



A Product of the  
Cooperative Engineering Program

**SAE J111 JUN88**

## **Seals — Terminology of Radial Lip**

**SAE Recommended Practice**  
Revised June 1988

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400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

# HIGHWAY VEHICLE PRACTICE

SAE J111

Submitted for recognition as an American National Standard

Issued May 1959  
Revised June 1988

Superseding J111 MAR85

## SEALS - TERMINOLOGY OF RADIAL LIP

### 1. SCOPE:

The purpose of this SAE Recommended Practice is to provide a glossary of radial seal terms and nomenclature which are normally encountered in the design, manufacture, installation, testing, inspection, and failure mode analysis of radial seals. The information will aid in the understanding and communication of those people associated with radial seals.

### 2. GLOSSARY:

Angle, Helixseal Rib (2-9)<sup>1</sup> - The angle formed by the leading edge of the rib and a line perpendicular to a plane tangent to the outside lip surface at the centerline of the rib base.

Angle, Molded Toe (1-30) - The angle between the toe face of a seal lip and the seal axis.

Angle, Contact Approach (1-25) - Synonym: angle, seal outside lip.

Angle Helix (2-2) - The angle between a helical rib and the lip line of contact.

Angle, Helix Contact (2-3) - The angle formed by the rib leading edge and the lip line of contact.

Angle, Inside Lip (1-19) - The angle between the inside lip surface and the axis of the seal case.

Angle, Outside Lip (1-25) - The angle between the outside lip surface and the axis of the seal case.

<sup>1</sup>Numbers in parentheses refer to figure and item number in that order.

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## 2. (Continued):

Angle, Trimming (1-19) - The angle between the trimmed face of a seal lip and the seal axis.

Assembly, Seal - A group of parts, which includes sealing surfaces, provisions for initial loading, and a secondary sealing mechanism which accommodates the radial and axial movement necessary for installation and operation.

Base, Seal (1-5) - Synonym: face, outside seal.

Bedding-In - Synonym: run-in.

Blister - A raised cavity or sack that deforms a surface of the seal material.

Bond - The adhesion established by vulcanization between two cured elastomer surfaces, or between one cured elastomer surface and one non-elastomer surface.

Bore, Housing (1-10) - A cylindrical surface which mates with the outside diameter of the outer seal case.

Bore, Seal Case - Synonym: diameter, outer-case inner.

Buna-N - See: nitrile.

Cap - That part of the seal head section which is removed during trimming.

Case, Bonded (3-4) - A design feature of a type of radial lip seal wherein the heel of the sealing element is attached to the seal case by an adhesive during the molding operation.

Case, Clinched (3-10) - A design feature of a type of radial lip seal wherein the heel of the sealing element is attached to the seal case by clamping it between two convolutions, or folds, of the case.

Case, Inner (1-4, 3-3) - A rigid, cup-shaped component of a seal assembly, which is placed inside the outer seal case. It has one or more of the following functions: reinforcing member, shield, spring retainer, lip clamping device.

Case, Molded (3-5) - A design feature of a type of radial lip seal wherein the lip and case are made integral in the molding process.

Case, Seal - A rigid member to which the seal lip is attached.

Case, Outer (1-2, 3-2) - The outer thin-wall rigid structure of the lip-seal assembly which contains the inner case, the primary-seal ring, the spring parts, and the secondary seal.

Cavity, Mold - A single unit or assembly of contoured parts in which a material, such as an elastomer, is shaped into a particular configuration.

## 2. (Continued):

Cavity, Seal - The annular area between a housing bore and a shaft, into which a seal is installed.

Checking - Short axial crack on the lip contact surface.

Clearance, Axial (1-14) - The gap between the toe face of the head section and the inside surface of the inner case.

Cocked Assembly - An installation in which the plane of the outside seal face is not perpendicular to the shaft axis.

Coil - One turn of the coiled wire garter spring.

Ø Composite - Term used to describe a seal element comprised of two or more compounds bonded together to enhance seal performance and/or reduce cost.

Crack - A sharp break or fissure in the sealing element.

Creep - The time dependent part of a strain resulting from stress.

Cure Time - The time required to produce vulcanization at a given temperature.

Curing Temperature - The temperature at which the elastomeric product is vulcanized.

Cut - A deep discontinuity in the seal material whereby no material is removed.

Cut, Trim - Damage to the elastomeric portion of the seal during trimming.

Deformation - A stress induced change of form or shape.

Diameter, Free-Lip - See: diameter, seal unsprung lip.

Diameter, Functional Lip - The apparent inner diameter of the seal lip when the seal case is concentric with the outer diameter of the sizing mandrel in an air gage, light box, or similar inspection equipment.

Diameter, Inside Face Inner (1-21) - The inner diameter of the inner case of a radial lip seal.

Diameter, Lip-Inner - See: diameter, seal lip.

Diameter, Molded Lip - The lip diameter in the free state (no spring) developed by the molding operation of the sealing element to form the contact line.

Diameter, Outer Case Inner (1-22) - The inside, or smallest diameter of the outer case on a lip-seal assembly.

## 2. (Continued):

Diameter, Lip (1-31) - The inner diameter of the seal lip, measured with the spring installed.

Diameter, Unsprung Lip (1-32) - The inner diameter of the seal lip, measured without the spring installed.

Diameter, Seal Outer (1-9) - The external diameter of a lip-seal assembly, which normally corresponds to the outer diameter of the outer seal case.

Diameter, Assembled Spring Inside - The inner diameter of the garter spring, with the ends securely joined.

Diameter, Spring Mean Coil - The spring coil diameter minus the spring wire diameter.

Diameter, Spring Outside Coil - The outer diameter of an individual helical coil of a garter spring.

Diameter, Trimmed Lip - The lip diameter in the free state (no spring) developed by knife trimming the molded portion of the sealing element to form the contact line.

Dimension, Radial Wall (1-8) - The distance between the seal lip contact line and the seal outside diameter measured in a radial direction on a finished seal in the free state.

Dry Running - Operation of a seal without lubrication at the seal-shaft interface.

Durometer - An instrument which measures the hardness of rubber by the penetration (without puncturing) of an indentor point into the surface of rubber.

Eccentricity, Lip ID to OD - See: variation, radial wall.

Eccentricity, Shaft - The radial distance which the geometric center of a shaft is displaced from the axis of shaft rotation.

Elasticity - The property of a material which causes it to return to its original shape after deformation.

Elastomer - an elastic rubberlike substance, such as natural or synthetic rubber.

Element, Sealing (3-1) - See: lip, seal.

Elongation - The increase in length of a specimen due to a tensile force expressed as a percentage of the original specimen length.

End Play - A measure of axial movement encountered or allowed, usually in reference to the shaft on which the seal lip contacts.

## 2. (Continued):

Extrusion - Permanent displacement of part of a seal into a gap, under the action of fluid pressure.

Face, Inside (1-7) - That surface of the inner case which faces, and is usually in contact with, the fluid being sealed.

Face, Molded Toe - Synonym: face, toe.

Face, Outside (1-5) - The surface of the seal case, perpendicular to the shaft axis, which is not in contact with the fluid being sealed.

Face, Rib Leading (2-11) - The face of the helix seal rib which is closest to the fluid side of the seal.

Face, Toe (1-20) - The annular surface of the spring-retaining lip.

Face, Trim (1-29) - The seal inside lip surface when formed by a trimming operation.

Factor,  $pV$  - An arbitrary term which is the product of face pressure and relative sliding velocity. The term is normally considered to provide some measure of severity of service or seal life.

Filler - A solid compounding ingredient which may be added, usually in finely divided form, in relatively large proportions, to a polymer.

Finish, Shaft Surface - See: texture, shaft surface.

Flash - Thin extensions of the elastomer formed by extrusion at the parting lines in the mold cavity or vent points.

Flashing - A rapid change in fluid state, from liquid to gaseous. In a dynamic seal, this can occur when frictional energy is added to the fluid as the latter passes between the primary sealing faces, or when fluid pressure is reduced below the fluid's vapor pressure because of a pressure drop across the sealing faces.

Flexibility, Cold - Flexibility of a material during exposure to a pre-determined low temperature for a specific length of time.

Flinger - Synonym: slinger.

Fluid Side - That side of the seal which in normal use faces toward the fluid being sealed.

Fluoroelastomer - A saturated polymer in which hydrogen atoms have been replaced with fluorine. It is characterized by excellent chemical and heat resistance.

Force, Lip - The radial force exerted by an extension spring and/or lip of a seal on the mating shaft. Lip force is expressed as force per unit of shaft circumference.

## 2. (Continued):

Groove, Spring (1-12) - A depression formed in the head section of the seal. It is generally semicircular in form and serves to accommodate and locate the garter spring.

Hardness - The resistance to indentation. Measured by the relative resistance of the material to an indentor point of any one of a number of standard hardness testing instruments.

Hardness, Durometer - An arbitrary numerical value which indicates the resistance to penetration of the indentor point into the rubber surface. Value may be taken immediately or after a very short specified time.

Hardness, Shore - The relative hardness of an elastomer obtained by use of a Shore durometer instrument.

Head - Synonym: section, head (1-18).

Heel - Synonym: section, heel.

Height, Contact Line (1-33) - The axial distance from the outside seal face to the lip contact line.

Height, Helix Seal Rib (2-10) - The height of the helical ribs, measured perpendicular to the outside lip surface.

Height, Lip (1-34) - The axial distance from the outside seal face to the toe face.

Housing (1-3) - A rigid structure which supports and locates the seal assembly with respect to the shaft.

Hydroseal - A sealing system having helically disposed elements formed on the shaft surface.

Inclusion - Foreign matter included in the seal material.

Incomplete Trim - A trimmed surface which does not have all designated material removed.

Index, Spring - The ratio of the mean coil diameter to the wire diameter of a garter spring.

Ø Insert, Lip (3-11) - A material such as PTFE bonded onto a lip of an elastomeric seal to provide improved sealing and/or exclusion performance not attainable with the elastomeric material alone.

Interface - The region between the static and dynamic sealing surfaces in which there is contact, or which experiences the closest approach and effects the primary seal.

Interference, Lip - See: interference, seal.

## 2. (Continued):

Interference, Seal - The difference between the seal lip and shaft diameters.

International Rubber Hardness Degrees (IRHD) - A standard unit used to indicate the relative hardness of elastomeric materials, where zero represents a material having a Young's modulus of zero, and 100 represents a material having a Young's modulus of zero, and 100 represents a material of infinite Young's modulus.

Knit Line - A blemish of the sealing element created by premature curing during molding operation.

Lead, Shaft - Sprial grooves on a shaft surface caused by relative axial movement of grinding wheel to shaft.

Leakage - Synonym: rate, leakage.

Length, Deflected - Refers to the working circumferential length (measured on spring centerline) of the garter spring with the seal lip assembled on a normal (designed) shaft diameter.

Length, Lip (1-6) - The axial distance between the thinnest part of the flex section and the contact line.

Length, Spring Free - The total unconfined length of a spring. For a garter spring, it would not include the nib length.

Life, Flex - The length of time to failure which indicates the relative ability of a material to withstand dynamic bending or flexing under specific test conditions.

Line, Contact (1-27) - The line of intersection between the outside and inside lip surfaces of a radial lip seal. In a cross-sectional view, this intersection is illustrated as a point.

Lip, Auxiliary - See: lip, secondary seal.

Lip, Dirt - See: lip, secondary seal.

Lip, Dust - See: lip, secondary seal.

Lip, Molded - A type of seal lip which requires no trimming to form the contact line.

Lip, Primary - The normally flexible elastomeric component of a lip seal assembly, which rides against the rotating surface and effects the seal.

Lip, Static (1-28) - That section of the helix seal lip incorporating the contact line.

Lip, Secondary (1-23) - A short, nonspring-loaded lip, located at the outside seal face of a radial lip seal to prevent ingress of atmospheric contaminants. Synonyms: lip, dirt; lip, auxiliary; lip, dust.

## 2. (Continued):

Lip, Spring Retaining (1-17) - The portion of the primary lip that restricts the axial movement of the extension spring from a predetermined position.

Load, Radial - The total force (load) acting on the seal lip which tends to maintain contact of the lip on the shaft. It is the sum of the forces developed from seal interference and the garter spring.

LOP - See: pressure, lip opening.

Lubricant, Mold - The substance used to coat the surfaces of a mold to prevent the elastomer from adhering to the mold cavity surface during vulcanization.

Lubricant Starvation - Lack of proper lubrication at the seal interface which may cause premature wear and early failure.

Modulus, Rubber - The tensile stress at a specified elongation. A measure of resistance to deformation.

Modulus, Young's - The ratio of the stress to the resulting strain (the latter expressed as a fraction of the original height or thickness in the direction of the force).

Mold Impression - A molded imperfection on the surface of the seal.

Monomer - A single organic molecule usually containing carbon and capable of additional polymerization.

Nib, Spring - A short end section of an extension spring formed by a reduction in the coil diameter used to join the two ends in forming a garter spring.

Nick - A void created in the seal material after molding.

Nitrile - A general term for the copolymers of butadiene and acrylonitrile.

Nonfil - A void in the seal material.

Offset - The radial distance between the axis of the seal bore and axis of shaft rotation. (Synonym: shaft-to-bore misalignment.)

Oil Resistance - The measure of an elastomer's ability to withstand the deteriorating effect of oil on the mechanical properties.

Oil Seal - A seal designed primarily for the retention of oil.

Oil Swell - The change in volume of a rubber material due to absorption of oil.

O-Ring - A toroidal shaped seal.

## 2. (Continued):

Out-of-Round, Shaft - The deviation of the shaft cross section from true circle. Out-of-round is measured as the radial distance, on a polar chart recording, between concentric, circumscribed, and inscribed circles which just contain the trace and are so centered that the radial distance is minimized.

Packing, Mechanical - A deformable material used to prevent or control the passage of matter between surfaces which move in relation to each other.

Pitch, Helix Seal Rib (2-12) - The circumferential displacement between adjacent helical ribs of a lip seal.

Plasticity - The degree or rate at which unvulcanized elastomer and elastomeric compounds will flow when subjected to forces of compression, shear, or extrusion.

Plasticizer - A material which, when incorporated in elastomer or a polymer, will change its hardness, flexibility, processability, and/or plasticity.

Plunge Ground - The surface texture of shaft or wear sleeve produced by presenting the grinding wheel perpendicular to the rotating shaft without axial motion.

Polyacrylate - A type of elastomer characterized by an unsaturated chain and being a copolymer of alkyl acrylate and some other monomer such as chloroethyl vinyl ether or vinyl chloracetate.

Polymer - Generic term for an organic compound of high molecular weight and consisting of recurrent structural groups.

Polymerization - The ability of certain organic compounds to react together to form a single molecule of higher atomic weight.

Ø Polytetrafluoroethylene (PTFE) - PTFE is a fluoropolymer with excellent thermal and chemical resistance and a low coefficient of friction. PTFE is usually compounded with fillers such as molybdenum disulfide, graphite, pigments and glass fibers to improve wear characteristics and other properties.

Porosity - A multitude of minute cavities in the seal material.

Position, Spring (1-11) - The axial distance between the "seal contact line" and the centerline of the spring groove of a radial lip seal; commonly referred to as the "R" value.

Precure - Partial cure. A term frequently used to designate the first cure of a material that is given more than one cure in its manufacture.

Pressure, Contact - The average pressure exerted by a seal on a shaft. This pressure is computed by dividing the total lip force by the total lip contact area. Sometimes referred to as radial pressure.

## 2. (Continued):

Pressure, Lip Opening - The pressure necessary for flowing air at 10 000 cm<sup>3</sup>/m between the contact surface of a radial lip seal and a shaft-size mandrel under the following conditions: the seal case outer diameter clamped to be concentric with the mandrel and the pressurized air applied to the outside lip surface.

Pressure, Radial - See: pressure, contact.

Pressure, Seal Cavity - The pressure of a fluid being sealed.

Pressure, Spring - The contact pressure which results from the spring load.

- Ø PTFE Seal, Lay Down Lip - Term used to describe a PTFE sealing element with a wide contact pattern on shaft. Often used with hydrodynamic features.
- Ø PTFE Seal, Line Contact Lip - A seal utilizing an insert of PTFE bonded to an elastomeric back-up material. Shaft contact is over a narrow area similar to most radial lip seals.

Rate, Leakage - The quantity of fluid passing through a seal in a given length of time.

Rate, Spring - The force, independent of initial tension, which is required for extending the working length of a spring a unit distance.

Rate, Wear - The amount of seal contact surface wear per unit of time.

Relaxation, Stress - A characteristic of an elastomer wherein a gradual increase in deformation is experienced under constant load, after the initial deformation.

Resilience - In elastomer or rubberlike materials subjected to and relieved of stress, resilience is the ratio of energy given up on recovery from the deformation to the energy required to produce the deformation. Resilience for an elastomer is usually expressed in percent.

Resistance, Cold - The ability of a seal or sealing material to withstand the effects of a low temperature environment without loss of serviceability.

Resistance, Heat - The ability of a seal or sealing material to resist the deteriorating effects of elevated temperatures.

Resistance, Ozone - The ability of a material to withstand the deteriorating effects of ozone (surface cracking).

Rib (1-26, 2-8) - A long, narrow projection which is normally triangular in cross-section and which is molded into the outside lip surface of a helix seal. It is oriented at an angle to the shaft axis. One end of the rib forms part of the seal-lip contact surface.

## 2. (Continued):

Roughness - Irregularities in shaft surface texture which result from the production process. (See SAE J448a).

Roughness, Axial Surface - Surface roughness of a shaft measured in a direction parallel with the centerline axis.

Roughness, Circumferential Surface - Surface roughness of a shaft measured in a direction (plane) normal to the centerline axis.

Rough Trim - A trimmed surface with irregularities on the outside and inside lip surfaces in the immediate vicinity of the contact line.

Run-In - The period of initial operation during which the seal lip wear rate is greatest and the contact surface is developed. Synonym: bedding-in.

Runout, Dynamic - Twice the distance the center of the shaft is displaced from the center of rotation and expressed in TIR. That runout to which the seal lip is subjected due to the outside diameter of the shaft not rotating in a true circle. Synonym: runout, shaft.

Runout, Shaft - See: runout, dynamic.

RWV - See: variation, radial wall.

Scoop Trim - A trimmed surface which is concave.

Scratch - A shallow discontinuity in the seal material whereby no material is used.

Scuffing - Metal surface degradation resulting from adhesive wear.

Seal, Mechanical - Any material or device that prevents or controls the passage of matter across the separable members of a mechanical assembly.

Seal, Birotational - A rotary shaft seal which will seal fluid regardless of direction of shaft rotation.

Seal, Dynamic - A seal which has rotating, oscillating, or reciprocating motion between it and its mating surface, in contrast to stationary-type seal, such as a gasket.

Seal, Helix - An elastomeric hydrodynamic lip seal having helical ribs on the outside lip surface.

Seal, Hydrodynamic - A dynamic sealing device which utilizes the viscous shear and inertia forces of the fluid; imparted by a helically grooved or ribbed seal lip, to generate a pressure differential that opposes fluid flow.

## 2. (Continued):

Seal, Lip - An elastomeric seal which prevents leakage in dynamic and static applications by reason of controlled interference between the seal lip and the mating surface.

Seal, Radial - A seal which exerts radial sealing pressure in order to retain fluids and/or exclude foreign matter.

Seal, Radial Lip - A type of seal which features a flexible sealing member referred to as a lip. The lip is usually of an elastomeric material. It exerts radial sealing pressure on a mating shaft in order to retain fluids and/or exclude foreign matter.

Seal, Unirotational - A seal designed for applications having a single direction of shaft rotation.

Seal, Unitized - A seal assembly in which all components necessary for accomplishing the complete sealing function are retained in a single package.

Seal, Split - A seal which has its primary sealing element split, approximately parallel with the shaft axial centerline. Typically used where conventional installation methods are impractical or impossible.

Sealer, Case OD - A coating applied to the case OD to prevent leakage between the seal case and the housing bore.

Section, Flex (1-16) - The portion of a seal lip which is bounded by the head and heel section of a lip seal. Its primary function is to permit relative motion between the seal lip and the case.

Section, Head (1-18) - The portion of a lip seal which is generally defined by the inside and outside lip surfaces and the spring groove.

Section, Heel (1-15) - The portion of a lip seal which is attached to the seal case and bounded by the flex section and the outside face.

Set, Compression - The deformation which remains in rubber after it has been subjected to and released from a specific percent compression for a definite period of time at a prescribed temperature. Compression set measurements are for the purpose of evaluating creep and stress relaxation properties of rubber.

Set, Permanent - The residual unrecoverable deformation in an elastomeric part after the load causing the deformation has been removed.

Side, Air - That side of a seal which in normal use faces away from the fluid being sealed.

Silicone - A type of elastomer having a basic polymer of dimethyl polysiloxane, with various attached vinyl or phenyl groups.

## 2. (Continued):

Slant, Seal - The difference between the maximum and minimum axial dimensions from the seal-lip contact line to the outside face of the case.

Sleeve, Wear - A replaceable metal ring generally used in assemblies to eliminate expensive shaft replacement caused by grooving that may occur at the seal-shaft interface.

Slinger - A washer-like device used for imparting radial momentum to a liquid in order to keep the latter away from the sealing interface. Often incorporated into a wear sleeve.

Spiral Trim - A trimmed surface which has a spiral pattern.

Spring Axial Position (1-11) - The axial distance between the projected intersection of the inside and outside lip surfaces and the centerline of the spring coil diameter (center plane of the spring) with the spring in position and the seal located on shaft.

Spring, Finger - A spring consisting of a multiple number of cantilevered elements located circumferentially on a ring. It can be designed to produce either a radial or an axial force.

Spring, Garter (1-13, 3-6) - A helically coiled wire with its ends connected to form a ring. It is used in tension for maintaining a radial sealing force between the sealing element of a radial lip seal and a shaft.

Stability, Dimensional - The ability to retain manufactured shape and size after having experienced the combination of operating stresses and temperatures.

Step Trim - A trimmed surface having a discontinuity perpendicular to the contact line.

Stick, Slip - A friction related phenomena in which the sealing element tends to adhere and rotate with the shaft surface momentarily until the elastic characteristics of the sealing element overcome the adhesive force causing the seal lip to lose contact with the rotating shaft long enough to allow leakage. This cycle repeats itself continuously and is normally associated with nonlubricated and boundary-lubricated conditions.

Surface, Contact (2B) - The portion of the seal lip which circumferentially contacts the shaft to form the seal-shaft interface.

Surface Contamination - Foreign matter on the seal surface.

Surface, Inside Lip (1-29, 2-5) - The inside truncated conical surface of the lip, the minor diameter of which terminates at the contact point.

Surface, Outside Lip (1-24, 2-7) - The outside truncated conical surface of the lip, the minor diameter of which terminates at the contact point.

## 2. (Continued):

Surface, Trim - Synonym: surface, trimmed seal.

Surface Speed - The linear velocity calculated from the shaft rotational speed using the nominal shaft diameter.

Surface, Trimmed Seal - The lip surface formed by a knife cutting operation to develop the contact line.

Synthetic Rubber - Synthetic elastomers made by polymerization of one or more monomers.

Tear - The removal or separation of a portion of the sealing element.

Tear Resistance - The property of an elastomeric material to resist tearing forces.

Tensile Strength, Ultimate - The force per unit of original cross-sectional area at the moment of a specimen rupture.

Tension, Initial Spring - The "preload" that has been wound into the coils of a spring during the coiling operation.

Test, Accelerated Life - Any set of test conditions designed to reproduce in a short time the effects obtained under service conditions.

Test, Bench - A laboratory test in which the functional operating conditions are approximated, but the equipment is conventional laboratory equipment and not necessarily identical with that in which the product will be used.

Test, Field - A test performed in the actual environment in which the product will be used.

Test, Flex - A laboratory method used to evaluate the resistance of a material to repeated bending.

Test, Life - A laboratory procedure used to determine that period of operation which a component or assembly will operate until it no longer performs its intended function.

Texture, Shaft Surface - A term used to describe the quality, appearance, or characteristic of the shaft surface resulting from operations, such as grinding, polishing, burnishing, etc. See SAE J448a for additional information.

Thickness, Film - In a dynamic seal, the distance separating the two surfaces which form the primary seal.

Trim - The removal of superfluous parts from a molded product, usually removal of parting line flash or feed sprues.

Trim, Crooked - Synonym: slant, seal.

## 2. (Continued):

Trim, Rough - Irregularities on the outside and inside lip surfaces in the immediate vicinity of the contact line.

Unbonded Flash - Flash which does not properly adhere to the mating material to which it is intended to be bonded.

Under-Cure - A degree of cure less than desired.

Value, "R" (1-11) - Synonym: position, spring.

Variation, Contact Line Height - The difference in the contact line height as measured at any two points on the contact line. Maximum contact line height variation is defined as seal slant.

Variation, Radial Wall - The difference between the minimum and maximum radial wall dimensions when measured around 360 deg of the seal lip.

Vibration, Torsional - A vibration which has a circumferential or angular direction. It is often generated by a stick-slip action between mating seal faces.

Volume Swell - Increase in physical size caused by the swelling action of a liquid, generally expressed as a percent of the original volume.

Vulcanization - An irreversible process during which a rubber compound, through a change in its chemical structure, for example, cross-linking, becomes less plastic and more resistant to swelling by organic liquids and the elastic properties are confined, improved, or extended over a greater range of temperature.

Washer, Bonded (3-8) - A flat, metal, washer-type ring which has been molded in place in the elastomeric material forming one of the sealing elements.

Weepage - A minute amount of liquid leakage by a seal.

Wetting - A formation of a continuous film of a liquid on a surface.

Width, Contact (2-1) - The width of the lip contact area of a radial lip seal, measured in the axial direction.

Width, Helix Contact (2-4) - The axial width of that portion of the contact surface of a helix seal which is formed by the helical ribs. It is equal to the total axial width of the contact surface minus the width of the static lip. See: seal, helix.

Width, Helix Seal Rib (2-13) - The maximum width of a helical rib measured perpendicular to the rib's longitudinal axis.

Width, Case (1-1) - The total axial width of the seal case.

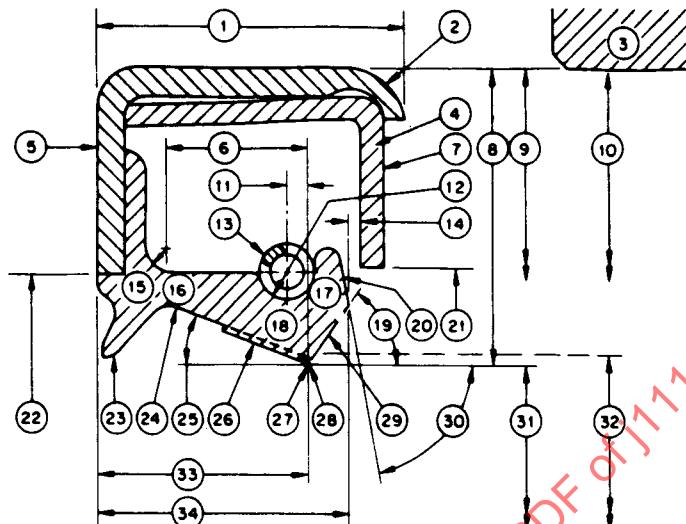
Width, Static Lip Contact (2-14) - The axial width of the contact surface developed by a static lip. See: seal, helix.

## 2. (Continued):

Wind-Up, Spring - The tendency of a garter spring with its ends assembled together to deform from a flat surface. Excessive spring wind-up results in the spring forming a "figure 8" configuration.

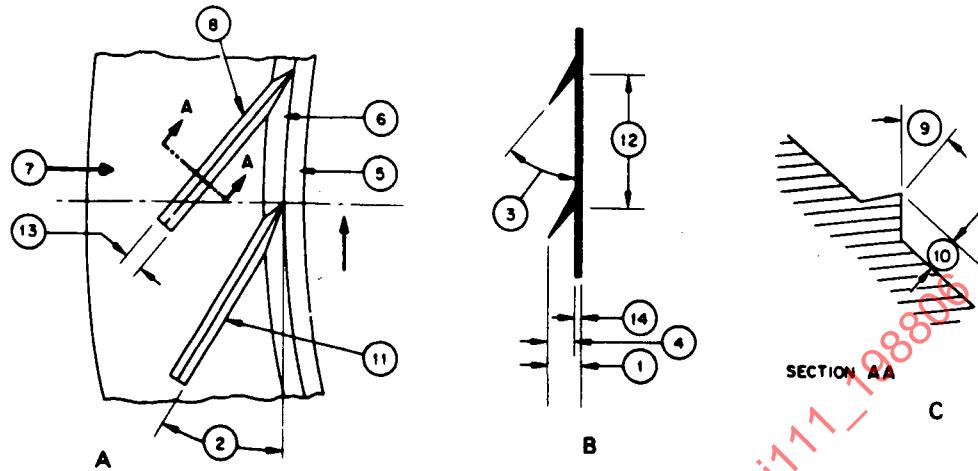
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The phi ( $\phi$ ) symbol is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. If the symbol is next to the report title, it indicates a complete revision of the report.



1 Case Width	18 Head Section
2 Outer Case	19 Inside Lip Angle
3 Housing	20 Toe Face
4 Inner Case	21 Inside Face Inner Diameter
5 Outside Face	22 Outer Case Inner Diameter
6 Lip Length	23 Secondary Lip
7 Inside Face	24 Outside Lip Surface
8 Radial Wall Dimension	25 Outside Lip Angle
9 Seal Outer Diameter	26 Rib (Helix Seal Only)
10 Housing Bore	27 Contact Line
11 Spring Axial Position	28 Static Lip
12 Spring Groove	29 Inside Lip Surface
13 Garter Spring	30 Molded Toe Angle
14 Axial Clearance	31 Lip Diameter
15 Heel Section	32 Unsprung Lip Diameter
16 Flex Section	33 Contact Line Height
17 Spring Retaining Lip	34 Lip Height

FIGURE 1 - Nomenclature for Details of Radial Lip Seal



- 1 Contact Width
- 2 Helix Angle
- 3 Helix Contact Angle
- 4 Helix Contact Width
- 5 Inside Lip Surface
- 6 Contact Line
- 7 Outside Lip Surface
- 8 Rib
- 9 Rib Angle
- 10 Rib Height
- 11 Rib Leading Face
- 12 Rib Pitch
- 13 Rib Width
- 14 Static Lip Contact Width

FIGURE 2 - Nomenclature for Outer Lip Surface and Contact Surface.  
Details of Radial Lip Seal (Helix Seal Type):  
(A) View in Plane of Outside Lip Surface,  
(B) View of Contact Surface,  
(C) Cross Section of Rib