



**Abrasion Resistance:** The ability of a rubber compound to resist surface wearing by mechanical action.

**Accelerator:** A chemical compound that speeds up the vulcanization of natural or synthetic rubbers.

**Air Checks / Traps:** Surface markings or depressions resulting from the trapping of air between the rubber surfaces being cured and the mold or press surface.

**Ambient Temperature:** The temperature of the environment surrounding a particular object.

**Aliphatic:** A major group of organic compounds characterized by the presence of straight chain arrangements of carbon atoms. The three subgroups that comprise aliphatic hydrocarbons are: paraffins (alkanes), olefins (alkenes), and acetylenes (alkynes).

**AMS:** Aerospace Material Specification.

**AN:** Abbreviation for Air Force-Navy (specifications).

**Aniline Point:** The lowest temperature at which equal parts of aniline and a test liquid (such as oil) will uniformly mix or blend. The aniline point of oil is a measure of aromaticity (the amount of unsaturated hydrocarbons present). The lower the aniline point, the more unsaturants are present and the higher the potential for swelling certain rubber compounds.

**Antioxidant:** Any organic compound that slows the process of oxidation.

**Antiozonant:** Any substance that slows the severe oxidizing effect of ozone on elastomers. Exposure to ozone typically causes surface cracking in many rubbers.

**Aromatic:** A major group of unsaturated cyclic hydrocarbons containing one or more rings. A typical aromatic compound is benzene, which has a six carbon ring, containing three double bonds.

**AS-568\*:** Aerospace Standard Uniform Dash Numbering System for O-rings. All military standard (MS) drawings currently use this system. Supersedes ARP-568\*.

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

**Axial Seal:** Squeezed, like a gasket, on both the top and bottom surfaces of the seal's cross section. A face seal.

**Back-up Ring:** A washer-like device of a relatively hard, tough material installed in the gland on the downstream side of the seal to prevent seal extrusion into the diametrical gap while under pressure.

**Bench Test:** A laboratory test approximating product service conditions.

**Bending Modulus:** The measure of applied force required to bend a material a given distance around a specified radius. A measure of material elasticity (stiffness).

**Bleeding:** A film or beads formed by such compound components as plasticizers that have migrated to the surface of rubber products because of incompatibility with the base elastomer and/or the compound ingredients.

**Blemish:** A surface mark or deformity.

**Blisters:** A raised spot on the seal's surface created by an internal void, or air-filled pocket.

**Bloom:** A milky surface discoloration caused by the migration of certain compound components (such as antiozonants) to the rubber's surface after molding or storage. The waxy film serves as a protective coating shielding the part from oxidation. This discoloration DOES NOT adversely affect material performance.

\*Note: The current revision of the Standard is "C" but it changes periodically.



## Glossary of Terms



**Bond:** The mechanical or chemical force that holds an elastomer to some other object. Mechanical bonding includes component interference and no molecular crossbridging between the elastomer and substrate, whereas chemical bonding involves contact adhesives with heat and pressure to adhere an elastomer to a primed surface.

**Break-Out:** The force required to overcome initial seal to gland surface adhesion, when part movement is intermittent. A common term used to describe one form of friction.

**Brittleness:** Tendency to crack upon physical deformation.

**Coefficient of Thermal Expansion:** Value used to determine the amount of linear dimensional change for a particular elastomer, which is temperature dependent.

**Cold Flexibility:** Flexibility following elastomer exposure to a specified low temperature for a specified period of time.

**Cold Flow:** A term describing the tendency of certain materials to continue to deform or “creep” under constant sealing pressure (compressive load).

**Cold Resistant:** Capable of low temperature operation without loss of serviceability.

**Composite Seal:** Combines the sealing performance of elastomers with the physical properties of the bonded material (i.e. metal, plastic, etc.).

**Compound:** An elastomeric material resulting from the combination of a number of individual chemical ingredients into a batch mix. Further processing of the thoroughly mixed ingredients, to induce cross linking of polymer chains (vulcanization), results in the creation of a useful rubber-like product.

**Compression Modulus:** The ratio of applied compressive force (stress) to the resulting deformation of the test material (strain). Compressive strain is expressed as a fraction of the original height or thickness of the test specimen in the direction of the applied force.

**Compression Set:** The amount by which an elastomeric material fails to return to its original size after release from a constant compressive load.

**Copolymer:** An elastomer (polymer) resulting from the chemical combination of two dissimilar monomers. For example, Nitrile from Butadiene and Acrylonitrile.

**Cracking:** Sharp breaks or fissures in rubber surfaces resulting from excessive strain or exposure to adverse environmental factors.

**Creep:** The progressive relaxation of an elastomeric material under constant sealing pressure (compressive load). Also known as cold flow.

**Cross Section:** A seal cut at right angles to the mold parting line. Also known as width.

**Cure:** Another term for “vulcanization” of compounded and molded rubber (green stock), resulting in the chemical bonding (cross linking) of polymer chains and the accompanying creation of useful elastomeric products. Curing typically occurs in the presence of sulfur and an accelerator, under pressure, at elevated temperature.

**Cure Date:** O-ring molding date. A product code of 2Q97, for example indicates a cure date of the second quarter (2Q) of 199,7 (97). No longer required by MIL-STD-1523.

**Curing Temperature:** The temperature of vulcanization.

**Cylinder:** Chamber in which a piston is driven.

**Deflash:** A process of removing unwanted, excess material (flash) from a finished product.

**Degassing:** Intentional, controlled outgassing of the volatile (evaporative) components of elastomeric materials.

**Diametrical Clearance:** The gap between the two mating metal surfaces forming a gland's internal cavity. Through slight oversizing and accompanying "squeeze," the O-ring seals this gap to prevent system leakage.

**Durometer:** A measure of the hardness of a rubber compound. In a Shore A scale, the resultant numerical rating of hardness runs from lower numbered (30 or 40) softer materials to higher numbered (80 to 90) harder materials. Usually designated with a  $\pm 5$  tolerance.

**Dynamic Seal:** Any application involving reciprocating, rotating, or oscillating motion relative to the seal.

**Elasticity:** The tendency of a material to return to its original shape after deformation.

**Elastomer:** A general term used to describe both natural and synthetic polymers possessing the resilience required to return to approximate original shape after major or minor distortion.

**Elongation:** Generally referred to in terms of tensile (pull apart) testing. Elongation is the increase in length of a test specimen, expressed as a percentage of its original (unstretched) length...relative to a given load at the breakpoint.

**Extrusion:** The forced extension of part of the seal into the diametrical clearance gap of the gland, caused by excessive system pressure.

**Face Seal:** Squeezed, like a gasket, on both the top and bottom surfaces of the seal's cross section. An axial seal.

**FDA:** Food and Drug Administration is a U.S. government agency that regulates the ingredients in rubber compounds that are intended for use in food and medical applications.

**Filler:** A finely divided material used to reinforce or modify elastomer physical properties, impart certain processing properties, or reduce cost. Typical examples are carbon black, clays, calcium carbonates and silicas.

**Flash:** Excess rubber around a molded part due to cavity overflow and/or parting line of molded surfaces.

**Flex Resistance:** The ability of an elastomeric product to resist the stress of constant bending.

**Flow Lines:** Molded article surface imperfections caused by failure of the rubber stock to blend with itself during the molding operation.

**Fluid:** A liquid or gas.

**Friction (Break-Out):** Friction developed in dynamic seal situations during machine start-up. When machine operation is irregular, O-rings tend to conform (adhere) to the microfine grooves of surrounding glandular surfaces, requiring extra initial force to break them out of these microfine grooves.

**Friction (Running):** A force which resists objects already in motion.

**Gasket:** A static (stationary) sealing device used to retain fluids under pressure or to seal out foreign matter.

**Gland:** Complete cavity into which the seal is installed. Includes a machined groove and mating metal surfaces.

**Groove:** The machined glandular recess into which the seal is fitted.

**Hardness:** Resistance of rubber to forced distortion as measured by the indentor point of a durometer gauge.

**Hardness, Shore A:** Durometer reading in degrees of rubber hardness as measured on a Shore A gauge. Scale is 0-100, with higher numbers indicating greater hardness.

**Hermetic Seal:** An airtight seal.



## Glossary of Terms



**I.D.:** The inside or hole diameter of an O-ring.

**ISO:** International Organization for Standardization – model for quality assurance in design, development, production, installation and servicing.

**Leakage Rate:** The rate at which a fluid (either gas or liquid) passes a barrier.

**Life Test:** A laboratory test of the amount and duration of product resistance to a set of destructive forces or conditions. Used to compare the relative performance capabilities of various product designs.

**LIM:** “Liquid Injection Molding” is a closed manufacturing process using LSR in an injection molding machine.

**Low Temperature Flexibility:** The ability of an elastomeric product to be flexed or bent at low temperatures without cracking.

**LSR:** “Liquid Silicone Rubber” is composed of a two-component, low viscosity, heat-curable rubber system.

**Memory:** Ability of an elastomeric material to return to its original size and shape after deformation.

**MIL:** Abbreviation for Military.

**MIL STD:** Military Standard.

**Mismatch:** Unequal O-ring cross-sectional radii caused by dimensional differences in the mold cavity.

**Modulus:** The tensile stress force in psi required to produce a specified increase in material length (usually 100% elongation).

**Modulus of Elasticity:** One of several measurements of stiffness or resistance to deformation.

**Mold:** Typically made from steel. Product is formed within machined cavity.

**Mold Cavity:** Hollow space of the mold within which the uncured rubber compound is shaped and cured to the desired finished product form.

**Mold Finish:** The surface finish of the mold which imparts the desired surface quality to the finished molded product.

**Mold Marks:** Slight irregularities in the surface of molded articles caused by mold machining marks, or damage to the mold itself.

**Mold Release:** A lubricant used to assist in the removal of rubber products from the mold.

**MS:** Abbreviation for Military Standard.

**Nominal Dimension:** The mean dimension of a molded article, from which small dimensional (plus and minus) deviations are allowed as manufacturing tolerances.

**Non-Fill:** A molding condition where the rubber fails to completely fill the mold cavity, resulting in an incomplete part.

**Occlusion:** The mechanical entrapment of gases, liquids or solids within the folds of a substance.

**O.D.:** The outside diameter of an O-ring; a dimensional reference.

**Off Register:** Eccentric O-ring cross-sectional radii caused by lateral shift of one mold cavity relative to the other.

**Oil Resistant:** Ability of vulcanized rubber to resist swelling and other detrimental effects of exposure to various oils.

**O-Ring:** A doughnut-shaped object, or torus, that functions as a seal, blocking the passage of liquids or gases, by being compressed between the two mating surfaces comprising the walls of the cavity (gland) into which the ring is installed.

**Oscillating Seal:** Most commonly used in faucet valves, in this application the inner or outer member of the gland moves in an arc around the axis of a shaft. Movement is limited to a few turns in one direction and a few turns in the return direction (i.e. faucet on, faucet off).

**Outgassing:** Primarily occurring in vacuum situations, the volatile (evaporative) components of some rubber compounds may become vaporized in the vacuum and released (outgassed) by the compound into the surrounding environment.

**Oxidation:** The reaction of oxygen with a rubber compound, typically resulting in surface cracking of the rubber material. As oxidation involves the transfer of electrons, reduction in the physical strength of elastomers may also occur from exposure to the oxidizing agent.

**Ozone Resistance:** The ability of vulcanized rubber to withstand cracking and physical deterioration from exposure to ozone, a more active oxidizing agent than oxygen itself.

**Permanent Set:** The deformation remaining in a rubber specimen following both stress and relaxation over a period of time.

**Permeability:** The rate of gas flow through a particular rubber material.

**Plasticizer:** A chemical agent added to the rubber compound batch mix to soften the elastomer for processing, as well as to improve physical properties of the compound product (i.e., increase elongation, reduce hardness, improve tack).

**Polymer:** A long molecular chain material formed by the chemical combination of many similarly structured, small molecular units.

**Post Cure:** A second step in the vulcanization of certain elastomers, used to drive off residual decomposition products resulting from initial vulcanization.

**QS 9000:** Quality System model, used in conjunction with the ISO 9000 standard, for the automotive industry.

**Radial Seal:** Compression is applied perpendicular to the seal centerline.

**Reciprocating Seal:** Seals used in moving piston and rod situations.

**Reinforcing Agent:** Fillers, such as Carbon Black, added to the elastomeric batch mix to improve such physical properties as tensile strength.

**Resilience:** The capability of returning to original size and shape after deformation.

**RMA:** Rubber Manufacturer's Association.

**RMS:** Root Mean Square. A measure of surface roughness typically applied to the machining of metal gland and shaft surfaces. RMS stands for the square root of the sum of the squares of micro-inch deviation from true flat.

**Rotary Seal:** Seals for rotating shafts, with the turning shaft protruding through the I.D. (hole) of the O-ring.

**Rubber:** A common name for both naturally occurring and synthetically made elastomers.

**Rubber, Natural:** A natural product of the juices of certain tropical plants (latex), improved through heat treating with sulfur (vulcanization).

**Rubber, Synthetic:** Man-made elastomers such as Nitrile, Fluorocarbon, Silicone, etc.

**Running Friction:** A force which resists objects already in motion.

**Runout (Shaft):** Same as gyration. When expressed in inches along, or accompanied by abbreviation "TIR" (total indicator reading), it refers to twice the radial distance between shaft axis and axis of rotation.

**SAE:** Society of Automotive Engineers.

**Scorching:** Premature curing of compounded rubber stock during processing or storage, with the potential for adversely affecting material flow and plasticity during subsequent shaping and curing processes.

**Seal:** Any device used to prevent the passage of a fluid (gas or liquid) or fine particles.



## Glossary of Terms



**Shelf-Aging:** The potential degradation of seal performance capabilities due to exposure of seal elastomers to stressful environmental factors during storage. Proper packaging and storage conditions help to avoid this problem.

**Shore A Hardness:** Durometer reading in degrees of rubber hardness as measured on a Shore A gauge. Scale is 0-100, with higher numbers indicating greater hardness.

**Shrinkage:** (1) All rubber materials shrink to some extent during molding. This is normal and should be taken into consideration (using individual polymer shrink rates) when designing rubber parts. (2) Decreased seal volume due to exposure to adverse environmental factors. Can be an indication of plasticizer extraction from system chemicals.

**Size, Actual:** Actual dimensions of a molded article (including manufacturing tolerances).

**Size, Nominal:** Basic dimensions of a part from which plus and minus tolerances are developed to account for the range of actual dimensions expected during manufacturing.

**Specific Gravity:** The weight of a given volume of any substance compared with the weight of an equal volume of water. Specific Gravity is used as a comparison tool to determine the relative density of seal materials, helping to identify base polymers and certain compounds.

**Spiral Failure:** Generally found on long stroke, hydraulic piston seals, spiral failure results when certain segments of the O-ring slide, while other segments simultaneously roll. At a single point on its periphery, the O-ring gets caught on an eccentric component, or against the cylinder wall, causing twisting and development of 45 degree angle, surface cuts.

**Sprue Marks:** Raised or recessed marks on the surface of a molded rubber part created by the removal of extra cured material left at the inlet (gate) of the mold by the sprue (pouring nozzle) of the molding machine.

**Squeeze:** Compression of the O-ring between the two mating surfaces comprising the walls of the cavity or “gland” into which the seal is installed. Squeeze may be either of two types: Axial - squeezed on the top and bottom O-ring surfaces, as in face seals. Radial - squeezed on the inner and outer O-ring surfaces, as in piston or rod seals. Squeeze helps to assure a leak-resistant seal.

**Stack Up Tolerance:** The summation of sealing system tolerances.

**Static Seal:** A gasket type application where the seal is contained within two non-moving gland walls, as in face seals.

**Strain:** Deformation per specified area unit of material due to applied force (stress).

**Stress:** Applied force per specified area unit of material.

**Swell:** Increased seal volume caused by exposure to adverse operating conditions, such as exposure to oils, fluids, heat, and the like.

**Tear Resistance:** Resistance to the growth of a cut in the seal when tension is applied.

**Temperature Range:** The working range marked by the limits of minimum and maximum operating temperatures for effective seal performance.

**Tensile Strength:** Pull-apart strength. A measure of the compound’s strength when stretched to the breaking point.

**Terpolymer:** A polymer resulting from the chemical combination of three monomers.

**Thermal Expansion:** Linear or volumetric expansion caused by temperature increases.

**Thermoplastics:** Polymeric materials that soften and can be re-formed when heated, returning to original properties when cooled.

**Thermoset:** Elastomers that undergo a permanent chemical crosslinking of molecules when processed, heated and molded, and therefore cannot be reprocessed.

**TIR (Total Indicator Reading):** A measurement of roundness with relationship to a centerline and expressed in total diametric deviation.

**Torque:** A turning or twisting force, generally associated with the rotation of a shaft.

**Torsional Strength:** Ability of a seal to withstand damage due to twisting.

**TPE:** Thermoplastic Elastomer combines the rubber-like performance of elastomers with the processing advantages of plastic. Scrap material can be recycled without significant loss in physical properties, unlike thermoset materials.

**Trim:** Removal of excess material (flash) from a molded rubber article.

**Trim Cut:** Damage to the molded article by trimming too close.

**Under-Cure:** A condition where rubber has not been cured enough, exhibiting poor physical properties and/or tackiness.

**Ultimate Elongation:** The % of specimen stretching at the point of breaking. Generally referred to in tensile testing.

**Viscosity:** Resistance to flow.

**Voids:** Empty pockets where not intended.

**Volume Change:** Increase or decrease in the size of a specimen expressed as a percentage of original volume. Generally associated with immersion of elastomer samples in various chemical agents.

**Volume Swell:** A term generally used to describe the increase in physical size of a specimen immersed in a particular chemical agent.

**Vulcanization:** The heat induced cross linking (curing) of polymer chains, converting basic visco-elastic liquids into three-dimensional networks of flexible, elastomeric chains (the molded rubber product).

**Weathering:** The tendency of some O-ring seals to surface crack upon exposure to atmospheres containing ozone and other pollutants.

**Width:** 1. The cross-sectional diameter of an O-ring.  
2. One half the difference between the I.D. and O.D. of the ring.