

Valve stem seals





What is a valve stem seal?

Valve stem seals are engineered to allow a small amount of oil to pass through their lips (oil-metering) to lubricate the valve stem / valve guide interface of an engine. If too much oil passes through the lip of the seal, emissions are worsened and coke builds up on the valve, potentially causing the engine to lose power or even fail. If too little oil passes through the lip of the seal, the valve does not receive enough lubrication and the valve will scuff, which ultimately will cause the valve to seize. The ideal metering rate lies between these two extremes.





Oil metering rate

The most important function

Oil metering to the valve guide / stem interface is the prime function of a valve stem seal.

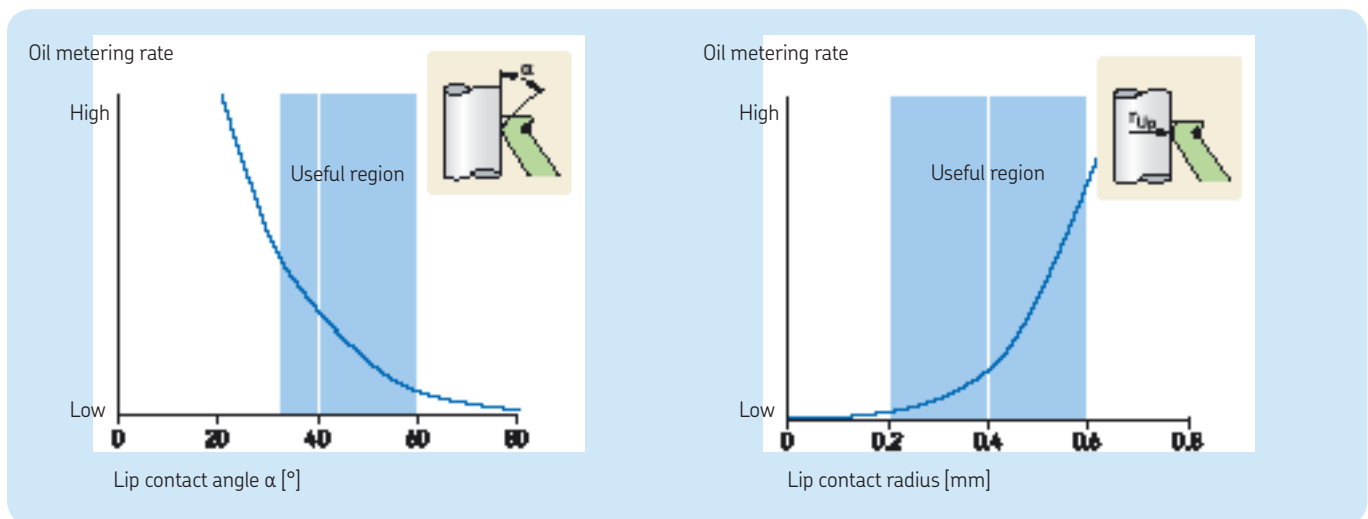
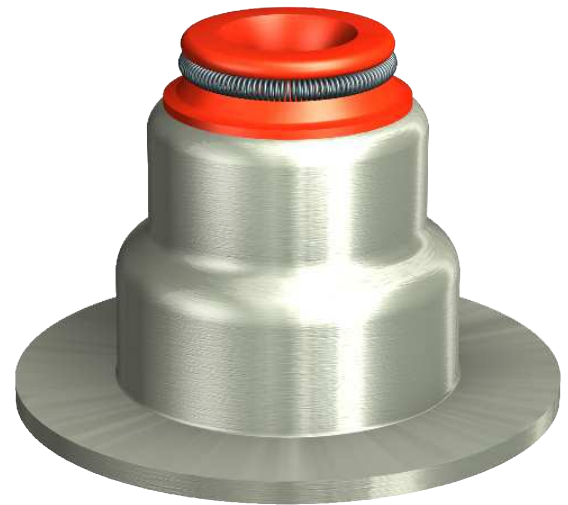
Although the requirements for each engine differ according to their design parameters and operating conditions, the oil flow of standard SKF seals will suit most engines.

Adjusting the oil metering rate to the exact requirements

Experience has shown that the standard SKF design provides the correct oil metering rate for most applications. This is true for diesel and gasoline applications as well as for intake and exhaust valves. There are however, applications where the oil metering rate must be adjusted. The oil metering rate can be tuned to the exact requirements of a specific engine by changing the geometry of the sealing lip.

The major factors influencing the oil metering rate are the radius of the sealing lip and the lip angle to the oil side.

The radial force of the seal, while being important for assuring lip contact to the valve stem under operating conditions, is not a major factor in determining the oil metering rate.



Valve stem seal technology

All valve stem seals are designed using the most modern Computer Aided Engineering (CAE) systems. This system includes the analysis and prediction of installation forces with the use of Finite Element Analysis (FEA) methods.

As a result, data useful for the layout of the installation equipment is available at the start of the programme.

The FEA tools can also be used for other aspects of the seal design. For example, design variations can be tested for pressure dependence.

Recommendations for the valve stem

- Normal surface treatments are acceptable (e.g. chrome plating).
- Surface roughness
 $R_z \leq 3 \mu\text{m} / R_{\text{max}} = 4 \mu\text{m}$.
- No lettering on the running surface permissible.

Recommendations for the valve guide

- OD tolerance $\pm 0,05 \text{ mm}$ for standard designs.
- Surface roughness
 $R_z 10\text{--}25 \mu\text{m} / R_{\text{max}} = 30 \mu\text{m}$ for the non-integrated seals. Lower surface roughness is no concern for the integrated seal, as it is retained by the valve spring.
- A lead-in chamfer is required and most designs, including symmetrical guides (chamfer the same at both ends), can be used with SKF seals.
- Traditional valve guide materials as well as sintered materials incorporating solid lubricants are fully acceptable.
- A misalignment of up to 0,3 mm between guide ID and OD is acceptable. Special seal designs may be required for values exceeding this amount.

Other recommendations

When the valve is fully open, the gap between the top of the valve stem seal and the bottom of the spring retainer should exceed 1,0 mm.

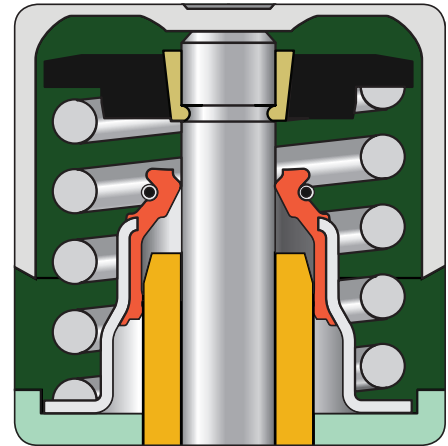
From a timing viewpoint, SKF should be contacted as early as possible in the development process, so that technical support on design and installation of the seal and the surrounding components can be provided.

Valve stem seal validation

The validation procedure varies according to customer requirements, however, the usual procedure for a new design is to test the oil metering rate and installation suitability. Oil metering rate is tested by running an original customer cylinder head with an electric motor. The temperature, speed, pressures, oil type etc. are decided with the customer, or the standard SKF test bench cycle can be used. If a cylinder head is not available, oil flow testing can also be performed on the standard SKF test bench, which simulates the engine environment. For the installation, the forces needed to press the seal on and to remove the seal from the valve guide are measured. It is normal that these tests are performed, however, they do not replace the tests the customer makes in the actual engine. This is the final proof of suitability, as the bench tests cannot fully simulate the characteristics of a fired engine.

What information do we need to design a new valve stem seal?

All the information required to design a valve stem seal is detailed on the questionnaire in this brochure. The completed questionnaire should be returned to us together with drawings of the valve, valve guide, valve



spring and assembly drawing, if available. The preference for either an integrated or non-integrated seal should also be given.

What valve stem seals are available?

Two basic designs of state of the art valve stem seals are offered:

1 The non-integrated seal type VSS

These seals only fulfil the function of oil metering rate. The design with the “L” shaped metal stamping is used for larger differences between valve stem and guide diameters.

2 The integrated seal type VSI

These seals additionally incorporate a spring seat to prevent wear by the valve spring on the cylinder head.

All seals incorporate the same dynamic and static sealing properties enabling reliable function over the life of the engine, but the integrated seal additionally includes a spring seat, thereby eliminating a separate spring seat, providing advantages at installation, warehousing and logistics. Additionally, all

can be offered in versions that resist high manifold pressures (→ page 6).

All designs use our specially formulated fluoropolymer materials. These materials provide excellent chemical and temperature resistance, as well as mechanical properties, to properties to provide minimal wear and high reliability.

What sizes are already available?

The strong market position of SKF means that there are already many sizes being manufactured. Should it not be possible to use a current seal, then tooling may have to be made for a seal designed to your specification. Our representative can advise you. A selection of existing valve stem seals sizes is provided on the reverse side of the separate questionnaire in this brochure.

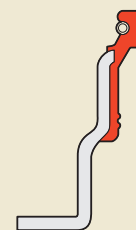
Non integrated type VSS



Non integrated type VSS with “L” shaped stamping



Integrated type VSI



Manufacturing and quality

SKF has heavily invested globally in unique state of the art manufacturing technology. The extensive level of automation enables us to provide seals with the highest quality and has been a contributing factor for SKF valve stem seals being the number one in Europe.

A very important aspect of our production process is visual inspection. All seals are inspected automatically using computer vision techniques to ensure that the critical areas for the function of the seal are without defects. The characteristics responsible for the

function of the seals are additionally controlled using statistical methods.

As a leader in automotive sealing technology and a certified supplier according to EN ISO 9001, ISO/TS 16949:2009 and ISO 14001, SKF is well placed to meet the most stringent customer requirements.

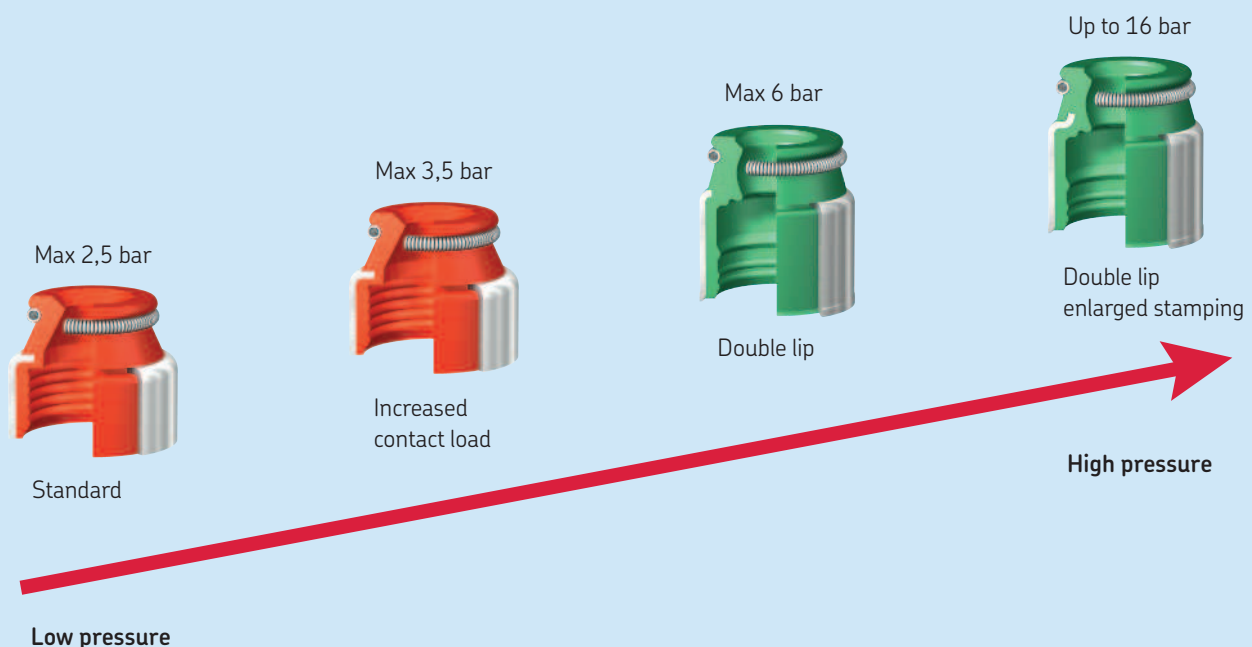
Valve stem seals for high pressure applications

Because of changing engine requirements, a new range of valve stem seals has been introduced which can reliably provide the required oil metering rate for increased manifold pressures. These seals can be used in both light vehicle and heavy duty engines, with solutions available for the pressure range of the application. Moving from the base line of the standard designs, the contact load can be increased, an additional sealing lip can be incorporated and, ultimately, an extended metal stamping can be used to obtain a maximum pressure resistance of up to 16 bar.

Installation security

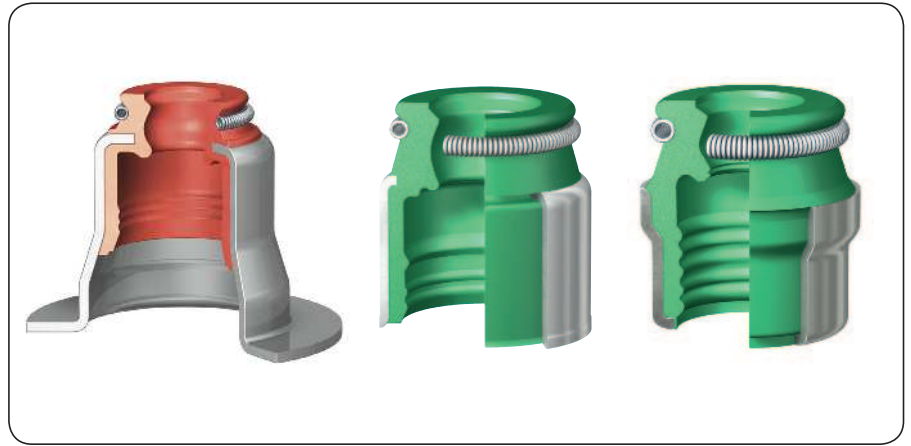
For high pressure applications where a seal without a valve spring seat is used, it is normally necessary to incorporate a retention feature on the valve guide. This prevents the pressure from popping the seal off the valve guide. SKF has developed an advanced design for easy assembly and proper retention and will provide a recommendation tailored to the application.

A range to meet exact needs



Light vehicles

Increasing fuel prices and legislation on fuel economy and CO₂ emissions has led to engine downsizing and an increasing use of boosting technologies. The result is that pressure in the manifolds is increasing. For such applications, if a modification of the contact load to the stem is not sufficient, then an additional sealing lip is used, to withstand this higher pressure and to allow the primary sealing lip to perform the oil metering function without pressure influence. All valve stem seal designs are available with this feature. The seals are designed to withstand a pressure of up to 6 bar. As a result, the lips do not open under pressure and the oil metering function is maintained. Because of this, the lubrication of the valve in the valve guide is not disturbed and wear is kept to a minimum.

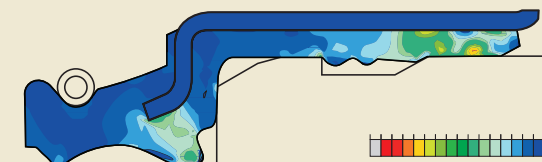


Heavy duty

In heavy commercial vehicles, in addition to boosting, an exhaust brake may be installed which leads to manifold pressures of up to 16 bar. For these applications, the pressure capability of the seal has been increased by extending the metal stamping to the area between the two sealing lips, thereby further improving the independent operation of each lip. Similarly, because the lips do not open under pressure, the wear of the valves and valve guides is minimized, providing a long service life of the valve train. Additionally, as the volume of blow-by gas is minimized (no gasses by-passing the valve stem seal), there is a potential to downsize the oil separation unit and thereby reduce cost.



FEA of high pressure valve stem seals
Material loading 120 °C and 12 bar pressure



Installation

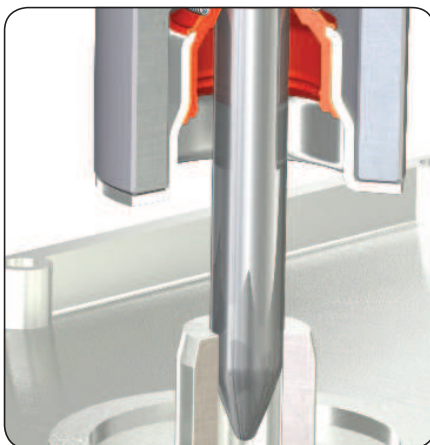
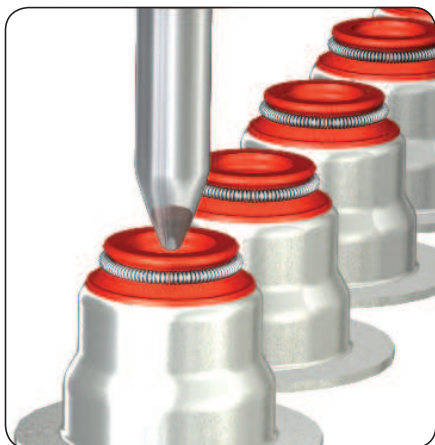
Simple but important

As our designs incorporate a metal ring bonded directly to the rubber elements, all SKF valve stem seals can be easily installed either by hand for small quantities, or fully automatically for high volumes. However, in order to ensure the correct function in the engine, the installation procedure is very important. This begins with the designs of the seal and valve guide, which must be tuned to each other for the best results. The seal must be positioned at the correct height on the guide and remain there for the life of the engine.

For a new application, we can recommend an installation tool design and advise on the installation procedure.

For an application where installation equipment is already available, it is important that the design of the seal takes this into consideration, thereby minimizing (or eliminating) equipment change costs. In this case, details of the existing equipment will be required.

A typical installation procedure



Check list for the assembly line

Your individual solution

Installation process

Is the valve inserted before the seal is installed?

What is the maximum installation force per seal?

What is the minimum installation force per seal?

What is the installation speed?

Is the cylinder head rotated after the seal installation?

Is a lubrication step included? If yes, please specify.

Is the presence of the garter spring on the seal checked? If so, how?

Is the final position of the installed seal checked? If so, how?

Is the final position of the seal determined by force?

Is a minimum seal removal force specified?

Seal Design:

For an existing seal, please provide a drawing.

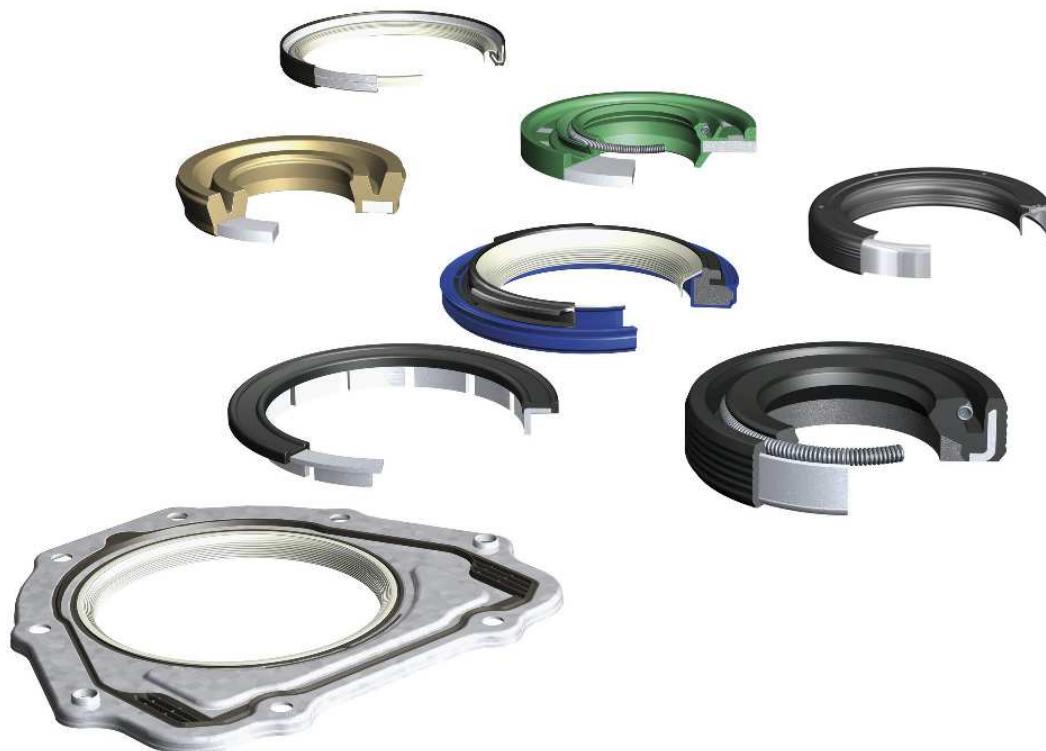
Which dimensions are critical for the feeding system?

Interested in additional sealing products?

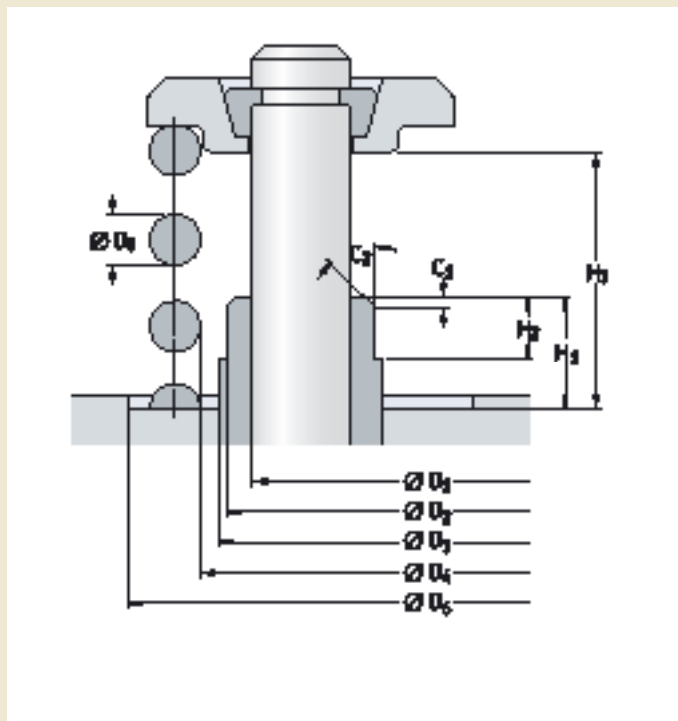
In addition to valve stem seals, SKF products provide complete automotive sealing solutions for engine, transmission, driveline, steering and suspension systems. This single source approach is possible through a worldwide network offering one-source accountability.

SKF sealing products include conventional rubber shaft seals, low friction and PTFE shaft seals, driveline and wheel end systems, seals for gas springs and shock absorbers. In all these product groups, there is a strong focus on minimizing friction, either to minimize emissions and fuel consumption or to improve the functional characteristics. For example, reducing friction of the shock absorber seals can improve the ride comfort of the vehicle.

Innovative sealing modules for automotive transmissions are also part of the SKF product range. In addition to sealing products, our advanced rubber technology has also been applied to the field of sensors. SKF is a leading supplier of ABS wheel bearing systems. These systems include trigger wheels with a magnetized rubber coating, which provide an accurate signal for rotational sensors. The use of these magnetic trigger wheels is expanding into engine and transmission applications.



- C₁ Chamfer length
- C₂ Chamfer angle
- D₁ Valve stem diameter
- D₂ Step diameter of valve guide
- D₃ Valve guide outer diameter
- D₄ Valve spring inner diameter
- D₅ Valve spring wire diameter
- D₆ Spot face diameter for spring seat
- H₁ Protrusion of valve guide
- H₂ Step height of valve guide
- H₃ Gap between head & spring cap (valve open)



If the valve stem seal questionnaire is missing, please contact your SKF representative:
 E-mail: seals.automotive@skf.com



The Power of Knowledge Engineering

Drawing on five areas of competence and application-specific expertise amassed over more than 100 years, SKF brings innovative solutions to OEMs and production facilities in every major industry worldwide. These five competence areas include bearings and units, seals, lubrication systems, mechatronics (combining mechanics and electronics into intelligent systems), and a wide range of services, from 3-D computer modelling to advanced condition monitoring and reliability and asset management systems. A global presence provides SKF customers uniform quality standards and worldwide product availability.

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