

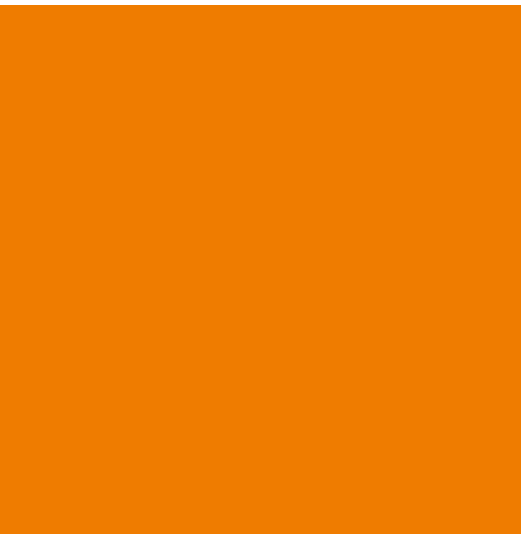
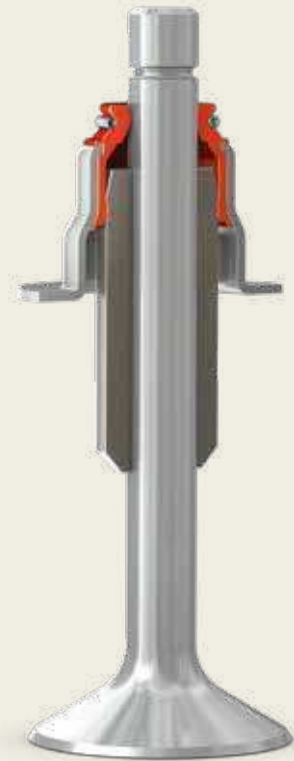
# Valve stem seals

For automotive combustion engines



# 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, oil consumption and 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 it 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 primary function of a valve stem seal, contributing significantly to an efficient and durable valve train of a combustion engine.

The requirements for each engine differ according to their design parameters and operating conditions. Technical knowledge and the experience of the market leader allows SKF to provide the optimal product for any engine.

## Adjusting the oil metering rate to the exact requirements

We can offer a range of standard valve stem seals, which provide the correct oil metering rate for many 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 defined design parameters of the sealing lip.

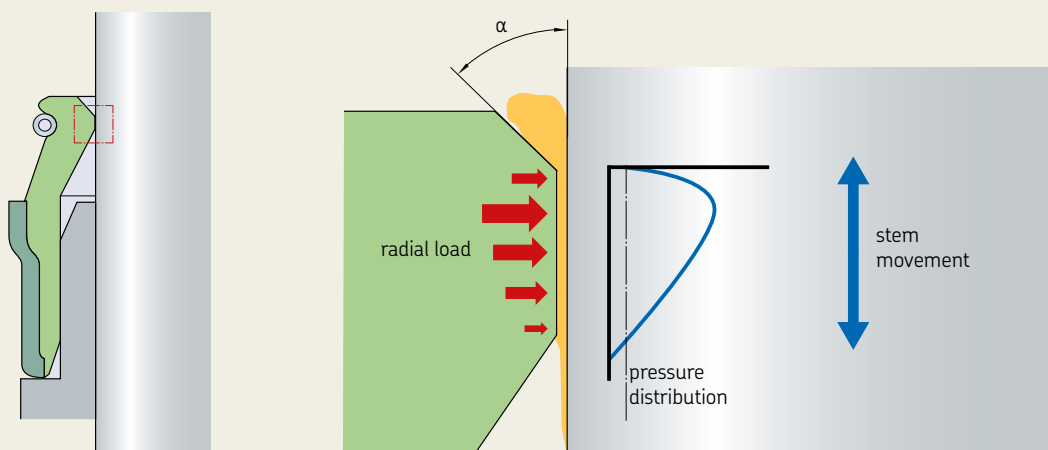
A sophisticated adjustment of seal lip design and contact load allows not only for modification of the average oil metering rate of a valve stem seal, but also for targeted tuning to support lubrication in defined engine application or load conditions.

## Materials and durability performance

Our valve stem seals are designed and validated to meet even extended durability targets of the engine. Dedicated FKM rubber material with widely proven performance is being used for standard applications, special material for the most aggressive oils and combustion residues is also available.



### Adjustment of seal contact pressure and oil metering rate



# Valve stem seal technology

All valve stem seals are designed using the most modern Computer Aided Engineering (CAE) systems and SKF proprietary simulation tools, which includes the analysis and prediction of installation forces. These simulation tools can also be used for further fine tuning of the seal design.

## Recommendations for the mating components

### Valve stem

- All common surface treatments are acceptable (e.g. chrome plating, nitriding).
- Surface roughness  $R_z \leq 2 \mu\text{m}$  /  $R_{\text{max}} = 3 \mu\text{m}$ .
- No lettering on the running surface permissible.

### Valve guide

- OD tolerance  $\pm 0.05 \text{ mm}$  for standard designs.
- Surface roughness
- $R_z 5\text{--}20 \mu\text{m}$  /  $R_{\text{max}} = 25 \mu\text{m}$  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, 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 0.4 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.

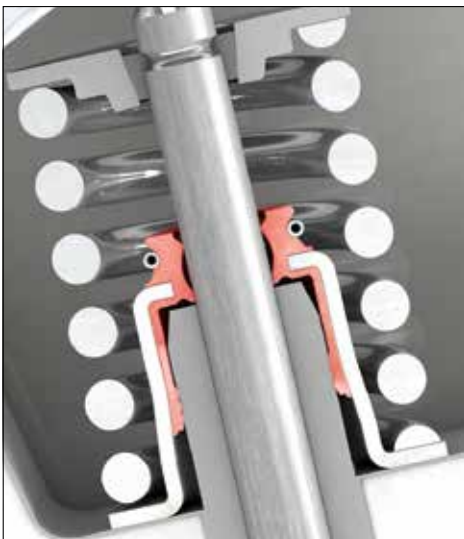
SKF should be contacted as early as possible in the development process, so that we can provide technical support on design and installation of the seal and the surrounding components.

## Validation process

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 on our standard valve stem seal bench, which simulates the engine environment. We can also use the actual customer cylinder head for bench testing to evaluate performance in the actual application. The temperature, speed, pressures, oil type etc. are decided with the customer, or the standard SKF test bench cycle can be used. For the installation we measure the forces needed to press the seal on and to remove the seal from the valve guide. These bench tests do not replace the tests done by the customer in the actual engine. This is the final proof of suitability, as the bench tests cannot fully simulate the characteristics of a fired engine.

## Manufacturing and quality

Thanks to our state of the art manufacturing technology and the extensive level of automation, we can provide seals with the highest quality. All seals are inspected automatically using computer vision techniques to ensure that the critical characteristics for the function of our seals are without defects. In addition, these are controlled by using statistical methods. As a leader in automotive sealing technology and a certified supplier according to EN ISO 9001, ISO/TS 16949 and ISO 50001, SKF is well placed to meet the most stringent customer requirements.



Valve stem sealing system

# Standard valve stem seals

Standard valve stem seals provide perfect and reliable functionality in various engine configurations with low and medium manifold pressure.

Our offer includes two basic designs:

## 1 The non-integrated seal type VSS (→ figure 1)

These seals only fulfil the function of oil metering rate.

The design with the L-shaped metal stamping (→ figure 2) is used for larger differences between valve stem and guide diameters.

## 2 The integrated seal type VSI (→ figure 3)

These seals additionally incorporate a spring seat to prevent wear by the valve stem 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, providing advantages at installation, warehousing and logistics.

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

## What sizes are already available?

Our offer includes valve stem seals for all common valve stem diameters on the market.

If it is not 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.

Fig. 1

Non-integrated type VSS



Fig. 2

Non-integrated type VSS with "L" shaped stamping



Fig. 3

Integrated type VSI



# Valve stem seals for high pressure applications

In addition to standard valve stem seals, our offer includes seals for engines with high pressure in the manifolds, e.g. because of turbochargers or for exhaust brakes on commercial engines. These seals are designed to support even the most challenging requirements of modern light vehicle and heavy-duty engines.

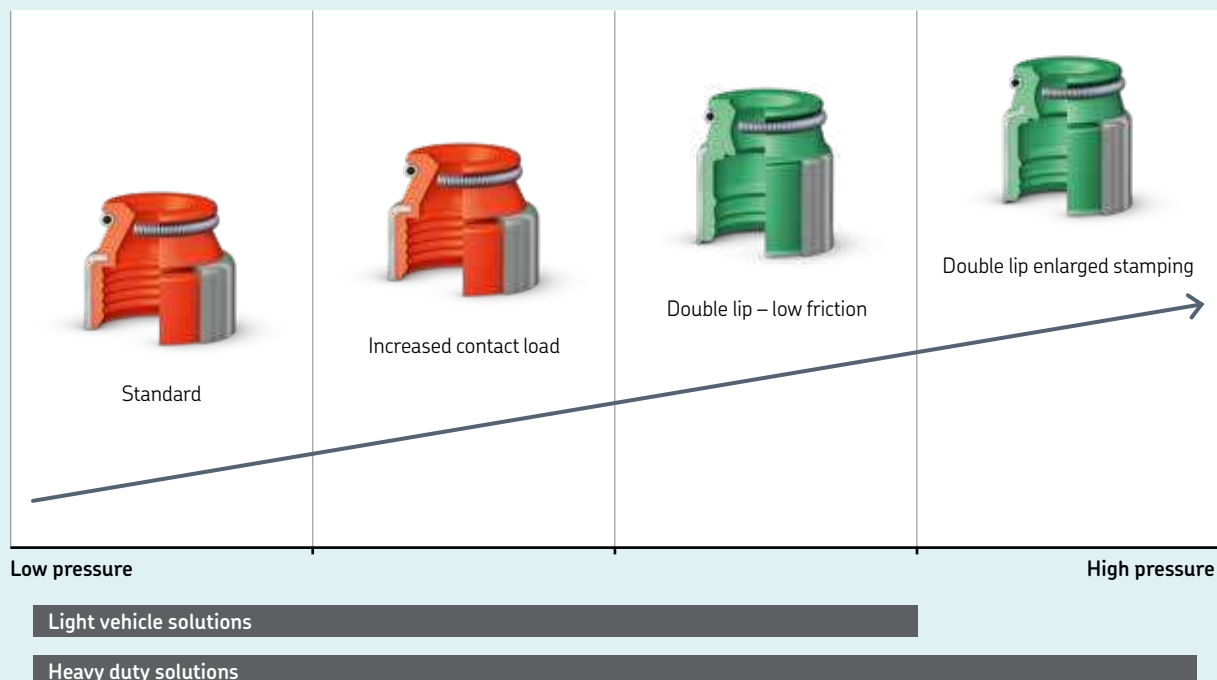
Moving from the base line of the standard designs, the contact load can be increased, an additional sealing lip can be incorporated and, ultimately, an extended metal stamping can be used to obtain a maximum pressure resistance. Featuring a patented, low friction design, these seals improve the quality of emissions and enhance engine operation by withstanding high pressures in the exhaust and intake ports of the engine.

The optional low friction design features of SKF's high pressure valve stem seals can be incorporated into all available seal designs without any changes to existing installation equipment. Our new rubber material can even withstand the most aggressive oils in the market.

## 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

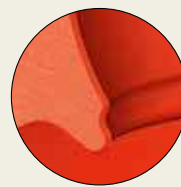


## Light vehicles

Increasing fuel prices and legislation on fuel economy and CO<sub>2</sub> emissions has led to engine downsizing and an increasing use of boosting technologies in light vehicles. For these applications, an additional sealing lip is used to withstand the higher pressure and to allow the primary sealing lip to perform the oil metering function without pressure impact. The design features an oil reservoir in a flexible pressure lip, which reduces friction and improves durability. This results in undisturbed lubrication of the valve in the valve guide and minimum wear.



### Low friction valve stem seal



Patented beaded pressure lip for reduced friction and increased durability



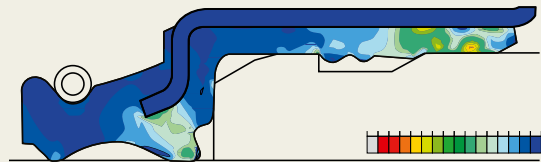
## Heavy duty

In heavy commercial vehicles, in addition to boosting, an exhaust brake may be installed which leads to very high manifold pressures. 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 thus to reduce cost.



### FEA of high pressure valve stem seals

Material loading 120 °C and 12 bar pressure



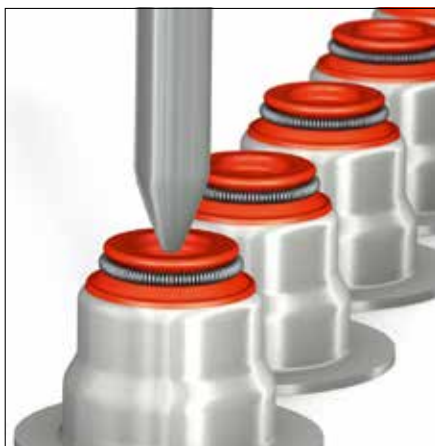
# Installation

## 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 manually 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 for the 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?



# Sealing solutions from SKF

In addition to seals for internal combustion engines, we offer an extensive range of seals for driveline, suspension and wheel-end applications in both traditional and hybrid/electric vehicles. This single source approach is possible through a worldwide network offering one-source accountability. In all our sealing concepts, there is a strong focus on minimizing friction, either to minimize CO<sub>2</sub> emissions and fuel consumption or to improve the functional characteristics.

## Global availability

We have the commitment and global resources to support the unique requirements of our customers' operations. With a global operations footprint, we offer sealing solutions for rotating and reciprocating applications from prototype to serial production close to our customers. Our offer is completed by a range of services including seal analysis, testing, installation assistance and training.

## Engineering and R&D

With increasing pressure to save development time and cost, our engineers benefit from a proprietary and specifically designed software which helps our designers to simulate sealing performance under a variety of conditions, to receive confirmation of seal design suitability.

## Materials

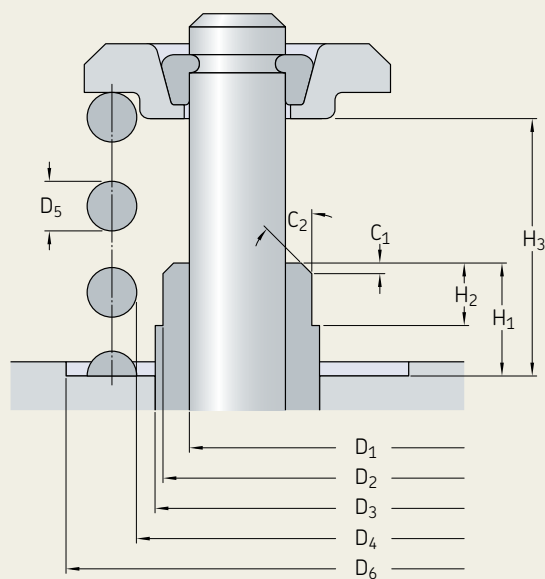
The selection and development of suitable materials is a critical element in sealing technology. Seals must resist increasingly high temperatures, forces and pressures. Specific media, alternative fuels or lubricant properties must also be considered to provide the right solution for specific customer application requirements. Newly developed materials include elastomers that provide lower friction or withstand a wide operating temperature range.

## Testing and analysis

We have a global network of testing facilities that are equipped to fully validate the function and performance of our seals. Advanced testing, such as key life testing which uses test-profiles and operating conditions taken from real applications, is available as well as testing in customer components and assemblies. All tests are conducted using final application requirements to represent end user working conditions.



- C<sub>1</sub> Chamfer length
- C<sub>2</sub> Chamfer angle
- D<sub>1</sub> Valve stem diameter
- D<sub>2</sub> Step diameter of valve guide
- D<sub>3</sub> Valve guide outer diameter
- D<sub>4</sub> Valve spring inner diameter
- D<sub>5</sub> Valve spring wire diameter
- D<sub>6</sub> Spot face diameter for spring seat
- H<sub>1</sub> Protrusion of valve guide
- H<sub>2</sub> Step height of valve guide
- H<sub>3</sub> Gap between head & spring cap (valve open)



### Have a bespoke application with a specific need?

All information required to design a valve stem seal is detailed on the designated product questionnaire on:

> [www.skf.com/valve-stem-seals](http://www.skf.com/valve-stem-seals)

The 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. Our experts will help you to deliver the solution you need. For further information, please contact:

> [seals.automotive@skf.com](mailto:seals.automotive@skf.com)



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