO 472.

**DIFFERENTIAL THERMAL ANALYSIS (DTA):** An experimental analysis technique in which a specimen and a control are heated simultaneously and the difference in their temperatures is monitored. The difference in temperature provides information on relative heat capacities, presence of solvents, changes in structure (that is, phase changes, such as melting of one component in a resin system), and chemical reactions. See also differential scanning calorimetry. See ISO 472.

**DIFFUSION:** The movement of a material such as a gas or a liquid, in the body of a plastic. If the gas or liquid is absorbed on one side of a piece of plastic and given off on the other side, the phenomenon is called permeability. Diffusion and permeability are not due to holes or pores in the plastic but are caused and controlled by chemical mechanisms.

**DIFFUSION COEFFICIENT:** The rate of moisture or other fluid absorption of a material with time at a given temperature.

## SAE AIR4844

## 3.4 (Continued):

**DILUENT:** An ingredient usually added to an adhesive to reduce the concentration of bonding materials. A diluting agent, any liquid or solid which, when added to another liquid or solid, reduces the quantity per unit volume of the base material in the total volume. A reactive diluent may also take part in the curing action and is primarily used to reduce viscosity. See ASTM D 907.

**DIMENSIONAL STABILITY:** Ability of a plastic part to retain the precise shape to which it was molded, cast, or otherwise fabricated.

**DIPOLE MOMENT:** See Reference 2.15. In covalent molecules, where the bonding depends upon a sharing of electrons between atoms, the distribution of electron charge density may not be symmetrical. If the electronegativity of the atoms is significantly different then there will be a bias in this charge density towards the nucleus with the higher electronegativity. Thus, while the molecule will be overall electrically neutral, one end will carry a small negative charge (excess of electron density) and the other will carry a small positive charge (deficit of electron density). This situation is called "dipole" and the molecule is said to have a "dipole moment".

**DISBOND:** An area within a bonded interface between two adherents in which an adhesion failure or separation has occurred. It may occur at any time during the life of the structure and may arise from a wide variety of causes. Also, colloquially, an area of separation between two laminae in the finished laminate (in this case, the term delamination is normally preferred). See also debond.

**DISPERSION:** A heterogeneous system in which a finely divided material is distributed in another material. See ISO 472.

**DISPERSION FORCES:** Often called Van der Waals forces are responsible for most of the adhesion forces involved in adhesive bonding. See Reference 2.15. An adequate explanation of this term is lengthy and somewhat difficult.

**DISPLACEMENT ANGLE:** In filament winding the advancement distance of the winding ribbon on the equator after one complete circuit.

**DISSIPATION FACTOR:** Refers to the distortion in phase of the alternating voltage caused by the material. It is computed from the difference in phase angle from the imposed voltage. Low values are preferred.

**DISTORTION:** In fabric, the displacement of fill fiber from the 90° angle (right angle) relative to the warp fiber. In a laminate, the displacement of the fibers (especially at radii), relative to their idealized location, due to motion during lay-up and cure.

**DISTRIBUTION:** A formula which gives the probability that a value will fall within prescribed limits. See Normal, Weibull, and Lognormal Distributions. MIL-HDBK-17.

## SAE AIR4844

## 3.4 (Continued):

**DOCTOR BLADE OR BAR:** A straight piece of material used to spread resin, as in application of a thin film of resin for use in hot melt prepregging or for use as an adhesive film. Also called paste metering blade. See ASTM D 907 and ISO 472.

**DOCTOR ROLL:** A roller mechanism that is revolving at a different surface speed, or in an opposite direction, resulting in a wiping action for regulating the adhesive supplied to the spreader roll.

**DOLLY:** In filament winding, the planar reinforcement applied to a local area between windings to provide extra strength in an area where a cut-out is to be made, for example, port openings. Usually placed at the knuckle joints of cylinder to dome.

**DOME:** In filament winding, the portion of a cylindrical container that forms the spherical or elliptical shell ends of the container.

**DOUBLE CANTILEVER BEAM TEST (DCB):** See ASTM D 3433 for both the parallel and tapered adherend versions. Used to obtain more accurate values of Mode I adhesive fracture energy than those obtained from wedge tests. The tapered version can be made by tapering depth or width. The latter is favored for composite specimens. Both tapered versions are designed to give a constant value of fracture energy with increasing crack length.

**DOUBLE CURVATURE:** See Complex Curvature.

**DOUBLE SPREAD:** The application of adhesive to both adherends in a joint. See ASTM D 907.

**DOUBLER:** (i) Localized area of extra layers of reinforcement, usually to provide stiffness or strength for fastening or other abrupt load transfers. See tabs. (ii) An extra piece of facing attached to strengthen or stiffen the panel or to distribute the load more widely into the core. ASTM C 274.

**DRAFT:** The taper or slope of the vertical surfaces of a mold designed to facilitate removal of molded parts.

**DRAFT ANGLE:** The angle of a taper on a mandrel or mold that facilitates removal of the finished part. The angle between the tangent to the surface at that point and the direction of ejection.

**DRAPE:** The ability of a fabric or prepreg to conform to a contoured surface.

**DRAW:** To shape plastic by stretching or deforming through dies.

**DRAWN FIBER:** Fiber with a certain amount of orientation imparted by the drawing process by which it was formed.

## SAE AIR4844

## 3.4 (Continued):

DRY: (i) To remove standing water from a part that has been in service.  
(ii) To remove absorbed moisture from a part that has been in service using moderate heat or heat and vacuum. Composite parts require drying before repair.

DRY (VERB): To change the physical state of an adhesive on an adherent by the loss of solvent constituents by evaporation or absorption.

DRY FIBER AREA: Area of fiber not totally encapsulated by resin.  
MIL-HDBK-17.

DRY ICE: Solid form of carbon dioxide, which has a temperature of  $-78^{\circ}\text{C}$  at atmospheric pressure. Also known as "DRIKOLD". Should not be used without good ventilation because as it evaporates the proportion of carbon dioxide in the air may reach unsafe levels.

DRY JOINTS: Lack of adhesion due to insufficient adhesive or poor contact of mating surfaces.

DRY LAMINATE: A laminate containing insufficient resin for complete bonding of the reinforcement. See also resin-starved area.

DRY LAY-UP: Construction of a laminate by the layering of preimpregnated reinforcement (partly cured resin) in a female mold or on a male mold, usually followed by bag molding or autoclave molding.

DRY SPOT: Of a laminate, the area of incomplete surface film on laminated plastics. In laminated glass, an area over which the interlayer and the glass have not become bonded. (See also resin starved area). See ISO 472.

DRY STRENGTH: The strength of an adhesive joint determined immediately after drying under specified conditions or after a period of conditioning in a standard laboratory atmosphere.

DRY WINDING: A term used to describe filament winding using preimpregnated roving, as differentiated from wet winding, where unimpregnated roving is pulled through a resin bath just before being wound on to a mandrel. See also wet winding.

DRYING OIL: One of the many natural, usually vegetable oils - the glyceryl esters of unsaturated fatty acids - that harden in air by oxidation to a resinous skin. Typical drying oils are linseed and tung oils. Drying oils are the binding agents of oil paints and varnishes and some adhesive coatings.

DRYING TEMPERATURE: The temperature to which an adhesive on an adherent or in any assembly, or the assembly itself, is subjected to dry the adhesive.

## SAE AIR4844

## 3.4 (Continued):

**DRYING TIME:** (i) The time required to dry a component with absorbed moisture to a specified level that can be measured. (ii) The time specified for drying a component, which is considered sufficient to achieve an adequate condition for bonding, when measurement methods are not available.

**DRYING TOWER:** In prepregging via a solvent process, a conveyor belt carries the prepreg through a drying section which uses heated air to remove excess solvent from the prepreg. Usually this heated section is vertical, due to space limitations.

**DSC:** See differential scanning calorimetry.

**DTA:** See differential thermal analysis.

**DUCTILITY:** The amount of plastic strain that a material can withstand before fracture. Also, the ability of a material to deform plastically before fracturing.

**DUPLEX FILM:** An adhesive film (Type II, Boeing) that has two different adhesives separated by a scrim cloth that is manufactured into one film. BMS - 5 - 70 is a duplex film with epoxy on one side and nitrile-phenolic on the other.

**DWELL:** (i) A pause in the application of pressure or temperature to a mold, made just before it is completely closed, to allow the escape of gas from the molding material. (ii) In filament winding, the time that the traverse mechanism is stationary while the mandrel continues to rotate to the appropriate point for the traverse to begin a new pass. (iii) In a standard autoclave cure cycle, an intermediate step in which the resin matrix is held at a temperature below the cure temperature for a specified period of time sufficient to produce a desired degree of staging used primarily to control resin flow.

**DYNAMIC MODULUS:** The ratio of stress to strain under vibratory conditions (calculated from data obtained from either free or forced vibration tests, in shear, compression, or elongation).

## 3.5 E:

**EDGE BLEED:** Removal of volatiles and excess resin through the edge of the laminate, as in matched die molding of a laminate. In autoclaved parts, edge bleeding is discouraged, since excess resin will only be removed from the area near an edge, resulting in uneven resin distribution. May also be called "Squeeze Out" or "Horizontal Bleed". For small repairs work is going on to establish whether "Squeeze Out" is better than "Vertical Bleed" for reducing void content.

**EDGE CLOSE-OUTS:** Members placed around the panel sides to protect the sandwich from damage or to attach the panel to a support or other panel.

## SAE AIR4844

## 3.5 (Continued):

**EDGE DELAMINATION:** A separation of the detail parts along an edge after the assembly has been cured.

**EDGE DISTANCE RATIO:** The distance from the center of the bearing hole to the edge of the specimen in the direction of the principal stress, divided by the diameter of the hole.

**EDGE JOINT:** A joint made by bonding the edge faces of two adherents.

**EDGEWISE:** Refers to cutting specimens and to the application of load. The load is applied edgewise when it is applied to the edge of the original sheet or specimen. For compression-molded specimens of square cross-section the edge is the surface parallel to the direction of motion of the molding plunger. For injection molded specimens of square cross section this surface is selected arbitrarily; for laminates the edge is the surface perpendicular to the laminae. (See also flatwise).

**E-GLASS:** A family of glasses with a calcium aluminoborosilicate composition and a maximum alkali content of 2.0%. A general purpose fiber that is most often used in reinforced plastics, and is suitable for electrical laminates because of its high resistivity. Also called electric glass.

**EJECTION:** Removal of the molded part from the mold by mechanical means or with compressed air.

**EJECTION RAM:** A small hydraulic ram fitted to a press to operate the ejector pins.

**ELASTIC DEFORMATION:** The part of the total strain in a stressed body that disappears upon removal of the stress.

**ELASTICITY:** That property of materials by virtue of which they tend to recover their original size and shape after removal of a force causing deformation. See also viscoelasticity. See ISO 472.

**ELASTIC LIMIT:** The greatest stress a material is capable of sustaining without permanent strain remaining after the complete release of the stress. A material is said to have passed its elastic limit when the load is sufficient to initiate plastic, or nonrecoverable, deformation. See ISO 472.

**ELASTIC RECOVERY:** (i) The fraction of a given deformation that behaves elastically. (ii) A perfectly elastic material has an elastic recovery of 1; a perfectly plastic material has an elastic recovery of 0.

**ELASTIC RECOVERY:** = elastic extension divided by total extension

**ELASTOMER:** A material that substantially recovers its original shape and size at room temperature after removal of a deforming force. See ASTM D 907 and ISO 472.

## SAE AIR4844

## 3.5 (Continued):

**ELASTOMERIC TOOLING:** A tooling system that uses the pressure from the thermal expansion of rubber materials to form composite parts during cure.

**ELECTRIC STRENGTH; DIELECTRIC STRENGTH:** The property of a dielectric which opposes a disruptive discharge. It is measured by the intensity of the electric field which will break down the dielectric. See ISO 472.

**ELECTRICAL DISSIPATION FACTOR:** The ratio of the power loss in a dielectric material to the total power transmitted through it; thus, the imperfection of the dielectric. Equal to the tangent of the loss angle.

**ELECTROFORMED MOLDS:** A mold made by electroplating metal on the reverse pattern of the cavity. Molten steel may then be sprayed on the back of the mold to increase its strength. Nickel is sometimes used for this purpose.

**ELECTROLYTE:** Any substance which, when dissolved in water or other suitable solvent, forms a solution that conducts electricity, the conductivity being due to ionic dissociation of the dissolved substance. Also a solution of an electrolyte.

**ELEVATED TEMPERATURE REPAIR:** A repair using a resin system that will be cured at temperatures above 70 °C (160 °F).

**ELONGATION:** Deformation caused by stretching. The fractional increase in length of a material stressed in tension. (When expressed as percentage of the original gauge length, it is called percentage elongation). See ISO 472.

**ELONGATION AT BREAK:** Elongation recorded at the moment of rupture of the specimen, often expressed as a percentage of the original length.

**ELUATE:** The liquid emerging from a column (in liquid chromatography). (MIL-HDBK-17)

**ELUENT:** The mobile phase used to sweep or elute the sample (solute) components into, through and out of the column. (MIL-HDBK-17)

**EMC:** Elastomeric molding tooling compound.

**EMI/RFI:** Electromagnetic/radio frequency interference

**EMISSIVITY:** The ratio of the total heat radiating power of a surface to that of a black body of the same area and the same surface temperature.

**EMULSIFIER:** A material which, when added to a mixture of dissimilar materials such as oil and water, will produce a stable, homogeneous emulsion.

**EMULSION:** A suspension of fine particles or globules of a liquid within a liquid. See ASTM D 907.

## SAE AIR4844

## 3.5 (Continued):

**ENCAPSULATION:** The enclosure of an item in plastic, or other material. Sometimes used specifically in reference to the enclosure of capacitors or circuit board modules. See ISO 472.

**END:** A strand of roving consisting of a given number of filaments gathered together. The group of filaments is considered an "end" or strand before twisting and a "yarn" after twist has been applied. An individual warp yarn, thread, fiber, or roving.

**END COUNT:** An exact number of ends supplied on a ball of roving.

**ENDOTHERMIC:** A chemical reaction which absorbs heat energy is said to be endothermic. A compound, the formation of which absorbs heat, is an endothermic compound. Such compounds are less stable than exothermic compounds, many of them being explosive.

**ENDURANCE LIMIT:** See fatigue limit.

**ENTRAINED AIR:** Air forced into liquid systems by the action of applicator mechanisms working in the mass. (Differentiated from foam particles in that the entrained air is not readily dissipated and tends to give false viscosity properties.)

**ENVIRONMENT:** The aggregate of all conditions (such as contamination, temperature, humidity, radiation, magnetic and electric fields, shock, and vibration) that externally influence the performance of an item.

**ENVIRONMENTAL STRESS CRACKING (ESC):** The susceptibility of a thermoplastic resin to crack or craze when in the presence of surface active agents or other environments.

**EPICHLOROHYDRIN:** The basic epoxidizing resin intermediate in the production of epoxy resins. It contains an epoxy group and is highly reactive with polyhydric phenols such as bisphenol A.

**EPOXIDE:** Compound containing the oxirane structure, a three-member ring containing two carbon atoms and one oxygen atom. The most important members are ethylene oxide and propylene oxide.

**EPOXIDE EQUIVALENT:** The weight of a resin in grams which contains 1 gram equivalent of epoxy.

**EPOXY RESIN:** A polymerizable thermoset polymer containing one or more epoxide groups and curable by reaction with amines, alcohols, phenols, carboxylic acids, acid anhydrides, and mercaptans. An important matrix resin in composites and structural adhesives. See ISO 472.

**EPOXY SILANE FINISH:** A finish applied to glass fiber for printed circuit boards. Used on epoxy/glass prepregs.

## SAE AIR4844

## 3.5 (Continued):

**EQUATOR:** In filament winding, the line in a pressure vessel described by the junction of the cylindrical portion and the end dome. Also called tangent line or point.

**EQUILIBRIUM WATER UPTAKE:** Point at which the rate of increase of water uptake is virtually nil.

**EROSION:** Destruction of metal or other material by the abrasive action of liquid or gas. Usually accelerated by the presence of solid particles of matter in suspension and sometimes by corrosion.

**ERM:** Elastic reservoir molding

**ESC:** See environmental stress cracking.

**ESD:** Electrostatic discharge - A large electrical potential (4000 V or more) moving from one surface or substance to another. ESD is also an abbreviation for electrostatic dissipation.

**ESTER:** The reaction product of an alcohol and an acid.

**EUTECTIC MIXTURE:** A mixture of two or more substances in such a ratio that it has the lowest melting point of any combination.

**EVEN TENSION:** The process whereby each end of roving is kept in the same degree of tension as the other ends making up that ball of roving. See also catenary.

**EXFOLIATION:** A surface defect on composite parts where the resin appears scaled or flaky.

**EXFOLIATION (METALLIC):** With metals, especially some aluminum alloys, exfoliation occurs due to corrosion. Exfoliation corrosion is a type of intergranular corrosion. It occurs when corrosion at the grain boundaries below the surface pushes up the metallic grains on the surface. Exfoliation corrosion occurs most commonly on extruded sections.

**EXOTHERM:** The liberation or evolution of heat during the curing of a plastic product or during any chemical reaction.

**EXOTHERMIC REACTION:** A reaction obtained when mixing certain substances together characterized by the evolution of heat. A reaction that gives off heat when certain substances are mixed together. The mixing of the two parts of an epoxy resin system produces an exothermic reaction. Exotherm can exceed curing temperature if uncontrolled.

**EXPANDABLE TOOLING:** Use of a hollow rubber mandrel which can be pressurized to form composite hardware during cure.

## SAE AIR4844

## 3.5 (Continued):

EXTEND: (i) To add fillers or low cost materials in an economy producing endeavor. (ii) To add inert materials to improve void-filling characteristics and reduce crazing.

EXTENDERS: Low cost materials used to dilute or extend high cost resins without extensive lessening of properties. See also fillers. See ISO 472.

EXTENSIBILITY: The ability of material to extend or elongate upon application of sufficient force, expressed as percent of the original length.

EXTENSIONAL-BENDING COUPLING: A property of certain classes of laminates that exhibit bending curvatures when subjected to extensional loading.

EXTENSIONAL-SHEAR COUPLING: A property of certain classes of laminates that exhibit shear strains when subjected to extensional loading.

EXTENSOMETER: A mechanical or optical device for measuring linear strain due to mechanical stress.

## 3.6 F:

FAA: Federal Aviation Administration

FABRIC: A material made of woven fibers or filaments.

FABRIC NONWOVEN: See nonwoven fabric.

FABRIC WOVEN: See woven fabric.

FABRICATING (FABRICATION): The manufacture of products from molded parts, rods, tubes, sheeting, extrusions, or other forms by appropriate operations, such as punching, cutting, drilling, and tapping. Fabrication includes fastening parts together or to other parts by mechanical devices, adhesives, heat sealing, welding, or other means.

FABRIC FILL FACE: That side of the woven fabric where the greatest number of the yarns are perpendicular to the selvage.

FABRIC PREPREG BATCH: Prepreg containing fabric from one fabric batch, impregnated with one batch of resin in one continuous operation.

FABRIC WARP FACE: That side of the fabric where the majority of the yarns are parallel to the selvage.

FACE DIMPLING: Buckling of the compressive facing into a honeycomb cell. ASTM C 274.

FACE WRINKLING: Buckling of the compressive facing into or away from the core. ASTM C 274.

## SAE AIR4844

## 3.6 (Continued):

**FACINGS:** (i) Skins and doublers in any layup. (ii) The outermost layer or composite component of a sandwich construction, generally thin and of high density, which resists most of the edgewise loads and flatwise bending moments, synonymous with face, skin, and facesheet. ASTM C 274.

**FADEOMETER:** An apparatus for determining the resistance of resins and other materials to fading. This device accelerates the fading by subjecting the article to high intensity ultra-violet rays of approximately the same wavelength as sunlight.

**FADING:** Any lightening of an initial color possessed by any material. Measured by accelerating the process by subjecting the material to high intensity ultraviolet rays of approximately the same wavelength as sunlight.

**FAILURE:** An event which occurs when a material, device, equipment or system ceases to perform its intended function acceptably.

**FAIRING:** A member or structure, the primary function of which is to streamline the flow of a fluid by producing a smooth outline and to reduce drag, as in aircraft frames and boat hulls.

**FAN:** In glass-fiber forming the fan shape is that made by the filaments between the bushing and the shoe.

**FATIGUE:** (i) The failure or decay of mechanical properties after repeated applications of stress. Fatigue tests give information on the ability of a material to resist the development of cracks, which eventually bring about failure as a result of a large number of cycles. The phenomenon leading to fracture under repeated or fluctuating stresses having a maximum value less than the tensile strength of the material. Fatigue fractures are progressive, beginning as minute cracks that grow under the action of the fluctuating stress. See ISO 472. (ii) In composites the effect of cyclic damage (fatigue) is manifested in different ways to metals e.g., splitting and delamination, matrix cracking and eventually fiber breakage. Although the failure modes are different the failure of composites under cyclic loading fits the basic definition of fatigue given in the first sentence of (i).

**FATIGUE LIFE:** The number of cycles of deformation required to bring about failures of the test specimen under a given set of oscillating conditions (stresses or strains). See ISO 472.

**FATIGUE LIMIT:** The stress level below which a material can be stressed cyclically for an infinite number of times without failure. See ISO 472.

**FATIGUE RATIO:** The ratio of fatigue strength to tensile strength. Mean stress and alternating stress must be stated.

**FATIGUE STRENGTH:** The maximum cyclical stress a material can withstand for a given number of cycles before failure occurs. The residual strength after being subjected to fatigue.

## SAE AIR4844

## 3.6 (Continued):

**FATTY ACID:** An organic acid obtained by the hydrolysis (saponification) of natural fats and oils, for example stearic and palmitic acids.

**FAYING SURFACE:** The surfaces of materials in contact with each other and joined or about to be joined together full stop.

**FEATHERING:** The tapering of an adherend on one side to form a wedge section, as used in a scarf joint.

**FELT:** A fibrous material made up of interlocked fibers by mechanical or chemical action, moisture, or heat. Made from fibers such as asbestos, cotton, glass, etc. See also batt.

**FIBER:** A general term used to refer to filamentary materials. Often fiber is used synonymously with filament. It is a general term for a filament with a finite length that is at least 100 times its diameter, which is typically 0.10 to 0.13 mm (0.004 to 0.005 in). In most cases it is prepared by drawing from a molten bath, spinning, or deposition on a substrate. See whisker. Fibers can be continuous or specific short lengths (discontinuous), normally no less than 3.2 mm (0.125 in). See ISO 472.

**FIBER AREAL WEIGHT (FAW):** The weight of fiber per unit area in a prepreg (or dry cloth) material. The weight of resin, including finish on the fiber, is not included in this value. Typical units are grams per square meter.

**FIBER-COMPOSITE MATERIAL:** A material consisting of two or more discrete physical phases, in which a fibrous phase is dispersed in a continuous matrix phase. The fibrous phase may be macro, micro, or submicroscopic, but it must retain its physical identity so that it could conceivably be removed from the matrix intact.

**FIBER CONTENT:** The amount of fiber present in a composite. This is usually expressed as a percentage volume fraction or weight fraction of the composite.

**FIBER COUNT:** The number of fibers per unit width of ply present in a specified section of a composite.

**FIBER DIAMETER:** The measurement (expressed in hundred thousandths) of the diameter of individual filaments.

**FIBER DIRECTION:** The orientation or alignment of the longitudinal axis of the fiber with respect to a stated reference axis.

**FIBERGLASS:** An individual filament made by drawing molten glass. A continuous filament is a glass fiber of great or indefinite length. A staple fiber is a glass fiber of relatively short length, generally less than 430 mm (17 in), the length related to the forming or spinning process used. A general term having the same meaning as fiberglass reinforcement below.

## SAE AIR4844

## 3.6 (Continued):

**FIBERGLASS REINFORCEMENT:** Material used to reinforce a resin matrix using continuous or discontinuous glass fibers. Available as mat, roving, fabric, etc., it is incorporated into both thermosets and thermoplastics.

**FIBER-MATRIX INTERFACE:** The region separating the fiber and matrix phases, which differs from them chemically, physically and mechanically. In most composite materials, the interface has a finite thickness (nanometers to thousands of nanometers) because of diffusion or chemical reactions between the fiber and matrix. Thus, the interface can be more properly described by the terms "interphase" or "interfacial zone". When coatings are applied to the fibers or several chemical phases have well defined microscopic thicknesses, the interfacial zone may consist of several interfaces.

**FIBER ORIENTATION:** Alignment of warp fibers in accordance with an engineering drawing. Can also mean fiber alignment in a nonwoven or mat laminate where the majority of fibers are in the same direction, resulting in a higher strength in that direction.

**FIBER PATTERN:** Visible fibers on the surface of laminates or molding. The thread size and weave of glass cloth.

**FIBER-REINFORCED PLASTIC (FRP):** A general term for a composite that consists of a resin reinforced with cloth, tape, mat, or strands or any fiber form and using any type of fiber.

**FIBER SHOW:** Strands or bundles of fibers that are not covered by plastic and that are at or above the surface of a composite. See ISO 472.

**FIBER SYSTEM:** The type and arrangement of fibrous material which comprises the fiber constituent of an advanced composite. Examples of fiber systems are collimated filaments or filament yarns, woven fabric, randomly oriented short-fiber ribbons, random fiber mats, whiskers etc. (MIL-HDBK-17)

**FIBER WASH:** Splaying out of woven or nonwoven fibers from the general reinforcement direction. Fibers are carried along with bleeding resin during cure.

**FILAMENT:** The smallest unit of a fibrous material. The basic units formed during drawing and spinning, which are gathered into strands of fiber for use in composites. Filaments usually are of extreme length and very small diameter, usually less than 25  $\mu\text{m}$  (1 mil). Normally, filaments are not used individually. Some textile filaments can function as a yarn when they are of sufficient strength and flexibility. See ISO 472.

**FILAMENT WOUND:** Pertaining to an object created by the filament winding method of fabrication.

## SAE AIR4844

## 3.6 (Continued):

**FILAMENTARY COMPOSITES:** A major form of advanced composites in which the fiber constituent consists of continuous filaments. Filamentary composites are defined here as composite materials composed of laminae in which the continuous filaments are in nonwoven, parallel, uniaxial arrays. Individual uniaxial laminae are combined into specifically oriented multiaxial laminates for application to specific envelopes of strength and stiffness requirements.

**FILAMENT WEIGHT RATIO:** In a composite material, the ratio of filament weight to the total weight of the composite.

**FILAMENT WINDING:** A process for fabricating a composite structure in which continuous reinforcements (filament, wire, yarn, tape, or other), either previously impregnated with a matrix material or impregnated during the winding, are placed over a rotating and removable form or mandrel in a prescribed way to meet certain stress conditions. Generally the shape is a surface of revolution and may or may not include end closures. When the required number of layers is applied, the wound form is cured and the mandrel removed. See ISO 472.

**FILL:** Yarn oriented at right angles to the warp in a woven fabric. Also called "weft" or "woof".

**FILLER:** A relatively inert substance added to a material to alter its physical, mechanical, thermal, electrical, and other properties or to lower cost or density. Sometimes the term is used specifically to mean particulate additives. See also inert filler. See ASTM D 907 and ISO 472.

**FILLER PLY:** Partial plies of a lay-up, usually located on honeycomb sandwich edge bands, which do not extend on to any portion of the honeycomb surface. Partial plies of a lay-up which run up to, but not on to a honeycomb sandwich assembly. Used to thicken the edge for countersunk screws or bolts. A partial ply used to stabilize or fill a local area.

**FILLET:** A rounded filling of adhesive that fills the corner or angle where two adherents are joined.

**FILLING YARN:** The transverse threads of fibers in a woven fabric. Those fibers running perpendicular to the warp. Also called weft.

**FILM:** A thin plane product of arbitrarily limited maximum thickness in which the thickness is very small in proportion to length and width, generally supplied in roll form. See ISO 472.

**FILM ADHESIVE:** A synthetic resin adhesive, usually of the thermosetting type, in the form of a thin, dry film of resin with or without a paper, glass, or other carrier.

## SAE AIR4844

## 3.6 (Continued):

**FINISH:** Chemical finish applied to glass fibers to facilitate resin wetting, resin bonding and good environmental performance of a cured laminate. Also improves fabric handling. A dilute epoxy finish is sometimes used on carbon fiber before prepregging. A number of finishes are used on glass-fiber fabrics and tapes depending on the resin system to be used. In order to ensure a good, durable bond it is absolutely essential that the glass to be used has been treated with a finish compatible with the chosen resin system, i.e., polyester, epoxy, phenolic, or other resin. Tables of resins and suitable glass finishes are supplied by glass-fiber manufacturers.

**FIRST-ORDER TRANSITION:** A change of state associated with crystallization or melting of a polymer.

**FIXTURES:** See tooling.

**FLAME RESISTANCE:** Ability of a material to extinguish flame once the source of heat is removed. See also self-extinguishing resin.

**FLAME RETARDANTS:** Certain chemicals that are used to reduce or eliminate the tendency of a resin to burn.

**FLAME RETARDED RESIN:** A resin compounded with certain chemicals to reduce or eliminate its tendency to burn.

**FLAME SPRAYING:** (i) Method of applying an aluminum coating to nonconducting composite panels to provide lightning protection or electromagnetic shielding to electronic components mounted behind the part. (ii) A method of applying a plastic coating in which finely powdered fragments of a plastic, together with suitable fluxes, are projected through a cone of flame on to a surface.

**FLAMMABLE:** A volatile liquid or gas which has a flash point of 30 °F (-1 °C) or lower. Flammable is synonymous with inflammable.

**FLAMMABILITY:** Measure of the extent to which a material will support combustion.

**FLASH:** That portion of the charge which flows from or is extruded from the mold cavity during the molding. Extra plastic attached to a molding along the parting line, which must be removed before the part is considered finished.

**FLASH MOLD:** A mold designed to permit the escape of excess molding material; such a mold relies on back pressure to seal the mold and put the piece under pressure.

**FLASH POINT:** The temperature to which a liquid must be heated before its vapors will flash or burn momentarily when a small flame is applied. This ignition will not take place unless there is also a spark or open flame. There are several standard methods of determining flash point, most of which are classified as "open cup" or "closed cup".

## SAE AIR4844

## 3.6 (Continued):

**FLASHBREAKER TAPE:** This is a tape used around the edge of a bonded joint so that any adhesive that spews out of the joint during curing can be easily removed. A spew or fillet can be beneficial to bond strength so it should be left in place if removal is not essential for cosmetic or other reasons.

**FLAT LAY:** (i) The property of nonwarping in laminating adhesives. (ii) An adhesive material with good noncurling and nondistension characteristics.

**FLATWISE:** Refers to cutting specimens and the application of load. The load is applied flatwise when it is applied to the face of the original sheet or specimen. See ISO 472.

**FLEXIBILIZER:** An additive that makes a finished plastic more flexible. See also plasticizer.

**FLEXIBLE MOLDS:** Molds made of rubber or elastomeric plastics, used for casting plastics. They can be stretched to remove cured pieces with undercuts.

**FLEXURAL MODULUS:** The ratio, within the elastic limit, of the applied stress on a test specimen in flexure to the corresponding strain in the outermost fibers of the specimen.

**FLEXURAL RIGIDITY:** The quantity  $E \times I$  is known as the flexural rigidity of a beam and is the Young's Modulus of the material multiplied by the Moment of Inertia of the cross section of the beam. See textbooks for more detail.

**FLEXURAL STRENGTH:** The maximum stress that can be borne by the surface fibers in a beam in bending. The flexural strength is the unit resistance to the maximum load before failure by bending, usually expressed in force per unit area.

**FLOAT:** A place in the fabric where a warp or filling yarn extends unbound over the yarns with which it should be interlaced.

**FLOATING ROLLER PEEL TEST:** See ASTM D 3167. The purpose of this test method is to provide for the determination of the metal-to-metal peel strength of adhesives by a method that will provide good reproducibility at low, as well as at high, strength levels and yet allow for a simple method of test specimen preparation and testing. It provides for the determination of relative peel resistance of adhesive bonds between one rigid adherend and one flexible adherend. This method provides a fixed peel angle whereas in the "T" peel test, even when adherends are of the same material and equal thickness, the angle of peel may vary.

**FLOW:** (i) The movement of resin under pressure, allowing it to fill all parts of a mold. (ii) The gradual but continuous distortion of a material under continued load, usually at high temperatures. Also called creep. (iii) A qualitative description of the fluidity of an adhesive material during the process of bonding, before the adhesive is set.

**FLOW LINE:** A mark on a molded piece made by the meeting of two flow fronts during molding. Also called striae, weld mark, or weld line.

## SAE AIR4844

## 3.6 (Continued):

**FLOW MARKS:** Wavy surface appearance of an object molded from thermoplastic resins, caused by improper flow of the resin into the mold.

**FLUOROPLASTICS:** Polyolefin polymers in which fluorine, fluorinated alkyl groups or other halogens replace hydrogen atoms in the carbon chain. This structure has outstanding electrical properties, excellent resistance to chemical attack, low coefficient of friction, excellent fire resistance, exceptionally good performance at high and low temperatures, low moisture absorption and outstanding weatherability. Fluoroplastics include PTFE, FEP, PFA, CTFE, ECTFE, ETFE, and PVDF. Strength is low to moderate. Cost is high.

**FLUTED CORE:** An integrally woven reinforcement material consisting of ribs between two skins in a unitized sandwich construction. Fluted core radomes consist of two fiberglass, or other nonconducting skins, separated by square fiberglass tubes. The tubes are impregnated with resin and laid side by side as an alternative to honeycomb core. The shape of the tubes is maintained by a wax mandrel which is melted out after the resin has cured. The advantage of this method is that any water penetrating the skin is automatically drained away. Other varieties of fluted core are also available.

**FLUTES ORIENTATION:** Direction of flutes, which are in direct contact with the skins.

**FOAM:** See cellular plastic.

**FOAMED PLASTICS:** Resins in sponge form, flexible or rigid, with cells closed or interconnected and density over a range from that of the solid parent resin to 0.030 g/cm<sup>3</sup>. Compressive strength of rigid foams is fair, making them useful as core materials for sandwich constructions. Also, a chemical cellular plastic, the structure of which is produced by gases generated from the chemical interaction of its constituents.

**FOAMING AGENT:** Chemicals added to plastics and rubbers that generate inert gases on heating, causing the resin to assume a cellular structure.

**FOAMING FILM ADHESIVE:** An adhesive film used to join honeycomb core in bonded assemblies. Contains a foaming agent that produces an expansion ratio, usually between 2 and 3, during cure.

**FOAM-IN-PLACE:** Refers to the deposition of foams when the foaming machine must be brought to the work that is "in place" as opposed to bringing the work to the foaming machine. Also, foam mixed in a container and poured into a mold, where it rises to fill the cavity.

**FOD:** Foreign object damage

**FORCE:** The male half of the mold that enters the cavity, exerting pressure on the resin and causing it to flow. Also called punch.

## SAE AIR4844

## 3.6 (Continued):

**FOREIGN OBJECT:** Any object that causes damage to an aircraft, e.g., stones or other materials from a runway, tools left in an engine intake or other material sucked in by the airflow. Hail impact and bird strikes are usually considered separately and metallic or nonmetallic particles in an adhesive which are not part of its formulation.

**FP FIBER:** Polycrystalline alumina fiber ( $Al_2O_3$ ). A ceramic fiber useful for high-temperature (1370 to 1650 °C, or 2500 to 3000 °F) composites.

**FPF:** First ply failure

**FRACTURE:** The separation of a body. Defined both as rupture of the surface without complete separation of laminate and as complete separation of a body because of external or internal forces.

**FRACTURE DUCTILITY:** The true plastic strain at fracture. (MIL-HDBK-17)

**FRACTURE STRESS:** The true, normal stress on the minimum cross-sectional area at the beginning of fracture.

**FRACTURE TOUGHNESS:** A measure of the damage tolerance of a material containing initial flaws or cracks. Used in aircraft structural design and analysis.

**FRAT:** Fiber-reinforced advanced titanium

**FREE RADICAL:** Compound which contains at least one unpaired electron in place of the more normal and more stable bond consisting of shared electrons

**FREE-RADICAL POLYMERIZATION:** A type of polymerization in which the propagating species is a long-chain free radical initiated by the introduction of free radicals from thermal or photochemical decomposition.

**FREE WALL:** The portion of a honeycomb cell wall that is not connected to another cell

**FRP:** See fiber-reinforced plastic.

**FUMED SILICA:** Trade Name CAB-O-SIL. Silica powder used as filler in epoxy resins.

**FUNGUS RESISTANCE:** The resistance of a material to attack by fungi in conditions promoting their growth.

**FURANE PLASTICS:** Dark colored thermosetting resins obtained primarily by the condensation polymerization of furfuryl alcohol in the presence of strong acids, sometimes in combination with formaldehyde or furfuryl aldehyde. The term also includes resins made by condensing phenol with furfuryl alcohol or furfuryl and furfuryl ketone polymers. The resins are available as liquids ranging from low viscosity fluids to thick, heavy syrups which cure to highly cross-linked, brittle substances. Also spelled "Furan". See ISO 472.

## SAE AIR4844

## 3.6 (Continued):

**FURFURAL RESIN:** A synthetic resin of the thermosetting type obtained by the condensation of furfural with phenol or its homologs. See ISO 472.

**FUSIBLE:** Capable of being melted and formed into a continuous adhesive film. The property of adhesive melting in combination with substrate melting to form a homogeneous mass at the interface.

**FUZZ:** Accumulation of short broken filaments after passing glass strands, yarns, or rovings over a contact point. Often weighted and used as an inverse measure of abrasion resistance.

**FUZZBALL:** Loose or frayed fibers that have formed into a ball and are entwined either with the fabric or on the surface. A minor fuzzball is loose or frayed fibers which are not raised above the fabric surface.

## 3.7 G:

**GALVANIC CELL:** A cell made up of two dissimilar conductors in contact with an electrolyte or two similar conductors in contact with dissimilar electrolytes. More generally a galvanic cell converts energy liberated by a spontaneous chemical reaction directly into electrical energy.

**GALVANIC CORROSION:** Corrosion associated with the current of a galvanic cell made up of dissimilar electrodes.

**GALVANIC SERIES:** A list of metals, but including graphite, starting with the least noble (magnesium) and ending with the most noble (platinum).

**GAP:** In filament winding, the space between successive windings, which windings are usually intended to lay next to each other. Separations between fibers within a filament winding band. The distance between adjacent plies in a lay-up of unidirectional tape materials.

**GAP-FILLING ADHESIVE:** An adhesive subject to low shrinkage in setting, used as sealant. An adhesive with sufficient viscosity to fill a gap and not run out of it.

**GATE (In injection and transfer molding):** The channel or orifice through which material is injected from the sprue (or runner in a multicavity mold) into a mold cavity. ISO 472.

**GAUGE LENGTH:** Length over which deformation is measured for a tensile or compressive test specimen. The deformation over the gauge length divided by the gauge length determines the strain. See ISO 472.

**GEL:** The initial jellylike solid phase that develops during the formation of a resin from a liquid. A semisolid system consisting of a network of solid aggregates in which liquid is held. See ISO 472.

**GELATION:** The point in a resin cure when the resin viscosity has increased to a point such that it barely moves when probed with a sharp instrument.

## SAE AIR4844

## 3.7 (Continued):

**GELATION TIME:** That interval of time, in connection with the use of synthetic thermosetting resins, extending from the introduction of a catalyst into a liquid adhesive system until the start of gel formation. Also, the time under application of a specified temperature for a resin to reach a solid state. See ISO 472.

**GEL COAT:** A quicksetting resin applied to the surface of a mold and gelled before lay-up. The gel coat becomes an integral part of the finished laminate, and is usually used to improve surface appearance and bonding. See ISO 472.

**GEL PERMEATION CHROMATOGRAPHY (GPC):** A form of liquid chromatography in which the polymer molecules are separated by their ability or inability to penetrate the material in the separation column.

**GEL POINT:** The stage at which a liquid begins to exhibit pseudoelastic properties. This stage may be conveniently observed from the inflection point on a viscosity time plot. The point in a cure beyond which the material will no longer flow without breaking down the matrix network formed to that point. The point at which the matrix transition from a fluid to a solid state takes place. See ISO 472.

**GENERALLY ORTHOTROPIC PLY:** (i) Is an orthotropic ply where the loads are not in the direction of the principal plane of elastic symmetry. (ii) The reference coordinate system does not coincide with the ply axis of an orthotropic ply. In this system the stress/strain relation appears anisotropic. See textbooks for detailed explanation.

**GEODESIC:** The shortest distance between two points on a surface. Also called geodetic.

**GEODESIC ISOTENSOID:** Constant stress level in any given filament at all points in its path.

**GEODESIC-ISOTENSOID CONTOUR:** In filament wound reinforced plastic pressure vessels, a dome contour in which the filaments are placed on geodesic paths so that the filaments will exhibit uniform tensions throughout their length under pressure loading.

**GEODESIC OVALOID:** A contour for end domes, the fibers forming a geodesic line. The shortest distance between two points on a surface of revolution. The forces exerted by the filaments are proportioned to meet hoop and meridional stresses at any point.

**GERBER CUTTER:** A computer controlled reciprocating knife process for cutting, kitting, and labelling prepreg fabric and tape plies.

**GFRP (or GRP):** Glass Fiber Reinforced Plastic

## SAE AIR4844

## 3.7 (Continued):

**GLASS:** An inorganic product of fusion that has cooled to a rigid condition without crystallizing. Glass is typically hard and relatively brittle, and has a conchoidal fracture. Any rigid noncrystalline solid, applied more commonly to noncrystalline inorganic oxides than to noncrystalline polymers.

**GLASS CLOTH:** Conventionally woven glass fiber material. See also scrim.

**GLASS FIBER:** A fiber spun from an inorganic product of fusion that has cooled to a rigid condition without crystallizing. A glass filament that has been cut to a measurable length. Staple fibers of relatively short length are suitable for spinning into yarn.

**GLASS FILAMENT:** A form of glass that has been drawn to a smaller diameter and extreme length. Most filaments are less than 0.15 mm (0.005 in) in diameter.

**GLASS FILAMENT BUSHING:** The unit through which molten glass is drawn in making glass filaments.

**GLASS FINISH:** A material applied to the surface of a glass reinforcement to improve the bond between the glass and the plastic resin matrix.

**GLASS FLAKE:** Thin, irregularly shaped flakes of glass, typically made by shattering a thin-walled tube of glass.

**GLASS FORMER:** An oxide that forms a glass easily. Also, one which contributes to the network of silica glass when added to it.

**GLASS, PERCENT BY VOLUME:** The product of the specific gravity of a laminate and the percent glass by weight, divided by the specific gravity of the glass.

**GLASS STRESS:** In a filament-wound part, usually a pressure vessel, the stress calculated using the load and the cross-sectional area of the reinforcement only.

**GLASS TRANSITION:** The reversible change in an amorphous polymer or in amorphous regions of a partially crystalline polymer from, or to, a viscous or rubbery condition to, or from, a hard and relatively brittle one. See ISO 472.

## SAE AIR4844

## 3.7 (Continued):

**GLASS TRANSITION TEMPERATURE (T<sub>g</sub>):** The approximate midpoint of the temperature range over which the glass transition takes place: glass and silica fiber exhibit a phase change at approximately 955 °C (1750 °F) and carbon/graphite fibers at 2205 to 2760 °C (4000 to 5000 °F). The temperature at which increased molecular mobility results in significant changes in the properties of a cured matrix resin system or plastic fiber. It is the point at which rigid behavior changes to a rubbery behavior. Both fibers and resin matrices have glass transition points but they are usually fairly widely separated. However, in the case of polyethylene and polypropylene fibers their T<sub>g</sub> values are below 0 °C and they require resin matrices that cure well below their melting points. Also, the inflection point on a plot of modulus versus temperature. The measured value of T<sub>g</sub> depends to some extent on the method of test. See ISO 472.

**GLOSS:** The shine, sheen or lustre of a dried film.

**GRANDFATHERED:** Certification of individuals that are considered qualified under a prior qualification program.

**GRAPHITE:** The crystalline allotropic form of carbon.

**GRAPHITE FIBER:** A fiber made from a precursor by oxidation, carbonization, and graphitization process (which provides a graphitic structure). See also carbon fiber.

**GRAPHITIZATION:** The process of pyrolyzation in an inert atmosphere at temperatures in excess of 1925 °C (3500 °F), usually as high as 2480 °C (4500 °F), and sometimes as high as 2700 °C (4890 °F), converting carbon to its crystalline allotropic form. Temperature depends on precursor and properties desired.

**GREENSTICK FRACTURE:** Fracture where the crack does not go right through the material but is deflected part-way through, allowing the remainder of the cross section to deform elastically.

**GREEN STRENGTH:** The ability of the material (such as a urethane elastomer), while not completely cured, to undergo removal from the mold and handling without tearing or permanent distortion.

**GREIGE, GRAY GOODS:** Any fabric before finishing, as well as any yarn or fiber before bleaching or dyeing: therefore, fabric with no finish or size.

**GUIDE PIN:** A pin which guides mold halves into alignment on closing.

**GUIDE PIN BUSHING:** The bushing through which the guide pin moves when the mold is closed.

**GUSSET:** A piece used to give added size or strength in a particular location of an object; the folded-in portion of a flattened tubular film.

## SAE AIR4844

## 3.8 H:

**HACKLES:** Raised strips or striations on a fracture surface caused by an array of small cracks produced during a shear failure.

**HAND:** The softness of a piece of fabric, as determined by the touch (individual judgment).

**HAND LAY-UP:** The process of placing (and working) successive plies of reinforcing material or resin-impregnated reinforcement in position on a mold by hand.

**HANDLING LIFE:** The out-of-refrigeration time over which a material retains its handleability.

**HANDLING STRENGTH:** A low level of strength initially obtained by an adhesive that allows specimens to be handled, moved, or unclamped without causing disruption of the curing process or affecting bond strength.  
See ASTM D 1144.

**HANG PICK:** (Hung filling yarn) A pick (fill yarn) caught on a warp yarn knot producing a triangular shaped hole in the fabric.

**HARDENER:** A substance or mixture added to a plastic composition to promote or control the curing action by taking part in it. The term is also used to designate a substance added to control the degree of hardness of the cured film. See also catalyst. See ASTM D 907 and ISO 472.

**HARDNESS:** The resistance to surface indentation usually measured by the depth of penetration (or arbitrary units related to the depth of penetration) of a blunt point under a given load using a particular instrument according to a prescribed procedure. See also Barcol hardness, Mohs hardness, Rockwell hardness, and Shore hardness.

**HARNES SATIN:** Weaving pattern producing a satin appearance. "Eight-harness" means the warp tow crosses over seven fill tows and under the eighth (repeatedly). Also produced as four harness and five harness.

**HAT:** A member in the shape of a hat.

**HEAT-ACTIVATED ADHESIVE:** A dry adhesive that is rendered tacky or fluid by application of heat, or heat and pressure, to the assembly. See ASTM D 907.

**HEAT BUILDUP:** The rise in temperature in a part resulting from the dissipation of applied strain energy, as heat or from applied mold cure heat. Also caused by exotherm during resin cure. See also hysteresis.

**HEAT CLEANED:** A condition in which glass or other fibers are exposed to elevated temperatures to remove preliminary sizings or binders not compatible with the resin system to be applied.

## SAE AIR4844

## 3.8 (Continued):

**HEAT-CONVERTIBLE RESIN:** A thermosetting resin convertible by heat into an infusible and insoluble mass.

**HEAT-DEFLECTION TEMPERATURE:** The temperature at which a standard test bar deflects a specified amount under a stated load. Now called deflection temperature under load (DTUL).

**HEAT DISTORTION POINT:** The temperature at which a standard test bar deflects a specified amount under a stated load. Now called deflection temperature.

**HEAT-FAIL TEMPERATURE:** The temperature at which delamination occurs under static loading in shear. See ASTM D 4498.

**HEAT RESISTANCE:** The property or ability of plastics and elastomers to resist the deteriorating effects of elevated temperatures.

**HEAT SEALING:** A method of joining plastic films by simultaneous application of heat and pressure to areas in contact.

**HEAT SEALING ADHESIVE:** A thermoplastic film adhesive that is melted between the adherent surfaces by heat application to one or both of the adjacent adherent surfaces.

**HEAT SINK:** A contrivance for the absorption or transfer of heat away from a critical element or part. Bulk graphite is often used as a heat sink. Also a metal part in a composite structure that will act as a heat sink.

**HEAT TREATING:** Term used to cover annealing, hardening, tempering, etc.

**HEATER BLANKET:** Rubber blanket, often silicone rubber for higher temperatures, containing electrical heating elements. Used with a "Hot-Bonder" control unit to heat up repair areas to cure film adhesives and prepregs.

**HELICAL WINDING:** In filament-wound items, a winding in which a filament band advances along a helical path, not necessarily at a constant angle except in the case of a cylinder.

**HERMETICALLY SEALED:** Air tight closure by fusion etc.

**HETEROGENEOUS:** Descriptive term for a material consisting of dissimilar constituents separately identifiable. A medium consisting of regions of unlike properties separated by internal boundaries. Note that not all nonhomogeneous materials are necessarily heterogeneous.

**HEXA:** Shortened form of hexamethylenetetramine, a source of reactive methylene for curing novolacs.

## SAE AIR4844

## 3.8 (Continued):

**HIGH-FREQUENCY HEATING:** The heating of materials by dielectric loss in a high-frequency electrostatic field. The material is exposed between electrodes and is heated quickly and uniformly by absorption of energy from the electrical field.

**HIGH-PRESSURE LAMINATES:** Laminates molded and cured at pressures not lower than 6.9 MPa (1.0 ksi), and more commonly in the range of 8.3 to 13.8 MPa (1.2 to 2.0 ksi).

**HIGH PRESSURE LAMINATING:** A term usually reserved for matched die molding, typically done under high pressures in a press. High pressure laminating is not so common as Autoclave molding.

**HIGH PRESSURE MOLDING:** A molding process in which the pressure used is greater than 6.9 MPa (1.0 ksi).

**HIGH-PRESSURE SPOT:** See resin-starved area.

**HIGH TEMPERATURE, PRESSURE SENSITIVE TAPE:** Tape used for a variety of applications in composite fabrication processes. It will stick to another material when it is applied under finger tip pressure and it is capable of withstanding the high temperatures encountered during an autoclave cure. The tape is removed after the cure cycle is complete and is not a part of the final composite assembly. Tape used for various composite fabrication purposes, such as securing thermocouple wires.

**HIP:** See hot isostatic pressing.

**HM:** High-modulus

**HMC:** High-strength molding compound

**HME:** High-vinyl-modified epoxy

**HOLOGRAM:** Three-dimensional photograph or image produced by interference between two sets of coherent light waves.

**HOMOGENEOUS:** Descriptive term for a material of uniform composition throughout. A medium that has no internal physical boundaries. A material whose properties are constant at every point, that is, constant with respect to spatial coordinates (but not necessarily with respect to directional coordinates).

**HOMOPOLYMERIZED:** A condition whereby a monomeric material is polymerized only with itself.

**HONEYCOMB:** Manufactured product of resin-impregnated sheet material (paper, glass fabric, and so on) or metal foil, formed into hexagonal-shaped cells. Other cell shapes are produced. Used as a core material in sandwich construction. See also sandwich constructions.

## SAE AIR4844

## 3.8 (Continued):

**HONEYCOMB SANDWICH ASSEMBLY:** A structural composition consisting of relatively dense, high strength facings (skin) bonded to a lightweight, cellular honeycomb core. See Sandwich Construction.

**HOOP STRESS:** The circumferential stress in a material of cylindrical form subjected to internal or external pressure.

**HORIZONTAL BLEED:** See Edge Bleed.

**HOT HEAD TAPE LAYER:** A computer controlled automated tape placement process for thermoplastic prepregs utilizing a gantry mounted hot shoe to partially consolidate each consecutive ply in a programmed orientation and laminate size.

**HOT ISOSTATIC PRESSING:** A process for fabricating certain metal matrix composites. A preform is consolidated under fluid pressure (usually an inert gas) at high temperature and pressure in a pressure vessel. This method can also be used to consolidate ceramic materials which have no metal matrix.

**HOT-MELT ADHESIVE:** An adhesive that is applied in a molten state and forms a bond after cooling to a solid state. A bonding agent that achieves a solid state and resultant strength by cooling, as contrasted with other adhesives, which achieve the solid state through evaporation of solvents or chemical cure. A thermoplastic resin that functions as an adhesive when melted between substrates and cooled. See ASTM D 907.

**HOT-SETTING ADHESIVE:** An adhesive that requires a temperature at or above 100 °C (212 °F) to set. See ASTM D 907.

**HOT/WET PROPERTIES:** The mechanical properties required of a composite or bonded metal assembly under prescribed conditions of temperature, time and relative humidity or water immersion. Testing is usually carried out at a specified temperature after exposure to the required environment for a specified period of time.

**HOT WORKING:** Any form of mechanical deformation processing carried out on a metal or alloy above its recrystallization temperature but below its melting point.

**HYBRID:** A composite laminate consisting of laminae of two or more composite material systems. A combination of two or more different fibers, such as carbon and glass or carbon and aramid, into a structure. Tapes, fabrics, and other forms may be combined; usually only the fibers differ. See also interply hybrid and intraply hybrid.

**HYDRAULIC PRESS:** A press in which the molding force is created by the pressure exerted by a fluid.

**HYDROBURST:** Test in which a fluid is used to load a pressure vessel to failure.

## SAE AIR4844

## 3.8 (Continued):

**HYDROCLAVE:** An autoclave that uses water as its pressurizing medium.

**HYDROGEN BONDING:** See Reference 2.15. Hydrogen bonding is a very important mechanism for intermolecular attraction and therefore adhesion. Hydrogen bonding is due to the strong interaction of hydrogen attached to one atom (such as oxygen, nitrogen, or carbon) by a polar covalent bond with an adjacent atom of high electronegativity (such as oxygen, nitrogen, or one of the halogens).

**HYDROLYSIS:** Chemical decomposition of a substance involving the addition of water. Reaction between ions of a salt and ions of water forming a solution which is either acidic or alkaline.

**HYDROMECHANICAL PRESS:** A press in which the molding forces are created partly by a mechanical system and partly by an hydraulic system.

**HYDROPHILIC:** Having an attraction for water. Capable of adsorbing or absorbing water. Easily wetted by water.

**HYDROPHOBIC:** Capable of repelling water. Poorly wetted by water. The opposite of hydrophilic.

**HYDROPROOF:** Test in which a fluid is used to carry out a proof loading requirement for a pressure vessel.

**HYGROSCOPIC:** Capable of attracting, absorbing, and retaining atmospheric moisture.

**HYGROTHERMAL EFFECT:** Change in properties due to moisture adsorption and temperature change.

**HYSTERESIS:** The energy absorbed in a complete cycle of loading and unloading. This energy is converted from mechanical to frictional energy (heat).

## 3.9 I:

**IGNITION LOSS:** The difference in weight before and after burning. As with glass, the burning off of the binder or size.

**IMMISCIBLE:** With respect to two or more fluids, not mutually soluble; incapable of attaining homogeneity.

**IMPACT DAMAGE:** Damage from foreign object (other than ballistic).

**IMPACT STRENGTH:** The ability of a material to withstand shock loading. The work done in fracturing a test specimen in a specified manner under shock loading.

## SAE AIR4844

## 3.9 (Continued):

**IMPACT TEST:** Measure of the energy necessary to fracture a standard notched bar by an impulse load. See also izod impact test, reverse impact test, and Charpy impact test.

**IMPACT VALUE:** The energy absorbed by a specimen of standard design when sheared by a single blow from a testing machine hammer. Expressed in  $J/m^2$  or  $ft \cdot lbf/in^2$ . See ASTM D 950.

**IMPREGNATE:** In reinforced plastics, to saturate the reinforcement with a resin.

**IMPREGNATOR:** A mechanical device for wetting or impregnating fabrics with resin. Generally consists of a trough through which the fabric is drawn and a set of adjustable scraper bars to remove excess resin.

**IMPREGNATED FABRIC:** A fabric impregnated with a synthetic resin. See also prepreg.

**INCLUSION:** A physical and mechanical discontinuity occurring within a material or part, usually consisting of solid, encapsulated foreign material. Inclusions are often capable of transmitting some structural stresses and energy fields, but in a noticeably different degree from the parent material. Visible foreign material such as particles, chips and films. See also voids.

**INDENTATION HARDNESS:** Hardness evaluated from measurements of area or indentation depth caused by pressing a specified indenter into the surface of a material with a specified force.

**INERT ATMOSPHERE:** The use of a gas (usually nitrogen) that does not absorb or react with ultraviolet light in a curing chamber, in place of oxygen.

**INERT FILLER:** A material added to a plastic to alter the end-item properties through physical rather than chemical means.

**INFRARED:** Part of the electromagnetic spectrum between the visible light range and the radar range. Radiant heat is in this range, and infrared heaters are frequently used in the thermoforming and curing of plastics and composites. Infrared analysis is used for identification of polymer constituents.

**INHIBITOR:** A substance that retards a chemical reaction. A material added to a resin to slow down curing. Also used in certain types of monomers and resins to prolong storage life. Synonym for retarder. See ASTM D 907 and ISO 472.

**INHOMOGENEOUS:** Consisting of more than one phase, e.g., discrete regions of different materials.

**INITIAL MODULUS:** The slope of the initial straight portion of a stress-strain or load-elongation curve. See also Young's modulus.

## SAE AIR4844

## 3.9 (Continued):

**INITIAL STRAIN:** The strain produced in a specimen by given loading conditions before creep occurs.

**INITIAL (INSTANTANEOUS) STRESS:** The stress produced by force in a specimen before stress relaxation occurs.

**INITIATOR:** Sources of free radicals, often peroxides or azo compounds. They are used in free-radical polymerizations, for curing thermosetting resins, as cross-linking agents for elastomers and polyethylene, and for polymer modification. See ISO 472.

**INJECTION MOLDING:** Method of forming a plastic to the desired shape by forcing the heat-softened plastic into a relatively cool cavity under pressure. The production of a composite component by the injection of resin or a fiber/resin mix into a closed mold.

**INNER SKIN:** That side of the part which is cured against the vacuum bag.

**INORGANIC:** Designating or pertaining to the chemistry of all elements and compounds not classified as organic. Matter other than animal or vegetable, such as earthy or mineral matter. Applies to the chemistry of all elements and compounds not classified as organic.

**INORGANIC PIGMENTS:** Natural or synthetic metallic oxides, sulfides, and other salts that impart heat and light stability, weathering resistance, color, and migration resistance to plastics.

**INPLANE LOADS:** Loads which are parallel to the facings. ASTM C 274.

**INSERT:** (i) An integral part of a plastic molding consisting of metal or other material that may be molded or pressed into position after the molding is completed. (ii) Apparatus placed into the sandwich for attaching items; synonymous with hard points. ASTM C 274. (iii) In the case of floor panels and others where high shear loads have to be carried through the panel to surrounding structure, special inserts are used to ensure that the required loads can be transmitted.

**INSERT PIN:** A pin which keeps an inserted part (insert) inside the mold by screwing or friction; it is removed when the object is being withdrawn from the mold. See ISO 472.

**INSTRUCTOR:** The Instructor shall meet the requirements of the appropriate Regulatory Agency and have the necessary skills and knowledge to plan, organize, and present classroom, laboratory, or on-the-job training programs of instruction, in accordance with approved course outlines. The individual shall be thoroughly familiar with the theory and practical applications of composite and bonded structure repair techniques as utilized by industry.

## SAE AIR4844

## 3.9 (Continued):

**INSULATION RESISTANCE:** The electrical resistance between two conductors or systems of conductors separated only by insulating material. The ratio of the applied voltage to the total current between two electrodes in contact with a specified insulator. The electrical resistance of an insulating material to a direct voltage.

**INSULATOR:** A material of such low electrical conductivity that the flow of current through it can usually be neglected. Similarly, a material of low thermal conductivity, such as that used to insulate structural shells.

**INTEGRAL COMPOSITE STRUCTURE:** Composite structure in which several structural elements, which would conventionally be assembled together by bonding or mechanical fasteners after separate fabrication, are instead laid up and cured as a single, complex, continuous structure, for example, spars, ribs, and one stiffened cover of a wing box fabricated as a single integral part. The term is sometimes applied more loosely to any composite structure not assembled by mechanical fasteners. All or some parts of the assembly may be co-cured.

**INTEGRALLY HEATED:** A term referring to tooling that is self-heating, through use of electrical heaters such as cal rods. Most hydroclave tooling is integrally heated. Some autoclave tooling is integrally heated to compensate for thick sections, to provide high heat-up rates, or to permit processing at a higher temperature than is otherwise possible with the autoclave.

**INTEGRAL SKIN FOAM:** Urethane foam with a cellular core structure and a relatively nonporous skin.

**INTERFACE:** The boundary or surface between two different, physically distinguishable media. On fibers, the contact area between fibers and sizing or finish. In a laminate, the contact area between the reinforcement and the laminating resin.

**INTERFERENCE FITS:** A joint or mating of two parts in which the male part has an external dimension larger than the internal dimension of the mating female part. Distension of the female by the male creates a stress, which supplies the bonding force for the joint.

**INTERLAMINAR:** Descriptive term pertaining to an object (voids, etc.), event (fracture, etc.), or potential field (shear stress, etc.) referenced as existing or occurring between two or more adjacent laminae.

**INTERLAMINAR SHEAR:** Shearing force tending to produce a relative displacement between two laminae in a laminate along the plane of their interface.

**INTERLAMINAR SHEAR STRENGTH (ILSS):** The maximum shear stress between layers that a laminated material can resist. See ASTM D 2344.

## SAE AIR4844

## 3.9 (Continued):

**INTERMEDIATE BEARING STRESS:** The bearing stress at the point on the bearing load-deformation curve where the tangent is equal to the bearing stress divided by a designated percentage (usually 4%) of the original hole diameter.

**INTERMEDIATE TEMPERATURE SETTING ADHESIVE:** An adhesive that sets in the temperature range from 30 to 100 °C (87 to 212 °F).

**INTERNAL ADHESIVE STRESS:** Stress created within an adhesive layer by the movement of the adherents at differential rates or by the contraction or expansion of the adhesive layer.

**INTERNATIONAL RUBBER HARDNESS DEGREE (IRHD):** A measure of hardness, the magnitude of which is derived from the depth of penetration of a specified indenter into a test piece under specified conditions. See ISO 1382 and ISO 472.

**INTERPHASE:** The boundary region between a bulk resin or polymer and an adherent in which the polymer has a high degree of orientation to the adherent on a molecular basis. It plays a major role in the load transfer process between the bulk of the adhesive and the adherent or the fiber and the laminate matrix resin.

**INTERPLY HYBRID:** A composite in which adjacent laminae are composed of different materials.

**INTRALAMINAR:** Descriptive term pertaining to an object (voids, etc.) event (fracture, etc.), or potential field (temperature gradient, etc.) existing entirely within a single lamina without reference to any adjacent laminae.

**INTRAPLY HYBRID:** A composite in which different materials are used within a specific layer or band.

**IPA:** Isopropylalcohol (or isopropanol, or 2-propanol). A wipe solvent used as a less hazardous replacement for MEK, or Acetone. It is rated as "Flammable" with a flash point of 53 °F (11.7 °C) and is toxic by inhalation and ingestion.

**IPC:** Illustrated Parts Catalogue. Provided by aircraft manufacturers.

**IRRADIATION:** As applied to plastics, the bombardment with a variety of subatomic particles, usually alpha-, beta-, or gamma-rays. Used to initiate polymerization and copolymerization of plastics and in some cases to bring about changes in the physical properties of a plastic.

**IRREVERSIBLE:** Not capable of redissolving or remelting. Descriptive of chemical reactions which proceed in a single direction and are not capable of reversal (as applied to thermosetting resins).

## SAE AIR4844

## 3.9 (Continued):

**ISOCYANATE PLASTICS:** Plastics based on resins made by the condensation of organic isocyanates with other compounds. Generally reacted with polyols on a polyester or polyether backbone molecule, with reactants being joined through the formation of the urethane linkage. See also polyurethane and urethane plastics. See ISO 472.

**ISOSTATIC PRESSING:** Pressing powder under a gas or liquid so that pressure is transmitted equally in all directions, for example, in sintering.

**ISOTROPIC:** Having uniform properties in all directions. The measured properties of an isotropic material are independent of the axis of testing.

**ISOTROPIC LAMINATE:** A laminate in which the strength properties are the same in all directions. Difficult to achieve. See quasi-isotropic.

**ISOTROPIC PLY:** A ply with similar properties in all directions, i.e., a sheet of metal or other material with similar properties in all directions.

**IZOD IMPACT TEST:** A test for shock loading in which a notched specimen bar is held at one end and broken by striking, and the energy absorbed is measured.

## 3.10 J:

**JOGGLE:** The projecting or retreating surface of a formed part, or the section of a tool that forms a joggle. An offset formed in a part or tool to step over or jog over another part.

**JOINT, BONDED:** That part of a structure at which two adherents are held together with a layer of adhesive. The point in a structure at which two parts are bonded together.

## 3.11 K:

**K FACTOR:** The coefficient of thermal conductivity. The amount of heat that passes through a unit cube of material in a given time when the difference in temperature of two opposite faces is 1°.

**KAPTON:** Du Pont Trade Name for Polyimide Film (HPF) - Low smoke and flame. Lightweight, resists hydraulic fluids. Heat resistant. Good low temperature performance.

**KERF:** The width of a cut made by a saw blade, torch, water jet, laser beam, etc.

**KEVLAR:** Du Pont company name for an aramid fiber. An organic polymer composed of aromatic polyamides having a para-type orientation (parallel chain extending bonds from each aromatic nucleus). Has good impact resistance, low density, high strength and low radio frequency attenuation. Absorbs some moisture. See aramid.

## SAE AIR4844

## 3.11 (Continued):

**KINK:** A yarn that has doubled back on itself to form a loop in the yarn.

**KNITTED FABRICS:** Fabrics produced by interlooping chains of yarn.

**KNOOP HARDNESS:** Hardness that is measured by calibrated machines that force a rhomb shape, pyramidal diamond indenter having specified edge angles under specified conditions into the surface of the test material; the long diagonal is measured after removal of the load. The microhardness Knoop tester uses a relatively small load to measure surface hardness.

**KNUCKLE AREA:** The area of transition between sections of different geometry in a filament-wound part, for example, where the skirt joins the cylinder of the pressure vessel. Also called Y-joint.

**K-SAMPLE DATA:** A collection of data consisting of values observed when sampling from k-batches.

## 3.12 L:

**LACK OF FILL OUT:** Characteristic of an area, occurring usually at the edge of a laminated plastic, where the reinforcement has not been wetted with resin.

**LACQUER:** Solution of natural or synthetic resins in readily evaporating solvents, used as a protective coating.

**LAMINA:** A single ply or layer in a laminate made up of a series of layers (organic composite). A flat or curved surface containing unidirectional fibers or woven fibers embedded in a matrix (metal matrix composite).

**LAMINAE:** Plural of lamina.

**LAMINATE (noun):** A product made by bonding together two or more layers (plies) of material. See also bi-directional laminate and unidirectional laminate, quasi-isotropic and isotropic laminate. See ASTM D 907 and ISO 472.

**LAMINATE (verb):** To unite laminae with a bonding material, usually with pressure and heat (normally used with reference to flat sheets, but also rods and tubes). See ASTM D 907.

**LAMINATE COORDINATES:** A reference coordinate system (used to describe the properties of a laminate), generally in the direction of principal axes, when they exist.

**LAMINATE ORIENTATION:** The configuration of a cross-plyed composite laminate with regard to the angles of cross-plying, the number of laminae at each angle, and the exact sequence of the lamina lay-up.

**LAMINATE PLY:** One fabric-resin or fiber-resin layer of a product that is bonded to adjacent layers in the curing process.

## SAE AIR4844

## 3.12 (Continued):

**LAMINATED MOLDING:** A molded plastic article produced by bonding together, under heat and pressure in a mold, layers of resin-impregnated laminating reinforcement; also called "laminated plastics".

**LAMINATION:** The process of preparing a laminate. Also any layer in a laminate. See ASTM D 907.

**LAMINATION SEQUENCE:** Composite lay-up usually begins with the ply nearest the tool surface. Each successive ply is then stacked or nested in sequence. Plies are laid up from the tool surface out.

**LAP:** In filament winding, the amount of overlay between successive windings, usually intended to minimize gapping. In bonding, the distance one adherent covers another adherent.

**LAP JOINT:** A joint made by placing one adherent partly over another and bonding the overlapped portions. See ASTM D 907.

**LAP SHEAR TEST:** This is carried out to ASTM D 1002 and Reference 2.15. Aluminum alloy adherends of a standard thickness are normally used but the test can be adapted for use with other materials including composites. In the standard test 1 in wide (25.4 mm) sheets are overlapped by 1/2 in (12.7 mm) and pulled at a specified crosshead speed. See also ASTM D 3164, ASTM D 3165, and ASTM D 3166 (fatigue test).

**LATENT CURING AGENT:** A curing agent that produces long-term stability at room temperature but rapid cure at elevated temperatures.

**LATEX:** A generic term describing any of many stable dispersions of insoluble resin particles in a water system. A milky juice, other than sap, secreted by certain plants in special cells usually present in all parts of the plant. Rubber latexes from different plants vary widely in properties. Hevea latex, of greatest interest, is thin and white like milk and consists of a dispersion of rubber in an aqueous serum containing other substances. See ISO 472.

**LATTICE PATTERN:** A pattern of filament winding with a fixed arrangement of open voids.

**LAY:** (1) In glass fiber the spacing of the roving bands on the roving package expressed in the number of bands per inch.  
(2) In filament winding the orientation of the ribbon with some reference, usually the axis of rotation.

**LAY-UP:** (i) The reinforcing material placed in position in the mold. (ii) The process of placing the reinforcing material in position in the mold. (iii) The resin-impregnated reinforcement. (iv) A description of the component materials, geometry, etc., of a laminate. (v) A stackup of composite materials that forms either a cured or uncured part. (BDS 1330) (vi) A process of fabrication involving the assembly of successive layers of resin impregnated material.

## SAE AIR4844

## 3.12 (Continued):

**LAYERED LAMINATE:** When two or more plies, either of the same or different materials, are bonded and stacked one on top of the other to act as a single structural layered element, then this structural element is called a layered laminate.

**L-DIRECTION:** The ribbon direction, that is, the direction of the continuous sheets of honeycomb.

**LENGTHWISE DIRECTION:** Refers to cutting specimens and the application of loads. For rods and tubes, lengthwise is the direction of the long axis. For other shapes of materials that are stronger in one direction than in the other lengthwise is the direction that is stronger. For materials that are equally strong in both directions lengthwise is an arbitrarily designated direction that may be with the grain, direction of flow in manufacture, longer direction, etc.

**LEVEL WINDING:** See circumferential winding.

**LINEAR EXPANSION:** The increase of a given dimension, measured by the expansion or contraction of a specimen or component subject to a thermal gradient or changing temperature. See also coefficient of thermal expansion.

**LINER:** In a filament-wound pressure vessel, the continuous, usually flexible coating on the inside surface of the vessel, used to protect the laminate from chemical attack or to prevent leakage under stress.

**LIQUID COUPLANT:** Liquid interface between a transducer and the subject of a nondestructive inspection.

**LIQUID CRYSTAL POLYMER:** A newer thermoplastic polymer that is melt processable and develops high orientation in molding, with resultant tensile strength and high-temperature capability that is notably improved. First commercial availability was as an aromatic polyester. With or without fiber reinforcement.

**LIQUID METAL INFILTRATION:** Process for immersion of fibers in a molten metal bath to achieve a metal matrix composite: for example, graphite fibers in molten aluminum.

**LIQUID RESIN:** An organic, polymeric liquid that becomes a solid when converted to its final state for use.

**LIQUID SHIM:** Material used to position components in an assembly where dimensional alignment is critical. For example, epoxy adhesive is introduced into gaps after the assembly is placed in the desired configuration.

**LIQUIDUS:** The maximum temperature at which equilibrium exists between the molten glass and its primary crystalline phase.

## SAE AIR4844

## 3.12 (Continued):

**LIMIT LOAD:** Limit loads are the maximum loads anticipated on an aircraft during its service life. The aircraft structure shall be capable of supporting the limit loads without suffering any detrimental permanent deformation. For all loads up to the "limit" loads the deformation shall be such as not to interfere with the safe operation of the aircraft.

**LMC:** Low pressure molding compound

**LOAD:** The force applied to the specimen at any given time.  
See ASTM D 4027.

**LOAD-DEFLECTION CURVE:** A curve in which the increasing tension, compression, or flexural loads are plotted on the ordinate axis and the deflections caused by those loads are plotted on the abscissa axis.

**LOCUS OF FAILURE:** Site of failure.

**LOFTING:** The drawing of lines from the basic geometry drawing for the aircraft (full scale) on metal to make a master layout for use by tooling departments. A loft will show sections through the aircraft giving profiles at particular points. It will show buttock lines, water lines and reference planes and provides the master profiles from which tools and parts are made.

**LOGNORMAL DISTRIBUTION:** A probability distribution for which the probability that an observation selected at random from this population falls between "a" and "b" ( $0 < a < b < B$ ) is given by the area under the normal distribution between  $\log a$  and  $\log b$ . The common (base 10) or the natural (base e) logarithm may be used. MIL-HDBK-17.

**LONGITUDINAL:** (i) Along the length of material. (ii) In the  $0^\circ$  direction.

**LONGOS:** Low angle helical or longitudinal windings.

**LOOM STATE:** Most reinforcement fibers as supplied by the manufacturer have a small amount of SIZE on their surface, designed to reduce filament damage and facilitate handling during weaving. Fabrics woven from these fibers and supplied untreated are described as "loom state".

**LOOP TENACITY:** The tenacity or strength value obtained by pulling two loops, as two links in a chain, against each other in order to demonstrate the susceptibility that a fibrous material has for cutting or crushing itself; loop strength.

**LOOSE PICK:** (Loose filling yarn) A filling yarn which is not flush with the surrounding fabric usually caused by insufficient tension.

**LOSS FACTOR:** The product of the dissipation factor and the dielectric constant of a dielectric material.

**LOSS MODULUS:** A damping term describing the dissipation of energy into heat when a material is deformed.

## SAE AIR4844

## 3.12 (Continued):

**LOSS ON IGNITION:** Weight loss, usually expressed as percent of total, after burning off an organic sizing from glass fibers, or an organic resin from a glass fiber laminate.

**LOSS TANGENT:** See electrical dissipation factor.

**LOT:** (i) A specific amount of material produced at one time using the same process and the same conditions of manufacture, and offered for sale as a unit quantity. (ii) (Prepreg material). One batch of prepreg material or a portion of one batch that is shipped to a purchaser for acceptance at one time. A lot may be one or more rolls of material but cannot exceed the amount of material produced in the batch the rolls are taken from.

**LOW PRESSURE LAMINATES:** In general, laminates molded and cured in the range of pressures from 2760 kPa (400 psi) down to and including pressure obtained by the mere contact of the plies.

**LOW PRESSURE MOLDING:** The distribution of relatively uniform low pressure [0.2 ksi (1.4 MPa) or less] over a resin-bearing fibrous assembly of cellulose, glass, asbestos or other material, with or without application of heat from an external source to form a structure possessing definite physical properties.

**LOW (ROOM) TEMPERATURE REPAIR:** A repair using a resin system that can be cured at temperatures not to exceed 70 °C (160 °F).

**LPF:** Last ply failure

**LUBRICANT:** A material added to most sizings to improve the handling and processing properties of textile strands, especially during weaving.

## 3.13 M:

**MACERATE:** To chop or shred fabric for use as a filler for a molding resin. The molding compound obtained when so filled.

**MACRO:** In relation to composites, denotes the gross properties of a composite as a structural element but does not consider the individual properties or identity of the constituents.

**MACROMECHANICS:** Is the study of a composite material as a whole and does not differentiate between the constituents (fibers and resin).

**MACROSCOPY:** Interpretation using only the naked eye, or magnification no greater than 10x.

**MACROSTRAIN:** The mean strain over any finite gage length of measurement that is large in comparison with interatomic distances.

## SAE AIR4844

## 3.13 (Continued):

**MANDREL:** The core tool around which resin-impregnated paper, fabric, or fiber is wound to form pipes, tubes, or structural shell shapes, usually by the filament winding process. See ISO 472.

**MARK-OFF:** (i) Visual evidence of interior details on the outer surface of a bonded assembly. (ii) Visual impression in a repair laminate caused by thermocouples or other items.

**MASKING:** (i) A tape or sheet material used to protect the masked area from chemical treatment, grit blasting or paint spray on a temporary basis. It is easily removable after the treatment has been completed. (ii) Masking tape used to protect acrylic and other plastic sheeting must use an adhesive which does not itself damage the plastic in either short or long-term storage. (iii) Some special masking tapes are supplied, which can be used to protect treated surfaces between treatment and adhesive bonding or painting. Such tapes must leave no residue that could reduce adhesion when they are removed.

**MASTER:** A pattern whose contours are the absolute and final contour definition of a part or assembly. Tooling masters are most generally made from tooling plaster but can also be made of composite material.

**MAT:** A fibrous material for reinforced plastic consisting of randomly oriented chopped filaments, short fibers (with or without a carrier fabric), or swirled filaments loosely held together with a binder. Available in blankets of various widths, weights, and lengths. Also, a sheet formed by filament winding a single-hoop ply of fiber on a mandrel, cutting across its width and laying out a flat sheet.

**MAT BINDER:** Resin applied to glass fiber and cured during the manufacture of mat, used to hold the fibers in place and maintain the shape of the mat.

**MATCHED METAL MOLDING:** A reinforced plastics manufacturing process in which matching male and female metal molds are used (similar to compression molding) to form the part, with time, pressure, and heat.

**MATERIAL ACCEPTANCE:** The testing of incoming material to ensure that it meets requirements.

**MATERIAL QUALIFICATION:** The procedures used to accept a material by a company or organization for production use.

**MATERIAL SYSTEM:** A specific composite material made from specifically identified constituents in specific geometric proportions and arrangements, and possessed of numerically defined properties.

**MATERIAL VARIABILITY:** Any source of variability due to variations in the spatial, consistency, mechanical or physical properties, chemical content or processing aspects of a material. See also MIL-HDBK-17.

## SAE AIR4844

## 3.13 (Continued):

**MATRIX:** The essentially homogeneous resin or polymer material in which the fiber system of a composite is imbedded. Both thermoplastic and thermoset resins may be used, as well as metals, ceramics, and glasses.

**MATRIX DOMINATED PROPERTIES:** Those mechanical properties that depend heavily on the strength and stiffness of the matrix, its compatibility or bondability to the fibers, and its ability to support the fibers so that they can continue to carry load. Short beam shear and compression strength fall into this category. Matrix dominated properties are also very sensitive to laminate quality in terms of void content, resin and fiber distribution.

**MEAN:** See Sample Mean and Population Mean. MIL-HDBK-17.

**MECHANICAL ADHESION:** Adhesion between surfaces in which the adhesive holds the parts together by interlocking action.

**MECHANICAL PRESSURE:** A pressure applied by other than fluid means. Mechanical pressure may be applied by deadweight, press, jacks, clamps etc.

**MECHANICAL PROPERTIES:** The properties of a material that are associated with elastic and inelastic reaction when force is applied, or the properties involving the relationship between stress and strain. (MIL-HDBK-17)

**MECHANICALLY FOAMED PLASTIC:** A cellular plastic in which the cells are formed by the physical incorporation of gases. See ISO 472.

**MEDIAN:** See Sample Median and Population Median. MIL-HDBK-17.

**MEK:** Methyl ethyl ketone. Also known as 2-butanone. A wipe solvent used for cleaning composite surfaces prior to bonding. Also used for cleaning metal surfaces prior to other treatments. Used as a diluent in some sprayable epoxy adhesives and primers. Some evidence of toxicity in animals. Classed as "Seriously Flammable" with a flash point of 20 °F (- 7 °C). May be procured to ASTM D 740.

**MEKP:** Methyl ethyl ketone peroxide, a catalyst for polyester resins.

**MELT:** (i) A charge of molten metal. (ii) A charge of molten plastic. See also liquid metal infiltration.

**MELTING RANGE:** Thermoplastics whose makeup includes a distribution of molecular weights which will not have a well defined melting point, but have a melting point.

**MER:** The repeating structural unit of any polymer.

## SAE AIR4844

## 3.13 (Continued):

**MESOPHASE:** An intermediate phase in the formation of carbon from a pitch precursor. This is a liquid crystal phase in the form of microspheres, which upon prolonged heating above 400 °C (750 °F) coalesce, solidify, and form regions of extended order. Heating to above 2000 °C (3630 °F) leads to the formation of graphite structure.

**METAL - METAL CONSTRUCTION:** An assembly that contains no honeycomb core material.

**METALLIC FIBER:** Manufactured fibre composed of metal, plastic-coated metal, metal-coated plastic, or a core completely covered by metal.

**METHACRYLATO-SILANE FINISH:** Applied to glass fibers to give the highest performance of laminates using polyester resins.

**M-GLASS:** A high beryllia (BeO<sub>2</sub>) content glass designed especially for high modulus of elasticity.

**MIBK:** Methylisobutylketone. A less commonly used solvent similar to MEK but with a higher flash point 64 °F (18 °C) and a lower evaporation rate. May be procured to ASTM D 1153.

**MICRO:** In relation to composites, denotes the properties of the constituents, that is, matrix, reinforcement, and interface only, and their effects on the composite properties.

**MICROBALLOONS:** Also called microspheres. Small, hollow glass spheres used as fillers in epoxy and polyester compounds to reduce density. Can also be made from phenolic resins and ceramics.

**MICROCRACKING:** Cracks formed in composites when thermal or mechanical stresses locally exceed the strength of the matrix. Since most microcracks do not penetrate the reinforcing fibers, microcracks in a cross-plyed tape laminate or in a laminate made from cloth prepreg are usually limited to the thickness of a single ply.

**MICROMECHANICS:** Is a study whereby the constituent materials (fibers and resin) are looked at separately and not as one entity.

**MICRON:** A unit of length replaced by the micrometer =  $10^{-6}$  m =  $10^{-3}$  mm = 0.00003937 in = 39.4  $\mu$  in.

**MICROPROCESSOR:** The basic element of a central processing unit developed on a single integrated circuit chip. A single integrated chip provides the basic core of a central processing unit, even though it may require additional components to operate as a central processing unit.

**MICROSTRAIN:** (i) The strain over a gauge length comparable to the material's interatomic distance. MIL-HDBK-17. (ii) In design the limit is often expressed as 5000 microstrain or some other figure. In this case it means microinches per inch. One microinch = one millionth of an inch.

## SAE AIR4844

## 3.13 (Continued):

**MICROSTRUCTURE:** A structure with heterogeneities that can be seen through a microscope.

**MIL:** The American term for one thousandth of an inch. A common unit used in measuring the diameter of glass fiber strands, wire, etc. (1 mil = 0.001 in = 25  $\mu\text{m}$ ).

**MILLED FIBER:** Continuous glass strands hammer milled into very short glass fibers. Useful as inexpensive filler or anticrazing reinforcing fillers for adhesives. See ISO 472.

**MISCIBLE:** That can be mixed with.

**MISPICK:** A fill yarn not properly interlaced causing a break in the weaving pattern.

**MISSING PICK:** (Missing filling yarn) A filling yarn missing from all or a portion of the width of the fabric.

**MMC:** Metal matrix composite

**MODIFIER:** Any chemically inert ingredient added to an adhesive formulation that changes its properties. See also filler, plasticizer and extender.

**MODULUS:** A measure of the ratio of the applied load to the resultant deformation of the material. The stiffness of a material. See modulus of elasticity.

**MODULUS, CHORD:** The slope of the chord drawn between any two specified points on the stress-strain curve. MIL-HDBK-17.

**MODULUS OF ELASTICITY:** The ratio of the stress applied to the strain or deformation produced in a material that is elastically deformed. If a tensile strength of 13.8 MPa (2.0 ksi) results in an elongation of 1%, the modulus of elasticity is 13.8 MPa (2.0 ksi) divided by 0.01, or 1380 MPa (200 ksi). Also called Young's modulus. See also offset modulus and secant modulus.

**MODULUS OF RESILIENCE:** The energy that can be absorbed per unit volume without creating a permanent distortion. Calculated by integrating the stress-strain curve from zero to the elastic limit and dividing by the original volume of the specimen.

**MODULUS OF RIGIDITY:** The ratio of stress to strain within the elastic region for shear or torsional stress. Also called shear modulus or torsional modulus.

**MODULUS OF RUPTURE, IN BENDING:** The maximum tensile or compressive stress value (whichever caused failure) in the extreme fiber of a beam loaded to failure in bending.

## SAE AIR4844

## 3.13 (Continued):

**MODULUS OF RUPTURE, IN TORSION:** The maximum shear stress in the extreme fiber of a member of circular cross section loaded to failure in torsion.

**MOHS HARDNESS:** A measure of the scratch resistance of a material. The higher the number, the greater the scratch resistance (No. 10 being termed diamond).

**MOISTURE ABSORPTION:** The pickup of water vapor from air by a material. It relates only to vapor withdrawn from the air by a material and must be distinguished from water absorption, which is the gain in weight due to the take-up of water by immersion.

**MOISTURE CONTENT:** The amount of moisture in a material determined under prescribed conditions and expressed as a percentage of the mass of the moist specimen, that is, the mass of the dry substance plus the moisture present.

**MOISTURE EQUILIBRIUM:** The condition reached by a sample when it no longer takes up moisture from, or gives up moisture to, the surrounding environment.

**MOISTURE METER:** An instrument that indicates moisture content in a material. Originally developed for paper and wood. Usually based on measurement of radio frequency signal loss attributed to the moisture content of the component or material. Such instruments are very useful on nonconducting fibers such as fiberglass and aramids but cannot be used on electrically-conducting fibers such as carbon fiber. They are made by Moisture Register Products Division of the Aqua Measure Instrument Co. and others.

**MOISTURE VAPOR TRANSMISSION:** A rate at which water vapor passes through a material at a specified temperature and relative humidity (g/mil/24 h/100 in<sup>2</sup>).

**MOLECULAR WEIGHT:** The sum of the atomic weights of all the atoms in a molecule. A measure of the chain length for the molecules that make up the polymer.

**MONOFILAMENT:** A single fiber or filament of indefinite length, strong enough to function as a yarn in commercial textile operations. See ISO 472.

**MONOLAYER:** The basic laminate unit from which cross-plyed or other laminate types are constructed. Also, a "single" layer of atoms or molecules adsorbed on or applied to a surface.

**MONOLITHIC:** Originally derived from monolith, meaning a single block of stone. In composite terminology it means made from fiber and resin only, i.e. solid composite as opposed to thin composite skins in a sandwich panel, which are bonded to a lightweight core of honeycomb or other material. See solid laminate.

## SAE AIR4844

## 3.13 (Continued):

**MONOMER:** A single molecule that can react with like or unlike molecules to form a polymer. The smallest repeating structure of a polymer (mer). For addition polymers, this represents the original unpolymerized compound. See ISO 472.

**MORPHOLOGY:** The overall form of a polymer structure, that is, crystallinity, branching, molecular weight, etc.

**MOLD:** The cavity or matrix into or on which the plastic composition is placed and from which it takes form. To shape plastic parts of finished articles by heat and pressure. The assembly of all the parts that function collectively in the molding process. See ISO 472.

**MOLDED EDGE:** An edge that is not physically altered after molding for use in final form, and particularly one that does not have fiber ends along its length.

**MOLDED NET:** Description of a molded part that requires no additional processing to meet dimensional requirements.

**MOLDING:** The forming of a polymer or composite into a solid mass of prescribed shape and size by the application of pressure and heat for given times. Sometimes used to denote the finished part. See ISO 472.

**MOLDING CYCLE:** The period of time required for the complete sequence of operations on a molding press to produce one set of moldings. The operations necessary to produce a set of moldings without reference to the total time taken.

**MOLDING POWDER OR COMPOUND:** Plastic material in varying stages of pellets or granulation, and consisting of resin, filler, pigments, reinforcements, plasticizers, and other ingredients, ready for use in the molding operation. See ISO 472.

**MOLDING PRESSURE:** The pressure applied to the ram of an injection machine or compression or transfer press to force the softened plastic to fill the mold cavities completely.

**MOLD-RELEASE AGENT:** A lubricant, liquid, or powder (often silicone oils and waxes), used to prevent sticking of molded articles in the cavity.

**MOLD SEAM:** Line on a molded or laminated piece, differing in color or appearance from the general surface, caused by the parting line of the mold.

## SAE AIR4844

## 3.13 (Continued):

**MOLD SHRINKAGE:** The immediate shrinkage that a molded part undergoes when it is removed from a mold and cooled to room temperature. The difference in dimensions, expressed in inches per inch, between a molding and the mold cavity in which it was molded (at normal-temperature measurement). The incremental difference between the dimensions of the molding and the mold from which it was made, expressed as a percentage of the mold dimensions.

**MOLD SURFACE:** The side of a laminate that faced the mold (tool) during cure in an autoclave or hydroclave.

**MULTICIRCUIT WINDING:** In filament winding, a winding that requires more than one circuit before the band repeats by laying adjacent to the first band.

**MULTIDIRECTIONAL:** Having multiple ply orientations in a laminate.

**MULTIFILAMENT YARN:** A large number (500 to 2000) of fine, continuous filaments (often 5 to 100 individual filaments) usually with some twist in the yarn to facilitate handling. See ISO 472.

**MULTIORIENTED PLY LAMINATE (MOPL):** A laminate made from multioriented plies i.e., plies with fibers in more than one direction.

**MULTIPLE LAYER ADHESIVE:** A film adhesive, usually supported, with a different adhesive composition on each side; designed to bond dissimilar materials such as the core-to-face bond of a sandwich composite. See also Duplex Film.

**MVT:** See moisture vapor transmission.

**MYLAR:** Du Pont Trade Name for polyester film. Excellent moisture and oxygen barrier. Used as a release sheet in adhesive and composite bonding. Also used as food packaging for in-flight meals.

## 3.14 N:

**NDE:** See nondestructive evaluation.

**NDI:** See nondestructive inspection.

**NDT:** See nondestructive testing.

**NEAT RESIN:** Resin to which nothing (additives, reinforcements, etc.) has been added.

**NEAT RESIN PROPERTIES:** Mechanical properties of the cured resin itself, without reinforcement. In this case "neat resin" includes all additives in the formulation being tested.

## SAE AIR4844

## 3.14 (Continued):

**NECKING:** The localized reduction in cross section that may occur in a material under tensile stress.

**NEEDED MAT:** A mat formed of strands cut to a short length, then felted together in a needle loom, with or without a carrier.

**NEGATIVELY SKEWED:** A distribution is said to be negatively skewed if the distribution is not symmetric and the longest tail is on the left. MIL-HDBK-17.

**NESTED LAMINATE:** In reinforced plastics, the placing of plies of fabric so that the yarns of one ply lie in the valleys between the yarns of the adjacent ply (nested cloth).

**NETTING ANALYSIS:** The analysis of filament-wound structures that assumes the stresses induced in the structure are carried entirely by the filaments, and the strength of the resin is neglected, and that assumes also that the filaments possess no bending or shearing stiffness, and carry only the axial tensile loads.

**NODE:** The connected portion of adjacent ribbons of honeycomb.

**NODE BONDS:** That area of the honeycomb core where the cell walls are adhesively bonded.

**NOL RING:** A parallel filament- or tape-wound hoop test specimen developed by the Naval Ordnance Laboratory (NOL) (now the National Surface Weapons Laboratory), for measuring various mechanical strength properties of the material, such as tension and compression, by testing the entire ring or segments of it. Also known as parallel fiber reinforced ring.

**NOMEX:** Aramid fiber or paper. The paper form is used to make honeycomb. Low smoke and flame.

**NOMINAL SPECIMEN THICKNESS:** The nominal ply thickness multiplied by the number of plies. MIL-HDBK-17.

**NOMINAL STRESS:** The stress at a point calculated on the net cross section without taking into consideration the effect on stress of geometric discontinuities, such as holes, grooves, fillets, etc. The calculation is made by simple elastic theory.

**NOMINAL VALUE:** A value assigned for the purpose of a convenient designation. A nominal value exists in name only. It is often an average number with a tolerance so as to fit together with adjacent parts.

**NONDESTRUCTIVE EVALUATION (NDE):** Broadly considered synonymous with nondestructive inspection (NDI). More specifically, the analysis of NDI findings to determine whether the material will be acceptable for its function.

## SAE AIR4844

## 3.14 (Continued):

**NONDESTRUCTIVE INSPECTION (NDI):** A process or procedure, such as ultrasonic or radiographic inspection, for determining the quality or characteristics of a material, part, or assembly, without permanently altering the subject or its properties. Used to find internal anomalies in a structure without degrading its properties. A term preferred to NDT because it describes more accurately the task being performed.

**NONDESTRUCTIVE TESTING (NDT):** Broadly considered synonymous with nondestructive inspection (NDI).

**NONHYGROSCOPIC:** Lacking the property of absorbing and retaining an appreciable quantity of moisture (water vapor) from the air.

**NONWOVEN FABRIC:** A planar textile structure produced by loosely compressing together fibers, yarns, rovings, etc., with or without a scrim cloth carrier. Accomplished by mechanical, chemical, thermal, or solvent means and combinations thereof.

**NORMAL DISTRIBUTION:** A two parameter ( $\mu$ ,  $\sigma$ ) family of probability distributions for which the probability that an observation will fall between "a" and "b" is given by the area under the curve between "a" and "b" using Equation 1. From MIL-HDBK-17.

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} \exp \left[ -\frac{(x-\mu)^2}{2\sigma^2} \right] \quad (\text{Eq.1})$$

**NORMAL STRESS:** The stress component that is perpendicular to the plane on which the forces act. See ISO 472.

**NORMALIZED STRESS:** Stress calculated by multiplying the raw stress value by the ratio of measured fiber volume to the nominal fiber volume. This ratio is often approximated by the ratio of the measured specimen thickness to the nominal specimen thickness. Stresses for fiber-dominated failure modes are often normalized. MIL-HDBK-17.

**NOTCHED SPECIMEN:** A test specimen that has been deliberately cut or notched, usually in a V-shape, to induce and locate point of failure.

**NOTCH FACTOR:** Ratio of the resilience determined on a plain specimen to the resilience determined on a notched specimen.

**NOTCH SENSITIVITY:** The extent to which the sensitivity of a material to fracture is increased by the presence of a surface nonhomogeneity, such as a notch, a sudden change in cross section, a crack, or a scratch. Low notch sensitivity is usually associated with ductile materials, and high notch sensitivity is usually associated with brittle materials.

**NOVOLAC:** A linear thermoplastic B-staged phenolic resin, which, in the presence of methylene or other cross-linking groups, reacts to form a thermoset phenolic.

## SAE AIR4844

## 3.14 (Continued):

**NYLON:** The generic name for all synthetic polyamides.

**NYLON PLASTICS:** Plastics based on a resin composed principally of a long-chain synthetic polymeric amide that has recurring amide groups as an integral part of the main polymer chain. Numerical designations (nylon 6, nylon 66, and so on) refer to the monomeric amides of which they are made. Characterized by great toughness and elasticity, low coefficient of friction and excellent electrical properties, chemical resistance and wear resistance. Resins are hygroscopic and dimensional stability is poorer than with most other engineering plastics.

## 3.15 0:

**OBSERVED SIGNIFICANCE LEVEL (OSL):** The probability of observing a more extreme value of the test statistic when the null hypothesis is true. MIL-HDBK-17.

**OFFSET MODULUS:** The ratio of the offset yield stress to the extension at the offset point.

**OFFSET YIELD STRENGTH:** The stress at which the strain exceeds by a specific amount (the offset) and extension of the initial approximately linear proportional portion of the stress-strain curve. It is expressed in force per unit area.

**OFFSET YIELD STRESS:** The stress at which the stress/strain curve departs from linearity by a specified percentage of strain (offset). See ISO 472.

**OJT (ON-THE-JOB TRAINING):** Training, during work time in learning equipment set-up, equipment operation, repair techniques and repair evaluation, under the technical guidance of an experienced composite repair technician or other designated individual.

**OLEFIN:** A group of unsaturated hydrocarbons of the general formula  $C_nH_{2n}$  named after the corresponding paraffins by the addition of "ene" or "ylene" to the root, for example, ethylene, propylene, and pentene.

**OLIGOMER:** A polymer consisting of only a few monomer units such as a dimer, trimer etc., or their mixtures. (MIL-HDBK-17)

**ONE-COMPONENT ADHESIVE:** An adhesive material incorporating a latent hardener or catalyst that is activated by heat.

**OPEN-CELL FOAM:** Foamed or cellular material with cells that are generally interconnected. Closed cell refers to cells that are not interconnected.

**OPEN TIME:** See "out time".

## SAE AIR4844

## 3.15 (Continued):

**ORANGE PEEL:** An uneven surface somewhat resembling that of an orange peel; said of injection moldings that have unintentionally ragged surfaces. Description of the surface of an acrylic plastic after overheating during buffing or polishing.

**ORGANIC:** Matter originating in plant or animal life or composed of chemicals of hydrocarbon origin, either natural or synthetic.

**ORIENTATION:** The alignment of the crystalline structure in polymeric materials in order to produce a highly aligned structure. Orientation can be accomplished by cold drawing or stretching in fabrication. Direction of alignment of tape or warp direction of fabrics in a composite.

**ORIENTED MATERIALS:** Materials, particularly amorphous polymers and composites, whose molecules and/or macro constituents are aligned in a specific way. Oriented materials are anisotropic. Orientation can generally be divided into two classes, uniaxial and biaxial.

**ORTHOTROPIC:** Having three mutually perpendicular planes of elastic symmetry.

**ORTHOTROPIC PLY:** A ply is said to be orthotropic if there are usually two different material properties in two mutually perpendicular directions at a point, and the two mutually perpendicular directions also form the planes of material properties symmetry at the point, i.e., a ply of woven fabric.

**OUT LIFE:** The period of time that a prepreg or film adhesive material remains in a handleable form and with properties intact outside of the specified storage environment and at room temperature.

**OUT TIME:** The time a prepreg is exposed to ambient temperature, namely, the total amount of time the prepreg is out of the freezer. The primary effects of out time are a decrease in the drape and tack of the prepreg and the absorption of moisture from the air. Also called "open time".

**OUTER SKIN:** That side of the part which is cured against the mold.

**OUTSIDE AGENCY:** The organization under contract for training services, which may include an examination of personnel to the requirements of a specified standard. Consultants and self-employed individuals are included in this definition.

**OVALOID:** A surface of revolution symmetrical about the polar axis that forms the end closure for a filament-wound cylinder.

**OVEN:** A vessel at atmospheric pressure used to provide a controlled and uniform temperature. It must be ventilated.

**OVEN DRY:** The condition of a material that has been heated under prescribed conditions of temperature and humidity until there is no further significant change in its mass.

## SAE AIR4844

## 3.15 (Continued):

**OVERCURING:** The beginning of thermal decomposition resulting from too high a temperature or too long a molding time.

**OVERLAP:** A simple adhesive joint, in which the surface of one adherent extends past the leading edge of another.

**OVERLAY SHEET:** A nonwoven fibrous mat (of glass, synthetic fiber, etc.) used as the top layer in a cloth or mat lay-up, to provide a smoother finish, minimize the appearance of the fibrous pattern, or permit machining or grinding to a precise dimension. Also called surfacing mat.

**OXIDATION:** In carbon/graphite fiber processing, the step of reacting the precursor polymer (rayon, PAN, or pitch) with oxygen, resulting in stabilization of the structure for the hot stretching operation. In general usage, oxidation refers to any chemical reaction in which electrons are transferred.

## 3.16 P:

**PACKAGE:** Yarn, roving, etc., in the form of units capable of being unwound and suitable for handling, storing, shipping, and use.

**PAN:** See polyacrylonitrile.

**PARAMETER:** An arbitrary constant, as distinguished from a fixed or absolute constant. Any desired numerical value may be given as a parameter.

**PARALLEL LAMINATE:** A laminate of woven fabric in which the plies are aligned in the same position as originally aligned in the fabric roll. A series of flat or curved cloth-resin layers stacked uniformly on top of each other. See ASTM D 907 and ISO 472.

**PARTICULATE COMPOSITE:** Material consisting of one or more constituents suspended in a matrix of another material. These particles are either metallic or nonmetallic.

**PARTING AGENT:** A material, liquid or solid film used on the tool surface to ease removal of the assembly. See mold release agent.

**PARTING LINE:** A mark on a molded piece where the sections of a mold have met in closing.

**PAS:** See polyarylsulfone.

**PASCAL SECOND:** The measure of the specific viscosity of a fluid. The older unit is the poise. To convert poise to Pa.s divide by 10.

## SAE AIR4844

## 3.16 (Continued):

**PASTE:** (i) An adhesive composition having a characteristic plastic-type consistency, that is a high order of yield value, such as that prepared by heating a mixture of starch and water and subsequently cooling the hydrolysed product. See ASTM D 907. (ii) An adhesive that flows very little without being forcibly spread. Having a similar consistency to toothpaste as it leaves the tube.

**PBI:** See polybenzimidazole.

**PEEK:** See polyether etherketone.

**PEEL PLY:** A layer of open-weave material, usually fiberglass or heat-set nylon, applied directly to the surface of a prepreg lay-up. The peel ply is removed from the cured laminate immediately before bonding operations, leaving a clean, resin-rich surface that needs no further preparation for bonding, other than application of a primer where one is required.

**PEEL STRENGTH:** The adhesive bond strength obtained in the peeling mode selected. For details of specific tests see ASTM D 903, ASTM D 1876, and for sandwich panels, ASTM D 1781.

**PEGGING:** The joining of two pieces of core by crush splicing them together with a third piece of core.

**PENETRATION:** A surface discontinuity which penetrates one skin and core or both skins and core, and whose width is the same order of magnitude as its length, i.e., hole, ballistic damage. The entering of an adhesive into an adherent.

**NOTE:** This property of a system is measured by the depth of penetration of the adhesive into the adherent.

**PERFORATED SKIN:** An outer skin of an acoustical panel that has a pattern of small holes punched or drilled to allow air passage in and out of the panel for noise abatement.

**PERMANENCE:** The property of a plastic that describes its resistance to appreciable changes in characteristics with time and environment. See ASTM D 907 and ISO 472.

**PERMANENT PATTERN:** A secondary pattern or master having all of the necessary coordination data and reference points on its surface from which a tool can be directly made with repeated accuracy.

## SAE AIR4844

## 3.16 (Continued):

**PERMANENT SET:** The deformation remaining after a specimen has been stressed a prescribed amount in tension, compression, or shear for a specified time period and released for a specified time period. For creep tests, the residual unrecoverable deformation after the load causing the creep has been removed for a substantial and specified period of time. Also, the increase in length, expressed as a percentage of the original length, by which an elastic material fails to return to original length after being stressed for a standard period of time.

**PERMEABILITY:** Is the product of the solubility coefficient and the diffusion coefficient. It is directly measured as the rate of transfer of liquid, vapor or gas through unit thickness, usually of a polymer in film form, per unit area and pressure difference across the film.

**PES:** Polyether sulfone

**PET:** Polyethylene terephthalate

**pH:** The measure of the acidity or alkalinity of a substance, neutrality being at pH 7. Acid solutions are less than 7, alkaline solutions are more than 7.

**PHASE:** (i) A visibly separate, but not necessarily separable, portion of a system. (ii) Two waveforms of the same frequency may not reach similar points of a cycle (e.g., peak values) at the same time. The amount by which they are out of step is called the "difference in phase," and is just as important as the magnitude when comparing two waveforms. Phase difference is normally expressed as the angle by which one wave is ahead of the other.

**PHENOLIC (PHENOLIC RESIN):** A thermosetting resin produced by the condensation of an aromatic alcohol with an aldehyde, particularly of phenol with formaldehyde. Used in high-temperature applications with various fillers and reinforcements. Used for aircraft interior components because in fire it gives off less smoke and toxic fumes than epoxy or polyester resins. See ISO 472.

**PHENYLSILANE RESINS:** Thermosetting copolymers of silicone and phenolic resins. Furnished in solution form.

**PHYSICAL CATALYST:** Radiant energy capable of promoting or modifying a chemical reaction.

**PI:** See polyimide.

**PIC:** See pressure-impregnation-carbonization.

**PICK:** (1) An individual filling yarn, running the width of a woven fabric at right angles to the warp, also called fill, woof and weft.  
 (2) To experience tack.  
 (3) To transfer unevenly from an adhesive applicator mechanism due to high surface tack.

## SAE AIR4844

## 3.16 (Continued):

**PICK COUNT:** The number of filling yarns per inch of woven fabric.

**PICK UP ROLL:** A spreading device where the roll for picking up the adhesive runs in a reservoir of adhesive. See ASTM D 907.

**PILED YARN:** Yarn made by collecting two or more single yarns. Normally, the yarns are twisted together, though sometimes they are collected without twist.

**PIN HOLES:** Small cavities that penetrate the surface of a cured part.

**PIT:** (i) A small, regular, or irregular crater in the surface of a plastic material, usually of a width approximately the same order of magnitude as its depth. (ii) A form of corrosion that occurs under particular conditions which result in small pits rather than general surface corrosion.

**PITCH:** A high molecular weight material left as a residue from the destructive distillation of coal and petroleum products. Pitches are used as base materials for the manufacture of certain high-modulus carbon fibers and as matrix precursors for carbon-carbon composites.

**PITCH FIBERS:** Reinforcement fiber derived from petroleum or coal tar pitch.

**PIW:** Pounds per inch width

**PLAIN WEAVE:** A weaving pattern in which the warp and fill fibers alternate; that is, the repeat pattern is warp/fill/warp/fill, etc. Both faces of a plain weave are identical. Properties are significantly reduced relative to a weaving pattern with fewer crossovers.

**PLANAR:** Lying essentially in a single plane.

**PLANAR HELIX WINDING:** A winding in which the filament path on each dome lies on a plane that intersects the dome, while a helical path over the cylindrical section is connected to the dome paths.

**PLANAR WINDING:** A winding in which the filament path lies on a plane that intersects the winding surface. See also polar winding.

**PLASTIC:** A material that contains as an essential ingredient, an organic polymer of large molecular weight, hardeners, fillers, reinforcements, etc.; is solid in its finished state; and at some stage in its manufacture or its processing into finished articles, can be shaped by flow. Made of plastic. A plastic may be either thermoplastic or thermoset. See ISO 472.

**PLASTIC DEFORMATION:** Change in dimensions of an object under load that is not recovered when the load is removed, as opposed to elastic deformation.

**PLASTIC FLOW:** (i) Deformation under the action of a sustained force. More likely to occur at high temperatures or long times. (ii) Flow of semi-solids in the molding of plastics.

## SAE AIR4844

## 3.16 (Continued):

**PLASTIC MEMORY:** The tendency of a thermoplastic material that has been stretched while hot to return to its unstretched shape upon being reheated.

**PLASTIC TOOLING:** Tools constructed of plastics, generally laminates or casting materials. A term employed for structures composed of plastics, usually reinforced thermosets, which are used as tools in the fabrication of metals or other materials including plastics.

**PLASTICIZE:** To make a material moldable by softening it with heat or a plasticizer.

**PLASTICIZER:** A material incorporated in a plastic to increase its workability and flexibility or distensibility. Normally used in thermoplastics. A lower molecular weight material added to an epoxy to reduce stiffness and brittleness, thereby resulting in a lower glass transition temperature for the polymer. See ASTM D 907 and ISO 472.

**PLATE SHEAR STRESS:** A type of honeycomb shear strength test in which the honeycomb is bonded between two thick steel plates which are displaced relative to each other to place the specimen in shear. Displacement is accomplished by loading either in tension or compression. The plate shear represents the best currently known method for obtaining true shear data on honeycomb material.

**PLATENS:** The mounting plates of a press, to which the entire mold assembly is bolted.

**PLY:** (i) In general, fabrics or felts consisting of one or more layers. (ii) The layers that make up a stack. (iii) Yarn resulting from twisting operations (three ply yarn, etc.). (iv) A single layer of prepreg. (v) A single pass in filament winding (two plies forming one layer). (vi) A sheet or layer that is considered to be one discrete piece of manufactured material such as fabric, tape or adhesive film etc.: A discrete piece may consist of just one piece or of adjoining pieces of the same material. (BDS 1330)

**PLY GROUPING:** Uncured or unconsolidated plies that are only part of a cured part and are grouped together for drawing clarity or for manufacturing engineering purposes. (BDS 1330)

**PLY ORIENTATION:** (i) The tow filament orientation of uni- or bi-axial material with respect to the tool or part reference axis. Usually expressed as 0, +45, 90, or -45° or a similar variation. (ii) The angle between the principal material direction of a ply (0° - direction) and a chosen coordinate system usually the reference coordinate system.

**PMR POLYIMIDES:** A novel class of high temperature resistant polymers. PMR represents in situ polymerization of monomer reactants.

## SAE AIR4844

## 3.16 (Continued):

**POISE:** The measure of the specific viscosity of a fluid. The c.g.s. unit of viscosity. 1 poise = 100 centipoise. The term poise is derived from the name of the man who discovered the laws of flow - Poiseuille. A more common term is now the Pascal second (Pa.s). Pa.s x 10 = poise.

**POISSON'S RATIO:** The ratio of the change in lateral width per unit width to change in axial length per unit length caused by the axial stretching or stressing of a material. The ratio of transverse strain to the corresponding axial strain below the proportional limit. See ISO 472.

**POLAR:** In an unsymmetrical molecule such as water or sulphur dioxide, the mean center of all the electronic charges does not coincide with the mean electrical center of the nuclei. Such a molecule is termed polar; it may be regarded as an electric doublet or dipole, analogous to a tiny magnet. Polar molecules have an electric moment which is equal to the distance between the two electrical centers multiplied by the total electric charge of either sign in the molecule. Liquid polar molecules in an electric field tend to orient themselves so that their potential energy is reduced to a minimum. When the electrical centers of a molecule coincide, the molecule has no electric moment and is said to be nonpolar.

**POLARITY:** Refers to the relative surface charge of a material resulting from the molecular structure of the adherent surface.

**POLAR SOLVENTS:** Such solvents as alcohols and ketones that contain hydroxyl or carbonyl groups, have high dielectric constants and show strong polarity.

**POLAR WINDING:** A winding in which the filament path passes tangent to the polar opening at one end of the chamber and tangent to the opposite side of the polar opening at the other end. A one-circuit pattern is inherent in the system.

**POLYACRYLONITRILE (PAN):** Used as a base material or precursor in the manufacture of certain carbon fibers.

**POLYAMIDE:** A thermoplastic polymer in which the structural units are linked by amide or thio-amide groupings (repeated nitrogen and hydrogen groupings). Many polyamides are fiber forming.

**POLYAMIDEIMIDE:** A polymer containing both amide (nylon) and imide (as in polyamide) groups; properties combine the benefits and disadvantages of both.

**POLYAMIDE PLASTIC:** See nylon plastics. See ISO 472.

**POLYARYLSULFONE (PAS):** A range of high temperature resistant thermoplastics with Tg values ranging from 190 to 260 °C (374 to 500 °F). The term is also occasionally used to describe the family of resins which includes polysulfone and polyether sulfone.

## SAE AIR4844

## 3.16 (Continued):

**POLYBENZIMIDAZOLE (PBI):** A condensation polymer of diphenyl isophthalate and 3,3' - di-aminobenzidine. Extremely high temperature resistance. Available as adhesive and fiber.

**POLYCARBONATE RESIN:** A thermoplastic polymer derived from the direct reaction between aromatic and aliphatic dihydroxy compounds with phosgene or by the ester exchange reaction with appropriate phosgene-derived precursors. Highest impact resistance of any transparent plastic. Impact resistance rapidly lost when in contact with certain solvents. See ISO 472.

**POLYCONDENSATION:** See condensation polymerization.

**POLYESTER RESINS:** Family of resins produced by the reaction of dibasic acids with dihydric alcohols. Polyethylene terephthalate (PET) is a thermoplastic which may be extruded, injection molded or blow molded. Unsaturated polyesters are thermosets and are used in the reinforced plastics industry for applications such as boats, auto parts etc. Modifications with multifunctional acids and bases and some unsaturated reactants permit crosslinking to thermosetting resins. Polyesters modified with fatty acids are called alkyds.

**POLYETHER ETHERKETONE (PEEK):** A linear aromatic crystalline thermoplastic. A composite with a PEEK matrix may have a continuous-use temperature as high as 250 °C (480 °F).

**POLYETHERIMIDE (PEI):** An amorphous polymer with good thermal properties for a thermoplastic. Reported Tg of 215 °C (419 °F) and continuous-use temperature of about 170 °C (338 °F).

**POLYETHERSULFONE (PES):** A thermoplastic material with a Tg of 230 °C (446 °F). ICI Trade Name, "Victrex" PES.

**POLYIMIDE (PI):** A polymer produced by reacting an aromatic dianhydride with an aromatic diamine. It is a highly heat-resistant resin. 315 °C (600 °F). Similar to a polyamide, differing only in the number of hydrogen molecules contained in the groupings. Suitable for use as a binder or adhesive. May be either thermoplastic or thermoset.

**POLYMER:** A high molecular weight organic compound, natural or synthetic, whose structure can be represented by a repeated small unit, the mer, for example, polyethylene, rubber, and cellulose. Synthetic polymers are formed by addition or condensation polymerization of monomers. Some polymers are elastomers, some are plastics, and some are fibers. When two or more dissimilar monomers are involved, the product is called a copolymer. The chain lengths of commercial thermoplastics vary from near a thousand to over one hundred thousand repeating units. Thermosetting polymers approach infinity after curing, but their resin precursors, often called prepolymers, may be relatively short - 6 to 100 repeating units - before curing. The lengths of polymer chains, usually measured by molecular weight, have very significant effects on the performance properties of plastics and profound effects on processibility. See ISO 472 and ASTM D 907.

## SAE AIR4844

## 3.16 (Continued):

**POLYMERIZATION:** A chemical reaction in which the molecules of a monomer are linked together to form large molecules whose molecular weight is a multiple of that of the original substance. When two or more monomers are involved, the process is called copolymerization. See ASTM D 907.

**POLYMER MATRIX:** The resin portion of a reinforced or filled plastic.

**POLYMETHYL METHACRYLATE:** A thermoplastic polymer synthesized from methyl methacrylate. It is a transparent solid with exceptional optical properties: available in the form of sheets, granules, solutions, and emulsions. Certain versions are commonly used for aircraft passenger and cockpit windows. See ISO 472.

**POLYPHENYLENE SULPHIDE (PPS):** A high-temperature thermoplastic useful primarily as a molding compound. Optimum properties depend on slightly cross-linking the resin. Known for chemical resistance.

**POLYPROPYLENE:** A tough, lightweight, thermoplastic made by the polymerization of high-purity propylene gas in the presence of an organometallic catalyst at relatively low pressures and temperatures.

**POLYSULPHIDE:** A synthetic polymer containing sulphur and carbon linkages, produced from organic dihalides and sodium polysulphide. Material is elastomeric in nature, resistant to light, oil, and solvents, and impermeable to gases.

**POLYSULFONE:** A high temperature resistant thermoplastic polymer with the sulfone linkage, with a  $T_g$  of 190 °C (375 °F).

**POLYURETHANE:** A thermosetting resin prepared by the reaction of diisocyanates with polyols, polyamides, alkyd polymers, and polyether polymers. See also isocyanate plastics and urethane plastics. See ISO 472.

**POPULATION:** The set of measurements about which inferences are to be made or the totality of possible measurements which might be obtained in a given testing situation. For example, "all possible ultimate tensile strength measurements for a carbon/epoxy system A, conditioned at 95% relative humidity and room temperature". In order to make inferences about a population, it is often necessary to make assumptions about its distributional form. The assumed distributional form may also be referred to as the population. MIL-HDBK-17.

**POPULATION MEAN:** The average of all potential measurements in a given population weighed by their relative frequencies in the population. MIL-HDBK-17.

**POPULATION MEDIAN:** That value in the population such that the probability of exceeding it is 0.5 and the probability of being less than it is 0.5. MIL-HDBK-17.

## SAE AIR4844

## 3.16 (Continued):

POPULATION VARIANCE: A measure of dispersion in a population. MIL-HDBK-17.

POROSITY: A condition of trapped pockets of air, gas, or vacuum, within a solid material. Usually expressed as a percentage of the total nonsolid volume to the total volume (solid plus nonsolid) of a unit quantity of material. See void content.

POSITIVE PRESSURE: (i) Pressure that is above normal atmospheric pressure as differentiated from vacuum pressure, which is below normal atmospheric pressure. (ii) A term also applied to air pressure in a clean room where lay up takes place prior to bonding. In this case the pressure in the room is slightly higher than outside to cause an outward flow of air to prevent dust and other contaminants entering the clean area.

POSITIVELY SKEWED: A distribution is said to be positively skewed if the distribution is not symmetric and the longest tail is on the right. MIL-HDBK-17.

POSTCURE: Additional elevated-temperature cure, usually without pressure to improve final properties and/or complete the cure, or decrease the percentage of volatiles in the compound. In certain resins, complete cure and ultimate mechanical properties are attained only by exposure of the cured resin to higher temperatures than those of curing. See ASTM D 907.

POST-FAB: Fabrication process where close-outs and inserts are attached or put into the panel after the facings are bonded to the core. ASTM C 274.

POSTFORMING: The forming, bending, or shaping of fully cured, C-staged thermoset laminates that have been heated to make them flexible. On cooling, the formed laminate retains the contours and shape of the mold over which it has been formed. See ISO 472.

POT: To embed a component or assembly in liquid resin, using a shell, can, or case that remains an integral part of the product after the resin is cured.

POTTING: Similar to encapsulating except that steps are taken to ensure complete penetration of all the voids in the object before the resin polymerizes.

POT LIFE: The length of time at some specified temperature that a catalyzed thermosetting resin system retains a viscosity low enough to be used in processing. Also called working life.

POTTING COMPOUND: A resin which has been thickened by use of filler (e.g., milled fibers or fine metal shavings). Also a resin reduced in density by the addition of hollow glass or phenolic microspheres. Used for jointing honeycomb and edge fill of sandwich panels.

## SAE AIR4844

## 3.16 (Continued):

**POURCOAT:** A liquid honeycomb sealant material (Type III - Boeing) of high solids content that is used to stabilize honeycomb core after crushing or as a seal against moisture entry by coating the cell walls. This pourcoat is applied by pouring it through the honeycomb cells.

**POWER FACTOR:** The cosine of the angle between voltage applied and the current resulting. Measurements are usually made at million-cycle frequencies.

**PPS:** See polyphenylene sulphide.

**PREBOND TREATMENT:** Synonym for surface preparation. See ASTM D 907.

**PRECISION:** The degree of agreement within a set of observations or test results obtained. Precision involves repeatability and reproducibility. MIL-HDBK-17.

**PRECURE:** (i) The full or partial setting of a synthetic resin or adhesive in a joint before the clamping operation is complete or before pressure is applied. (ii) To cure a part prior to joining it with other parts to form a bonded part. (BDS 1330)

**PRECURSOR:** For carbon or graphite fiber, the rayon, PAN, or pitch fibers from which carbon and graphite fibers are derived.

**PREFIT:** A process for checking the fit of mating detail parts in an assembly prior to adhesive bonding, to ensure proper bond lines. Mechanically fastened structures are sometimes prefitted to establish shimming requirements.

**PREFORM:** A preshaped fibrous reinforcement formed by distribution of chopped fibers or cloth by air, water flotation, or vacuum over the surface of a perforated screen to the approximate contour and thickness desired in the finished part. Also, a preshaped fibrous reinforcement of mat or cloth formed to the desired shape on a mandrel or mock-up before being placed in a mold press. See ISO 472.

**PREFORM BINDER:** A resin applied to the chopped strands of a preform, usually during its formation, and cured so that the preform will retain its shape and can be handled.

**PREGEL:** An unintentional, extra layer of cured resin on part of the surface of a reinforced plastic. Not related to gel coat.

**PREHEATING:** The heating of a compound before molding or casting, to facilitate the operation or reduce the molding cycle.

**PREIMPREGNATION:** The practice of mixing resin and reinforcement and effecting partial cure before use or shipment to the user. See also prepreg.

## SAE AIR4844

## 3.16 (Continued):

**PREMIX:** A molding compound prepared prior to and apart from the molding operations and containing all components required for molding: resin, reinforcement, fillers, catalysts, release agents, and other ingredients. See ISO 472.

**PREMOLDING:** The lay-up and partial cure at an intermediate cure temperature of a laminated or chopped-fiber detail part to stabilize its configuration for handling an assembly with other parts for final cure.

**PREPLIED PLIES:** Multiple plies of prepreg material that have been stacked up and compacted together to form a layup and packaged or stored prior to being cured individually or in combination with other parts. (BDS 1330)

**PREPLIED TAPE:** Tape received from the manufacturer with two or more plies laid into specific orientation.

**PREPLY:** A composite material lamina in the raw-material stage, ready to be fabricated into a finished laminate. The lamina is usually combined with other raw laminae before fabrication. A preply includes a fiber system that is placed in position relative to all or part of the required matrix material to constitute the finished lamina. An organic matrix preply is called a prepreg. Metal matrix preplies include green tape, flame-sprayed tape, and consolidated monolayers.

**PREPOLYMER:** A chemical intermediate whose molecular weight is between that of the monomer or monomers and the final polymer or resin.

**PREPREG:** Either ready-to-mold material in sheet form or ready-to-wind material in roving form, which may be cloth, mat, unidirectional fiber, or paper impregnated with resin and stored for use. The resin is partially cured to a B-stage and supplied to the fabricator, who lays up the finished shape and completes the cure with heat and pressure. The two distinct types of prepreg available are: (1) commercial prepregs, where the roving is coated with a hot melt or solvent system to produce a specific product to meet specific customer requirements; and (2) wet prepreg, where the basic resin is installed without solvents or preservatives but has limited room-temperature shelf life. See ISO 472.

**PREPREG BATCH:** Prepreg containing reinforcement material from one batch, impregnated with one batch of resin in one continuous operation.

**PREPREG LOT:** Prepreg from one batch submitted for acceptance at one time.

**PRESS CLAVE:** A simulated autoclave made by using the platens of a press to seal the ends of an open chamber, providing both the force required to prevent loss of the pressurizing medium and the heat required to cure the laminate inside.

## SAE AIR4844

## 3.16 (Continued):

**PRESSURE:** Force measured per unit area. Absolute pressure is measured with respect to zero. Gauge pressure (or relative pressure) is measured with respect to atmospheric pressure.

**PRESSURE BAG MOLDING:** A process for molding reinforced plastics in which a tailored, flexible bag is placed over the contact lay-up on the mold, sealed, and clamped in place. Fluid pressure, usually provided by compressed air or water, is placed against the bag, and the part is cured.

**PRESSURE-IMPREGNATION-CARBONIZATION (PIC):** A densification process for carbon-carbon composites involving pitch impregnation and carbonization under high temperature and isostatic pressure conditions. This process is carried out in hot isostatic press (HIP) equipment.

**PRESSURE INTENSIFIER:** A layer of flexible material (usually a high-temperature rubber) used to ensure the application of sufficient pressure to a location, such as a radius, in a lay-up being cured.

**PRESSURE-SENSITIVE ADHESIVE:** A viscoelastic material that, in solvent-free form, remains permanently tacky. Such material will adhere instantaneously to most solid surfaces with the application of very light pressure.

**PRIMARY STRUCTURE:** One critical to flight safety. See Catastrophic Failures.

**PRIMER:** A coating applied to a surface, before the application of an adhesive, lacquer, enamel, etc., to improve the adhesion performance or load-carrying ability of the bond. Some primers contain a corrosion inhibitor. See ASTM D 907.

**PRINTED WIRING BOARD:** A completely processed conductor pattern, usually formed on a stiff flat base (laminated plastic). It serves as a means of electrical interconnection and physical attachment for printed circuits. Also called printed circuit board.

**PROCESSING WINDOW:** The range of processing conditions, such as stock (melt) temperature, pressure, shear rate, etc., within which a particular grade of plastic can be fabricated with optimum or acceptable properties by a particular fabrication process, such as extrusion, injection molding, sheet molding, etc. The processing window for a particular plastic can vary significantly with design of the part and the mold, with the fabricating machinery used, and with the severity of the end-use stresses.

**PROMOTER:** A chemical, itself a feeble catalyst, that greatly increases the activity of a given catalyst. See also accelerator.

**PROOF:** To test a component or system at its peak operating load or pressure.

## SAE AIR4844

## 3.16 (Continued):

**PROOF PRESSURE:** The test pressure that pressurized components shall sustain without detrimental deformation or damage. The proof pressure test is used to give evidence of satisfactory workmanship and material quality.

**PROPORTIONAL LIMIT:** The greatest stress which a material is capable of sustaining without deviation from proportionality of stress and strain. (Hooke's law). It is expressed in force per unit area. See also elastic limit. See ISO 472.

**PROTOTYPE:** A model suitable for use in complete evaluation of form, design, performance, and material processing.

**PS:** Polysulfone

**PSI:** Pounds per square inch

**PUCKERS:** Areas on prepreg materials where material has locally blistered from the separator film or release paper.

**PULLED IN FILLING:** An extra filling yarn dragged into the fabric along with a regular filling yarn and extending across a portion of the fabric.

**PULP MOLDING:** The process by which a resin-impregnated pulp material is preformed by application of a vacuum and subsequently is oven cured or molded.

**PULTRUSION:** A continuous process for manufacturing composites that have a constant cross-sectional shape. The process consists of pulling a fiber-reinforcing material through a resin impregnation bath and through a shaping die, where the resin is subsequently cured. See ISO 472.

**PUNCTURE:** A break in the skin that may or may not extend through inner and outer skin.

**PURCHASER INSPECTION:** The examination and/or testing of any material for conformance to specification requirements prior to acceptance from a vendor

**PVF:** Polyvinylfluoride. See "Tedlar".

**PYROLYSIS:** With respect to fibers, the thermal process by which organic precursor fiber materials, such as rayon, polyacrylonitrile (PAN), and pitch, are chemically changed into carbon fiber by the action of heat in an inert atmosphere. Pyrolysis temperatures can range from 800 to 2800 °C (1470 to 5070 °F), depending on the precursor. Higher processing graphitization temperatures of 1900 to 3000 °C (3450 to 5430 °F) generally lead to higher modulus carbon fibers, usually referred to as graphite fibers. During the pyrolysis process, molecules containing oxygen, hydrogen, and nitrogen are driven from the precursor fiber, leaving continuous chains of carbon. Also means material decomposition from heat.

**PYROMETER:** Instrument for measuring temperature.

## SAE AIR4844

## 3.17 Q:

**QUADRAX BIAXIAL TAPE:** Trade name of unidirectional thermoplastic prepreg tape ribbons interlaced in fabric weaves that have the benefits of fabric formability and the strength of unidirectional tapes in both longitudinal and transverse directions.

**QUALIFICATION:** Demonstrated skill, training, knowledge, and experience required for personnel to properly perform the duties of a specific job.

**QUALIFICATION TEST:** A series of tests conducted by the procuring activity, or an agent thereof, to determine conformance of material, or materials system, to the requirements of a specification which normally results in a qualified products list under the specification.

**NOTE:** Generally, qualification under a specification requires a conformance to all tests in the specification, or it may be limited to conformance to a specific type or class, or both, under the specification. See ASTM D 907.

**QUALIFIED PRODUCTS LIST (QPL):** A list of commercial products that have been pretested and found to meet the requirements of a specification, especially a government specification.

**QUALITY ASSURANCE:** The function of evaluating product quality and the procedures taken to ensure that the final product conforms to the specification requirements. It has for its purpose the continuing assurance of the customer that the product he receives is of or better than the quality level he expects.

**QUARANTINED:** To be located in a separate place awaiting some further action, i.e., requalification test, inspection, repair information, spare parts or disposal.

**QUASI-ISOTROPIC LAMINATE:** A laminate laid up symmetrically with an equal number of plies at each 0°, 45°, and 90° angle. The properties in the plane of such a laminate will be nearly the same in all directions. The term may also be applied to laminates laid up with 0° and ±60° plies.

## 3.18 R:

**RADICAL:** A very reactive chemical intermediate.

**RAMPING:** A gradual programmed increase/decrease in temperature or pressure to control cure or cooling.

**RANDOM EFFECT:** A common shift in a group of measurements due to a random level change of a usually uncontrollable factor. MIL-HDBK-17.

**RANDOM ERROR:** That part of data variation due to level changes in uncontrolled factors which affect each observation separately and independently. MIL-HDBK-17.

## SAE AIR4844

## 3.18 (Continued):

**RANDOM PATTERN:** A winding with no fixed pattern. If a large number of circuits is required for the pattern to repeat, a random pattern is approached. A winding in which the filaments do not lie in an even pattern.

**RANGE:** The difference between the extreme high and low test values obtained from specimens cut from one test assembly.

**REACTION INJECTION MOLDING (RIM):** A process for molding polyurethane, epoxy, and other liquid chemical systems. Mixing of two to four components in the proper chemical ratio is accomplished by a high-pressure impingement-type mixing head, from which the mixed material is delivered into the mold at low pressure, where it reacts (cures).

**REACTIVE DILUENT:** As used in epoxy formulations, a compound containing one or more epoxy groups that functions mainly to reduce the viscosity of the mixture.

**REDUCTION OF AREA:** The difference between the original cross sectional area of a tension test specimen and the area of its smallest cross section, usually expressed as a percentage of the original area. MIL-HDBK-17.

**REFERENCE COORDINATE SYSTEM:** A coordinate system in which the structure is described with respect to loads and ply orientation. Usually an orthogonal coordinate system is chosen. For plates usually two axes are in the midplane of the plate and the third in the thickness direction perpendicular to it.

**REFRACTIVE INDEX:** The ratio of the velocity of light (of specified wavelength) in air to its velocity in the substance under examination. Also defined as the sine of the angle of incidence divided by the sine of the angle of refraction as light passes from air into the substance. (MIL-HDBK-17)

**REFRACTORY:** Refractories are special materials of construction capable of withstanding high temperatures in various industrial processes and operations. The main bulk of commercial refractories are complex solid bodies consisting of high melting oxides or a combination of oxides of elements such as silicon, aluminum, magnesium, calcium, and zirconium, with small amounts of other elements present as impurities. Refractoriness is the ability of a material to withstand the action of heat without appreciable deformation or softening under particular service conditions. These materials are used for furnace linings, crucibles for melting metals, rocket nozzles, etc.

**REINFORCED MOLDING COMPOUND:** Compound supplied by raw material producer in the form of ready-to-use materials, as distinguished from premix.

## SAE AIR4844

## 3.18 (Continued):

**REINFORCED PLASTICS:** Molded, formed, filament-wound, tape-wrapped, or shaped plastic parts consisting of resins to which reinforcing fibers, mats, fabrics, etc., have been added before the forming operation to provide some strength properties greatly superior to those of the base resin. See ISO 472.

**REINFORCED REACTION INJECTION MOLDING (RRIM):** A reaction injection molding with a reinforcement added. See also reaction injection molding.

**REINFORCEMENT:** A strong material bonded into a matrix to improve its mechanical properties. Reinforcements are usually long fibers, chopped fibers, whiskers, particulates, etc. The term should not be used synonymously with filler. A material used to reinforce, strengthen or give dimensional stability to a part.

**RELATIVE HUMIDITY:** The ratio of the actual pressure of existing water vapor to the maximum possible (saturation) pressure of water vapor in the atmosphere at the same temperature, expressed as a percentage.

**RELAXATION TIME:** The time required for a stress under a sustained constant strain to diminish by a stated fraction of its initial value.

**RELAXED STRESS:** The initial stress minus the remaining stress at a given time during a stress-relaxation test.

**RELEASE AGENT:** A material that is applied in a thin film to the surface of a mold to keep the resin from bonding to the mold. Also called parting agent. See also mold release agent. See ISO 472.

**RELEASE FILM:** An impermeable layer of film that does not bond to the resin being cured. See also separator.

**RELEASE PAPER:** A sheet, serving as a protectant or carrier, or both, for an adhesive film or mass, which is easily removed from the film or mass prior to use. See ASTM D 907.

**RELIABILITY:** The probability that an assembly or part will function properly in the operating environment for the expected service life.

**REPAIR:** The rebuilding of a rejected assembly to restore its intended form, fit and function.

**RESIDUAL GAS ANALYSIS (RGA):** The study of residual gases in vacuum systems using mass spectrometry.

**RESIDUAL STRAIN:** The strain associated with residual stress.

**RESIDUAL STRESS:** The stress existing in a body at rest, in equilibrium, at uniform temperature, and not subjected to external forces. Often caused by the forming and curing process.

## SAE AIR4844

## 3.18 (Continued):

**RESILIENCE:** The ratio of energy returned, on recovery from deformation to the work input required to produce the deformation (usually expressed as a percentage). The ability to regain an original shape quickly after being strained or distorted.

**RESIN:** A solid or pseudo solid organic material, usually of high molecular weight, that exhibits a tendency to flow when subjected to stress. It usually has a softening or melting range, and fractures conchoidally. Most resins are polymers. In reinforced plastics, the material used to bind together the reinforcement material; the matrix. See also polymer. See ISO 472 and ASTM D 907.

**RESIN APPLICATOR:** In filament winding the device which deposits the liquid resin onto the reinforcement band.

**RESIN BATCH:** Resin mixed in one mixer in one operation or resins blended together in one homogeneous mix with traceability to the individual component lots.

**RESIN CONTENT:** The amount of resin in a laminate expressed as either a percentage of total weight or total volume.

**RESIN/FIBER DUST:** Nuisance dust composed of a mixture of resin and fiber formed from solid material by crushing, grinding, drilling, etc., of nonmetallic composites.

**RESIN, LIQUID:** An organic polymeric liquid which becomes a solid when converted into its final state for use. Various curing agents may be used. Some require heat for a specified time, some cause curing at room temperature. See ASTM D 907.

**RESIN POCKET:** An apparent accumulation of excess resin in a small, localized section visible on cut edges of molded surfaces, or internal to the structure and nonvisible. See also resin-rich area. See ISO 472.

**RESIN-RICH AREA:** Localized area filled with resin and lacking reinforcing material. See also resin pocket.

**RESIN-STARVED AREA:** Localized area of insufficient resin, usually identified by low gloss, dry spots, or fiber showing on the surface.

**RESIN RIDGE:** A sharp buildup on the surface of a part consisting of only resin.

**RESIN SYSTEM:** A mixture of resin and ingredients such as catalyst, initiator, diluents, etc., required for the intended processing and final product.

## SAE AIR4844

## 3.18 (Continued):

**RESIN TRANSFER MOLDING (RTM):** A process whereby catalyzed thermosetting resin is transferred or injected into an enclosed mold in which the fiber reinforcement has been placed. Cure is normally accomplished without external heat. RTM combines relatively low tooling and equipment costs with the ability to mold large structural parts. In general thermoplastics are too viscous to be used in RTM even if heat is applied.

**RESINOGRAPHY:** The science of the morphology, structure, and related descriptive characteristics as correlated with the composition or conditions and with the properties or behavior of resins, polymers, plastics, and their products.

**RESINOID:** Any of the class of thermosetting synthetic resins, either in their initial temporarily fusible state or in their final infusible state. See ASTM D 907. See also novolak and thermosetting.

**RESISTIVITY:** The ability of a material to resist passage of electrical current either through its bulk or on a surface.

**RESITE:** An alternative term for 'C' stage. See ASTM D 907 and ISO 472.

**RESITOL:** An alternative term for 'B' stage. See ASTM D 907 and ISO 472.

**RESOLE:** An alternative term for 'A' stage. See ASTM D 907 and ISO 472.

**RETARDER:** See inhibitor. See ISO 472.

**REVERSE HELICAL WINDING:** In filament winding, as the fiber delivery arm traverses one circuit, a continuous helix is laid down, reversing direction at the polar ends. In contrast to biaxial, compact, or sequential winding. The fibers cross each other at definite equators, the number depending on the helix. The minimum region of crossover is three.

**REVERSE IMPACT TEST:** A test in which one side of a sheet of a material is struck by a pendulum or falling object and the reverse side is inspected for damage.

**RGA:** See residual gas analysis.

**R-GLASS:** American and European version of S-Glass.

**RHEOLOGY:** The study of the flow of materials, particularly plastic flow of solids and the flow of non-Newtonian liquids. The science treating the deformation and flow of matter.

**RIB:** A reinforcing member designed into a plastic part to provide lateral, horizontal, hoop, or other structural support.

**RIBBON:** A fiber having essentially a rectangular cross-section, where the width-to-thickness ratio is at least 4:1.

## SAE AIR4844

## 3.18 (Continued):

**RIBBON DIRECTION:** In honeycomb, the direction of the node bonds.

**RIGID PLASTICS:** For purposes of general classification, a plastic that has a modulus of elasticity either in flexure or in tension greater than 690 MPa (100 ksi) at 23 °C (70 °F) and 50% relative humidity. See ISO 472.

**RIGID RESIN:** A resin having a modulus high enough to be of practical importance, for example, 690 MPa (100 ksi) or greater.

**RIGIDITY:** The property of bodies by which they can resist an instantaneous change of shape. the reciprocal of elasticity.

**RIM:** See reaction injection molding.

**RISE TIME:** In urethane foam molding, the time between the pouring of the urethane mix and the completion of foaming.

**ROCKWELL HARDNESS:** A value derived from the increase in depth of an impression as the load on an indenter is increased from a fixed minimum value to a higher value and then returned to the minimum value. Indenters for the Rockwell test include steel balls of several specific diameters and a diamond cone penetrator having an included angle of 120° with a spherical tip having a radius of 0.2 mm (0.0070 in). Rockwell hardness numbers are always quoted with a prefix representing the Rockwell scale corresponding to a given combination of load and indenter, for example, HRC 30.

**ROOM TEMPERATURE:** A temperature in the range of 20 to 30 °C (68 to 86 °F). The term room temperature is usually applied to an atmosphere of unspecified relative humidity.

**ROOM-TEMPERATURE CURING ADHESIVE:** An adhesive that sets (to handling strength) within an hour at temperatures from 20 to 30 °C (68 to 86 °F) and later reaches full strength without heating.

**ROOM-TEMPERATURE-SETTING ADHESIVE:** An adhesive that sets in the temperature range from 20 to 30 °C (68 to 86 °F), in accordance with the standard limits for room temperature specified in ASTM D 618 and ASTM D 907. Compare to cold-setting adhesive, hot-setting adhesive, and intermediate-temperature-setting adhesive.

**ROOM-TEMPERATURE VULCANIZING (RTV):** Vulcanization or curing at room temperature by chemical reaction; usually applies to silicones and other rubbers.

**ROSIN:** A resin obtained as a residue in the distillation of crude turpentine from the sap of the pine tree (gum resin) or from an extract of the stumps and other parts of the tree (wood resin),

**ROVING:** A number of yarns, strands, tows, or ends collected into a parallel bundle with little or no twist. This term is applied most commonly to glass and Kevlar. See ISO 472.

## SAE AIR4844

## 3.18 (Continued):

**ROVING BALL:** The supply package offered to the winder, consisting of a number of ends or strands wound to a given outside diameter onto a length of cardboard tube. Usually designated by either fiber weight or length in yards.

**ROVING CLOTH:** A textile fabric, coarse in nature, woven from rovings.

**ROW NUCLEATION:** The mechanism by which stress-induced crystallization is initiated, usually during fiber spinning or hot drawing.

**RRIM:** See reinforced reaction injection molding.

**RTM:** See resin transfer molding.

**RTV:** See room-temperature vulcanizing.

**RUBBER:** Cross-linked polymers with glass transition temperature below room temperature, which exhibit highly elastic deformation and have high elongation. See ISO 472.

**RULE OF MIXTURES:** When two materials are mixed together it is normally the case that the properties of the mixture are an average of the properties of the constituents according to the proportion of each in the mixture. This applies, for example, to particulate reinforced composites and fillers in resins.

**RUNNER:** (i) The secondary feed channel in an injection or transfer mold that runs from the inner end of the sprue to the cavity gate. (ii) The molding material in this secondary feed channel. ISO 472.

**RUPTURE:** A cleavage or break resulting from physical stress. Work of rupture. The integral of the stress-strain curve between the origin and the point of rupture.

**RUPTURE STRENGTH:** The true value of rupture strength is the stress in a material at failure based on the ruptured cross-sectional area itself.

## 3.19 S:

**SAFETY HARDENER:** A curing agent which causes only a minimum toxic effect on the human body, either on contact with the skin or as concentrated vapor in the air.

**SAGGING:** Run-off or flow-off of adhesive from an adherend surface due to application of excess or low viscosity material.

**SAMPLE:** (i) A small portion of a material or product intended to be representative of the whole. (ii) Statistically, a sample is the collection of measurements taken from a specified population. MIL-HDBK-17.

## SAE AIR4844

## 3.19 (Continued):

**SAMPLE MEAN:** The arithmetic average of the measurements in a sample. The sample mean is an estimator of the population mean. MIL-HDBK-17.

**SAMPLE MEDIAN:** Order the observations from smallest to largest. Then the sample median is the value of the middle observation if the sample size is odd; the average of the two central observations if "n" is even. If the population is symmetric about its mean, the sample median is also an estimator of the population mean. MIL-HDBK-17.

**SAMPLE STANDARD DEVIATION:** The square root of the sample variance. MIL-HDBK-17.

**SAMPLE VARIANCE:** The sum of the squared deviations from the sample mean, divided by  $n-1$ . MIL-HDBK-17.

**SANDWICH CONSTRUCTIONS:** Panels composed of a lightweight core material, such as honeycomb, foamed plastic, etc., to which two relatively thin, dense, high-strength or high-stiffness faces or skins are adhered.

**SANDWICH PANEL:** A panel consisting of two thin face sheets bonded to a thick, lightweight honeycomb or foam core.

**SANDING:** The use of abrasive papers to either prepare a surface by light abrasion using a fine grit paper, or remove material and/or shape a part with a coarse grit paper.

**SATIN:** A type of finish having a satin or velvety appearance, specified for plastics or composites.

**SATIN WEAVE:** See harness satin.

**SATURATION:** An equilibrium condition in which the net rate of absorption under prescribed conditions falls essentially to zero. (MIL-HDBK-17)

**S-BASIS:** The S-basis property allowable is the minimum value specified by the appropriate Federal, Military, Society of Automotive Engineers, American Society for Testing and Materials, or other recognized and approved specifications for the material.

**SBS:** See short beam shear.

**SCARF ANGLE:** The angle of taper of a scarf joint, i.e., the taper ratio of length to thickness.

**SCARF JOINT:** A joint made by cutting away similar angular segments on two adherents and bonding the adherents with the cut areas fitted together. See also lap joint. See ASTM D 907.

## SAE AIR4844

## 3.19 (Continued):

**SCORING:** A type of wear in which the working face acquires grooves, axial or circumferential, according to whether the motion is reciprocating or rotary. Also applied to a similar effect on the rigid, nonmoving member. A groove which is smooth and has significant width compared to depth. A blunt scratch.

**SCOURING:** Cleaning process to remove size (steam, acid wash) followed by drying under controlled conditions.

**SCRATCH:** An elongated surface discontinuity which is infinitely small in width compared to length. Shallow mark, groove, furrow or channel normally caused by improper handling or storage.

**SCRIM:** A low-cost reinforcing fabric made from continuous filament yarn in an open-mesh construction. Used in the processing of tape or other B-stage material to facilitate handling. Also used as a carrier of adhesive, to be used in secondary bonding.

**SEALANT:** A material applied to a joint in paste or liquid form that hardens or cures in place, forming a seal against gas or liquid entry.

**SECANT MODULUS:** Idealized Young's modulus derived from a secant drawn between the origin and any point on a nonlinear stress-strain curve. On materials whose modulus changes with stress, the secant modulus is the average of the zero applied stress point and the maximum stress point being considered. See also tangent modulus.

**SECONDARY BONDING:** The joining together, by the process of adhesive bonding, of two or more already cured composite parts, during which the only chemical or thermal reaction occurring is the curing of the adhesive itself.

**SECONDARY STRUCTURE:** In aircraft and aerospace applications, a structure that is not critical to flight safety but failure could cause significant problems. See Catastrophic Failures.

**SELECTIVE REINFORCEMENT:** The addition of advanced composite materials to selected areas for local augmentation of strength or stiffness.

**SELF-EXTINGUISHING RESIN:** A resin formulation that will burn in the presence of a flame but will extinguish itself within a specified time after the flame is removed.

**SELF-IGNITION TEMPERATURE:** The temperature of a material at which spontaneous combustion takes place when the temperature rises slowly.

**SELF-SKINNING FOAM:** A urethane foam that produces a tough outer surface over a foam core upon curing.

**SELF-VULCANIZING:** Pertaining to an adhesive that undergoes vulcanization without the application of heat. See ASTM D 907. See also vulcanization.

## SAE AIR4844

## 3.19 (Continued):

**SELVAGE:** The woven-edge portion of a fabric parallel to the warp, finished off so as to prevent the yarns from unravelling. Modern "Jet" looms (since 1980s) leave cut ends in the weft but locking threads provided to stop edge unravelling. Selvage is always cut off. It is never incorporated into the work.

**SEMICRYSTALLINE:** In plastics, materials that exhibit localized crystallinity. See also crystalline plastic.

**SERVICE CONDITIONS:** The heat, cold, flexing, shock, impact, vibration etc. that an adhesive or composite will be subjected to in service.

**SEPARATOR:** A permeable layer that also acts as a release film. Porous Teflon-coated fiberglass is an example. Often placed between lay-up and bleeder to facilitate bleeder system removal from laminate after cure. Also called "separator cloth".

**SEPTUM:** Adhesive and prepreg cured between two pieces of core.

**SET:** (i) The irrecoverable or permanent deformation or creep after complete release of the force producing the deformation. (ii) To convert an adhesive into a fixed or hardened state by chemical or physical action, such as condensation, polymerization, oxidation, vulcanization, gelation, hydration, or evaporation of volatile constituents. See ASTM D 907. See also cure and dry.

**SETTING TEMPERATURE:** The temperature to which an adhesive or assembly is subjected to set the adhesive. See cure temperature.

**SETTING TIME:** The period of time during which an assembly is subjected to heat or pressure, or both, to set the adhesive.

**SET UP:** To harden, as in curing of a polymer resin.

**S-GLASS:** (Silica/Alumina/Magnesia) Structural Glass, used as fiber reinforcement, designed to give high tensile strength. More expensive than E-Glass.

**SHEAR:** An action or stress resulting from applied forces that causes or tends to cause two contiguous parts of a body to slide relative to each other in a direction parallel to their plane of contact. In interlaminar shear, the plane of contact is composed primarily of resin. See also shear strength and shear stress.

**SHEAR CRIMPING:** Buckling of the compressive facing due to low core shear modulus. Usually causes the core to fail in shear at the crimp. ASTM C 274.

**SHEAR EDGE:** The cutoff edge of the mold.

## SAE AIR4844

## 3.19 (Continued):

**SHEAR FRACTURE (FOR CRYSTALLINE TYPE MATERIALS):** A mode of fracture resulting from translation along slip planes, which are preferentially oriented in the direction of the shearing stress. MIL-HDBK-17.

**SHEAR MODULUS:** The ratio of shearing stress to shearing strain within the proportional limit of the material.

**SHEAR RIGIDITY:** The sandwich property which resists shear distortions; synonymous with shear stiffness. ASTM C 274.

**SHEAR STRAIN:** The tangent of the angular change, caused by a force between two lines originally perpendicular to each other through a point in a body. Also called angular strain.

**SHEAR STRENGTH:** The maximum shear stress that a material is capable of sustaining. Shear strength is calculated from the maximum load during a shear or torsion test and is based on the original cross-sectional area of the specimen.

**SHEAR STRESS:** The component of stress tangent to the plane on which the forces act. See ISO 472.

**SHEAROGRAPHY:** Was developed for strain measurements. The process now provides a full-field video strain gauge, in real time, over large areas. It is an enhanced form of holography, which requires the part to be under stress. A laser is used to illuminate the part while under stress. The output takes the form of an image processed video display.

**SHEET, SHEETING:** A thin, generally plane product in which the thickness is small in proportion to length and width. See ISO 472.

**SHEET MOLDING COMPOUND (SMC):** A composite of fibers, usually a polyester resin, and pigments, fillers and other additives that have been compounded and processed into sheet form to facilitate handling in the molding operation.

**SHEETING:** (i) Sheet made in continuous lengths and generally supplied in roll form. (ii) A synonym for sheet. See ISO 472.

**SHELF LIFE:** The length of time a material, substance, product, or reagent can be stored under specified environmental conditions and continue to meet all applicable specification requirements and/or remain suitable for its intended function. Synonym for storage life.

**SHELL TOOLING:** A mold or bonding fixture consisting of a contoured surface shell supported by a substructure to provide dimensional stability.

**SHOE:** A device for gathering filaments into a strand, in glass fiber forming.