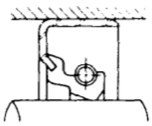
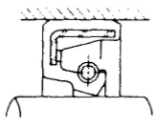
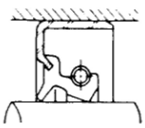
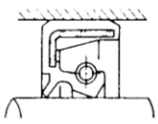
## Oil Seals

Oil seals in an automotive environment perform two main functions; to retain the engines lubricant within the engine and to exclude outside contaminants such as dirt and dust from entering the engine. In order to perform these functions there are four key components that make up the Oil Seal Concept. The shaft; on which the oil seal must run, the bore; in which the oil seal is housed, the conditions; in which the oil seal must operate, and the oil seal itself.

When a radial lip oil seal is operating correctly, the sealing lip does not actually come in contact with the surface of the shaft. The difference in internal and external engine pressures allows a very thin film of oil to seep between the seal lip and the shaft. It is on this film of oil that the sealing lip runs. If the load provided by the oil seals' garter spring and the internal pressure of the seals elastomer (rubber) are correct then the film of oil is maintained and oil is prevented from leaking past the sealing lip. An incorrect balance of engine pressures and seal load will allow either too much oil through causing the seal to leak or too little oil through resulting in excessive lip wear and eventual leakage.

### Standard Design Types

In the majority of automotive applications radial lip oil seals fall into one of two main design categories. The table below illustrates the differences between "S Lip" and "T Lip" design oil seals.

| Lip Type | Body Type | | Features | Main Applications |
|---|---|---|---|---|
| | B – Metal Case | C – Rubber Case | | |
| S |  |  | Single sealing lip with garter spring to provide a consistent radial load against the shaft. | General non-pressure sealing applications and severe grease sealing conditions. |
| T |  |  | Single sealing lip with garter spring combined with an auxiliary dust lip to provide effective light duty dust exclusion. | General non-pressure sealing applications and severe grease sealing conditions with light duty exclusion of dust or foreign materials. |

Variations on standard seal design types include the addition of hydrodynamic sealing lips which have helical ribs or helix lines which help pump oil back under the sealing lip. Hydrodynamic sealing lips can be mono-directional or bi-directional. Other variations include flange style casings and special synthetic fabric dust lips. These variations are identified by the use letter which prefix and or suffix the standard design code i.e.: TC is a rubber cased, single lip oil seal, with an auxiliary dust lip. HTCKL is a rubber cased, single lip oil seal with mono directional helix lines for a left hand rotation with a special synthetic fabric dust seal.

**Materials**

One of the most important components of the radial lip oil seal is the elastomer material used in the seals construction. There are many different classes of elastomer blends specially developed to meet a wide variety of sealing requirements each with an individual formula to satisfy various sealing conditions. The majority of these blends use a base polymer from one of the four main groups listed below:

**Nitrile** – Commonly known as Buna-N, nitrile is the most common base polymer used in fluid sealing. Nitrile has very good resistance to the swelling effects of petroleum based products. Generally when a nitrile seal fails in service it is because it has been subjected to temperatures outside of its recommended limits or to chemicals that have a degrading effect on nitrile. The result is hardening and eventual embrittlement.

**Polyacrylate** – Used in applications where a higher temperature resistance is required. Polyacrylate has very good resistance to the swelling effects of petroleum based products and it's resistance to the decomposition products of extreme pressure gear oil additives.

**Silicone** – Functions satisfactorily over a very wide temperature range and at extreme temperatures silicone is superior. With excellent resistance to compression set the main application for silicone is crankshaft seals. In comparison to other elastomers used in the manufacturing of oil seals silicone has a very poor resistance to abrasion.

**Fluoroelastomer** – Common trade names include Viton, Technoflon and Fluorel. Has very good heat resistance and swelling in highly aromatic fuels is low. Certain oil additives can cause embrittlement at relatively low temperatures. Fluoroelastomers have a very good resistance to abrasion.

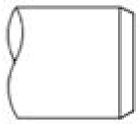
**A Special Caution on Fluoroelastomers –** Fluoroelastomer is a synthetic material containing fluorine used for gaskets, o-rings and seals. When used within design specifications it is completely safe however if exposed to high temperatures the material decomposes and one of the by products formed is hydrofluoric acid. This acid is extremely corrosive and is almost impossible to remove especially from human tissue. When inspecting equipment which has been exposed to high temperatures check if any gaskets, o rings or seals have suffered from decomposition which will appear as charred or black and sticky. DO NOT under any circumstances touch either the seal or the area containing the seal until a substantial cooling period has been allowed. The affected area should be decontaminated before undertaking any further work.

Note: Viton is the registered trade mark of Du Pont Inc., Technoflon is the registered trade mark of Montecatini Spa., Fluorel is the registered trade mark of Minnesota Mining & Manufacturing Ltd.

**Shaft Finish, Hardness and Tolerance**

If a radial lip oil seal is to perform correctly, the condition of the shaft surface where the seal is to operate is as important as the condition of the seal itself. Shafts having too rough or too smooth a finish will greatly affect the performance and service life of the seal. Research by oil seal manufacturers recommend that the shaft surface at the point of seal lip contact be machine lead free with a finish between 0.25 micrometers to 0.50 micrometers Ra (10 microinches to 20 microinches).

The preferred method of achieving this finish is by plunge grinding to spark out with short to medium marks which are at 90 degrees to the shaft axis. These machine marks retain oil which improves seal life. A grinding wheel of 80 grits is recommended. The ratio grinding wheel rpm to the shaft rpm must not be a whole number ratio or lead will result (i.e. 10.5:1 not 10:1). To assist in installation of the oil seal the leading edge of the shaft should be chamfered 15/30° with the corners blended and burr free.



15/30° with corners blended and burr free

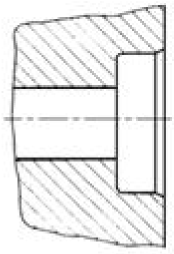
Another shaft condition relevant to oil seal performance is hardness. Oil seal manufacturers recommend a minimum shaft hardness of 45 Rockwell C to prevent excessive wear. Oil seals are designed and manufactured to operate on a specific shaft diameter. For shafts up to 100mm (4.0”) in diameter the tolerance is ±0.08mm (0.003”). Shafts 100 to 150mm (4.0 to 6.0”) in diameter the tolerance is ±0.10mm (0.004”).

**Housing**

A bore chamfer is necessary to assist in the installation of the oil seal. A proper chamfer angle of 15/30° and depth of 1.5~2.5mm minimises cocking or lack of squareness of the seal to the shaft, distortion of the seal case and reduces force required in assembly.

For metal case seals a bore surface finish of 0.25 micrometers Ra (100 microinches) is recommended. A slightly rougher surface finish of 0.375 micrometers Ra (150 microinches) is acceptable for rubber case seals. Excessively rough bore finishes may allow paths for fluid to leak between the seal OD and the bore. Too smooth a finish may allow the seal to back out of the bore.

15/30° with corner burr free



**Installation**

Before the installation of any oil seal, it should be checked that no foreign matter is adhering to the seal, the sealing lip is not damaged, cut or distorted and the garter spring has not been displaced. The sealing lip of the oil seal should be pre-lubricated to reduce friction on the contact surfaces and help protect the seal lip during initial run-in. The case of the oil seal should be dry and free of dirt. Do not lubricate or apply any retaining agent to the seal case.

An installation tool should always be used when installing an oil seal. The use of a tool improves ease of installation and reduces the possibility of seal cocking (non-perpendicular to shaft). A hydraulic or pneumatic press is advised to supply the necessary, uniform force to install the seal.

The advisable sequence for oil seal installation is to install the seal over the shaft and then in the housing bore. Care should be taken not to damage or deform the seal lip. When installing over a keyway or spline a sleeve or bullet should used to protect the seal lip from cuts or tears. Where the shaft must be installed through the seal centering guides for the shaft will prevent lip deformation and dislodging of the spring. When possible the shaft should be rotated as it passes through the seal to reduce sliding friction.