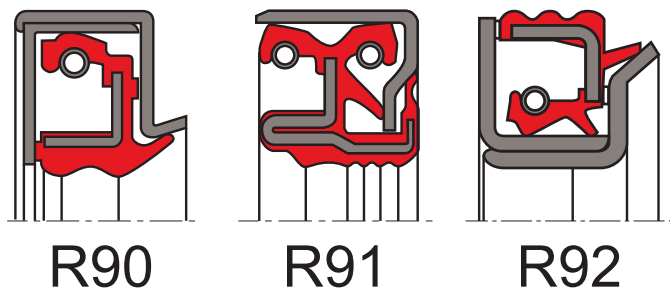


## oil seal R90, R91, R92

## seal spec



### description

the special oil seal has been developed to meet the ever increasing requirements of long service life, high functional reliability, environmental safety, simple handling and superior total economy.

special oil seal are fully enclosed seals with an integrated sealing system, that performs the function of oil seal, wear sleeve and dust protection in one unit. no extra components such as shaft sleeves or dirt protection are needed.

unique to all the special oil seal is that the sealing lip is fixed on the stationary part of the hardware. because of this the sealing force is constant, independent of the rotary speed.

### application



### R90

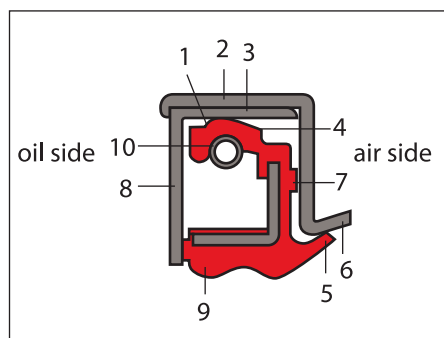


figure 1 R90

the inner section of the R90 is secured against the shaft. the outer section, press fitted into the wheel hub, rotates together with the hub around the inner section, creating a completely enclosed seal. dirt and water, the major enemies of hub seals, are effectively kept at distance, whilst the lubrication of the rubber lip remains intact. this decreases friction and increases seal life accordingly.

### the main features of the R90 are:

- the sealing (1) element is non-rotating, which means that the radial force is kept unchanged at various speeds.
- the sealing surface (2) is in close contact with the wheel hub, which gives an excellent heat transfer.
- the structure of the sealing counterface (3) has been chosen after several thousands of test hours. the position of the sealing lip ensures best lubrication.
- the sealing lip (4) normally has bi-directional TURBO pattern (see page 135).
- integral prelubricated dust-sealing (5) functions.
- the protruding conical part (6) of the case deflects heavier particles due to the centrifugal force.
- the excluding lip (5) protects against water splash and finer particles.
- moulded distance lugs (7) automatically locate the sealing element in the right position.
- the lugs (7) are spaced and dimensioned to ensure the sealing lip has adequate lubrication.
- the inner case (8) also protects the sealing lip from direct oil spray caused by taper roller bearings.
- the robust ribs (9) give:
  - a firm seat on the shaft
  - a smooth sliding during installation
  - a positive static seal even if one of the ribs is located on a defective shaft surface



- the compression spring (10) maintains the radial force. the initial force exerted by the sealing element will in some applications reduce due to ageing of the rubber exposed to heat, load or chemical action.
- for such applications where the seal is exposed to dirty environment, i.e. off road use, the R90 can be equipped with an additional specially developed dirt protection, the HRV seal.

#### R91

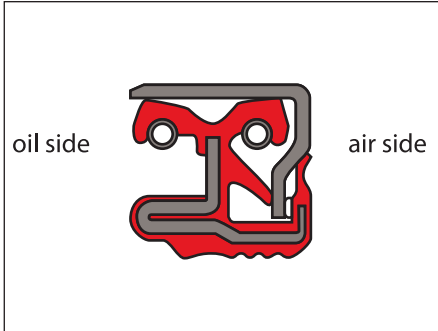


figure 2 R91

R91 is specifically designed for rotating hubs on off-road machines in heavy duty applications, i.e. wet rice fields. the design offers significant improvements in providing improved ability to exclude water, dirt and dust for much longer time. its ability to sustain eccentricities, over-pressure and shaft misalignments are equal to radial seals.

the R91, while based on R90, features two sealing lips, equipped with compression springs, to provide excellent sealing performance and an additional dust lip. mudbox-tests are showing more than doubled lifetime performance compared with the other system seals.

#### R92

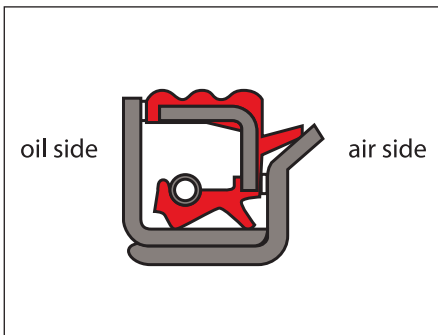


figure 3 R92

the R92 is, like R90 and R91, a fully enclosed seal however designed for rotating shafts. The R92 has the same features but the design has been inverted, i.e. the sealing element is fixed in the stationary housing and the casing components rotates with the shaft.

the R92 is used to prevent oil from leaking out of a bearing housing, i.e. a differential pinion housing for rear axles on trucks, and at the same time preventing road dirt, salt and water splash to enter.

the design is compact and integrates the necessary shaft counterface as well as the dirt exclusion. the dirt exclusion function consists of two rubber lips, one axial and one radial, the space between these filled with grease, and the rotating seal case, which acts as an effective deflector due to the centrifugal force

#### TURBO-pattern - hydrodynamic sealing aids

TURBO is the seal-mart designation of a range of hydrodynamic sealing aids supporting the sealing function. the hydrodynamic sealing aids are located on the air side of main sealing lip in form of ribs or other geometrical figures of a variety of shapes. optimum sealing conditions are attained when a thin film of lubricant is formed so that the lip does not come in contact with the sealing counterface. such conditions are created by the TURBO-pattern, which brings about a pumping effect. the pumping effect starts at relatively low shaft speed, and is understood as the capacity of the seal lip to pump the medium to be sealed back from the air side to the medium side.

in order to avoid leakage at standstill or low speed, the TURBO-pattern includes a static edge, which provides continuous contact line against the shaft. the frictional loss of the seals provided with TURBO-pattern is significantly lower than that caused by seals without hydrodynamic sealing aids. a lower friction does also allow higher shaft speeds, or provide longer service life.

the TURBO pattern is available in three versions: bidirectional, left hand or right hand rotation. the standard is bi-directional as most applications have alternating movement of the hub or shaft. if an application have rotation in one direction only, the corresponding left or right hand type can be specified. the direction of rotation is always defined as seen from the air side.

**table 2 materials**

standard material*	standard metal case	standard spring
s-mart NBR (75 Shore A)	carbon steel	carbon steel
s-mart HNBR (75 Shore A)		carbon steel
s-mart FKM (75 Shore A)	carbon steel	carbon steel

\* special grades and other materials (ACM, EACM, MVQ) on request.

**material****metal case**

the cases are normally stamped of cold rolled steel sheet, EN 10 130 - Fe P04. the high demands on the metal cases; high surface finish, free from scratches etc., calls for production in special tools.

**compression spring**

-for the spring, spring steel SS14 1774 - DIN 17223 - is normally employed. if resistance to corrosion is required, stainless steel SS 14 2331 - DIN 1.4301 - is used.

**sealing element**

the material of the sealing element must be selected according to the working conditions of the seal and the environmental conditions.

some of the requirements associated with environmental considerations are:

- good chemical resistance
- good resistance to heat and low temperature
- good resistance to ozone and weathering

the functional demands include:

- high resistance to wear
- low friction
- low compression set
- good elasticity

in addition, cost considerations make good processability a desirable feature.

no material is available today, which satisfies all these requirements. the choice of material is therefore always a compromise between the relative significance of the factors involved.

however, FORSHEDA has succeeded in developing a Nitrile Rubber compound (NBR), which exhibits good all-round properties, and for this reason it is the compound most commonly used.

the materials normally used for the sealing element are:

Nitrile Rubber (NBR), Hydrogenated Nitrile Rubber (HNBR) and Fluorinated Elastomers (FKM).

the additional dirt seal is normally made of nitrile rubber.

nitrile rubber is the basis material for special oil seal, as it covers most standard application requirements for general oil- and grease resistance. it is from function and cost aspects the best choice when temperature is not excessively high.

nitrile can be used up to 125°C in non-aggressive oils. however for long time use, or in aggressive oils, service temperature is reduced to 80°C. nitrile generally has good mechanical properties and the material used for cassette seals is optimised for best heat and abrasion resistance.

hydrogenated nitrile rubber is a further development of NBR, where the chemical double bonds in the polymer molecules are saturated with hydrogen. since the double bonds of NBR are sensitive to heat and ozone, the HNBR will be superior to NBR in heat, ozone and weather resistance. it can generally be used up to 150°C in nonaggressive media, however for long time use maximum service temperature is 120°C.

the HNBR for the cassette seal is fully saturated and thus well suited for use in aggressive oils. the temperature should however be limited at 120°C. as saturated HNBR cannot be vulcanised with sulphur, the material has resistance to most hypoid oils up to about 120°C for long time use. low friction and high abrasion resistance are additional typical features.

fluorinated elastomers represents peak performance regarding heat and chemical resistance. they can be used up to 200°C for long time, and are generally very resistant to oil, grease and fuels. Ozone and weather resistance is outstanding.

mechanical and low temperature properties are however lower compared to nitrile. thus fluor elastomers should be considered only when the material properties are fully used. some oil additives like amines and high pH-values may damage fluoroelastomers, when used at high temperatures.



### temperature resistance

increasing temperature accelerates the ageing of rubber, the elongation decreases, and the compression set increases and finally the material becomes hard and brittle. cracks at the sealing edge are a typical indication that the seal has been exposed to excessively high temperature. the ageing of the rubber has appreciable significance on the useful life of the seal. it can generally be said that a temperature increase of 10°C (in air) will half the theoretical useful life of the rubber. low temperatures are generally not a big problem since the seals themselves generate heat by friction when rubbing against another surface. if the seal has been chilled down, its original properties will return as soon as it is warmed up again. some leakage may however arise during the start-up phase, before rubber material is softened by friction heat.

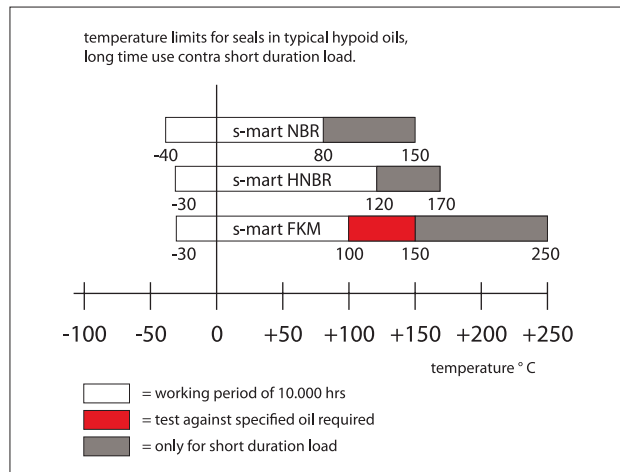


figure 5 temperature recommendations in typical hypoid oils

the temperature limits for the standard materials in hypoid oils are illustrated in figure above. they should only be regarded as approximate, since the oil type and the time of exposure also affect the materials. the temperature ranges within the shaded areas in the illustrations are temperatures that can be allowed only for certain periods of time. the higher the temperature, the shorter the period of time. at low temperatures, time has no influence on ageing.

however, seals are not often working in air as only medium, but they are also affected by other media. temperature limits in combination with other oils and media can be obtained from your local sales office.

### oil resistance

innumerable types of oils are available on the market and each of these has a different effect on the rubber. in addition, a given type of oil from different manufactures may have a different influence.

the additives in the oil generally affect the rubber. this is the case with hypoid oil, which contains sulphur. since sulphur is used as vulcanizing agent for nitrile rubber, the sulphur additive in the oil acts as a vulcanizing agent at temperatures above +80°C. as a result of this secondary curing, nitrile rubber will rapidly become hard and brittle. hydrogenated nitrile and fluorinated rubbers, which are not vulcanised with sulphur, can therefore be used for this type of oil, even though the operating temperature may not require these.

oxidised oils represent another example illustrating the difficulty of tabulating the oil resistance of rubber materials. these oils are oxidised during operation and their properties will therefore change substantially.

due to the above stated, no detailed information is given about resistance to certain types of oils. in case of questions or doubt, it is advisable to contact the local seal-mart office who have access to the many years of in-house testing made by FORSHEDA AB. additional testing can be carried out in specific oil types provided a sufficient sample is available.

### chemical resistance

since the special oil seal are normally exposed to oil or grease, and not other chemicals, tables for chemical resistance to different media are not included. for guidelines about chemical resistance, please look under "radial oil seals" or contact your local sales office.

### application

for the R90, R91, R92, requirements on the shaft finish and hardness are less stringent in comparison with traditional radial shaft seals. a simple fine turning operation gives an adequate surface on the shaft as well as for the housing bore. diameter tolerances and finish values are shown in figure 7 and 6.

as the sealing elements have built in counterfaces of their own, no wear on the shaft itself will occur and consequently no hardening of the shaft is necessary. suitable lead in chamfers facilitates the installation of the seal.

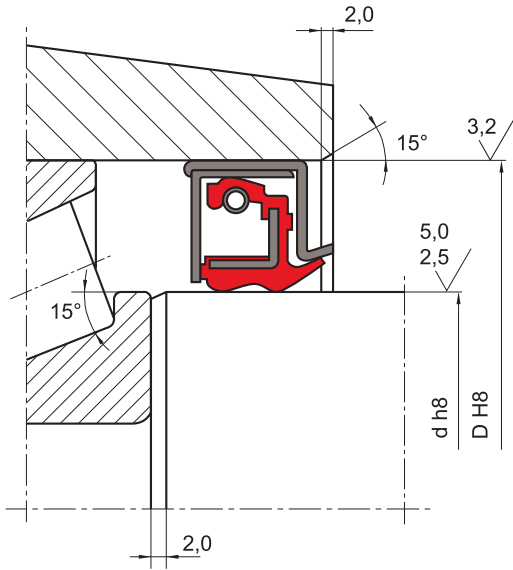


figure 6 R90 in wheel hub application

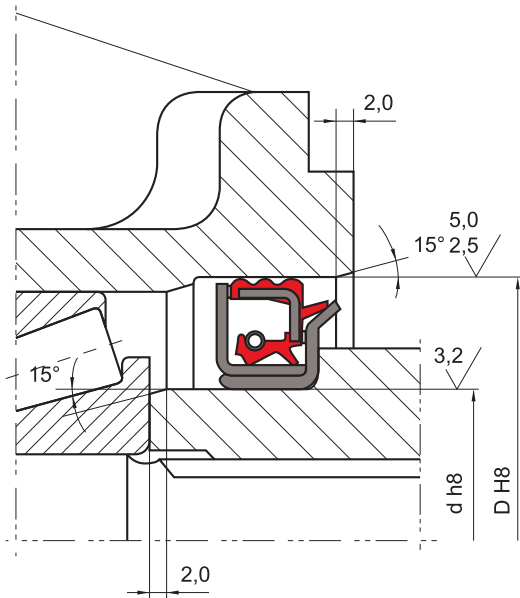


figure 7 R92 in pinion application

**shaft run out**

shaft run out should as far as possible be avoided or kept within a minimum. at higher speeds there is a risk that the inertia of the sealing lip prevents it from following the shaft movement. the seal must be located next to the bearing and the bearing play is maintained at the lowest possible value.

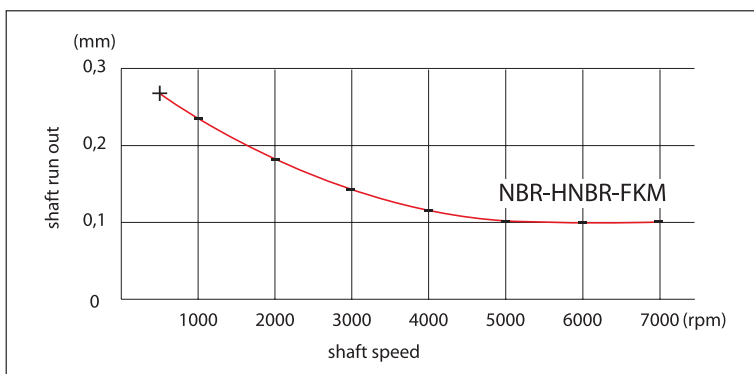


figure 8 permissible run out of the shaft

**eccentricity**

eccentricity between shaft and housing bore centres should be avoided in order to eliminate unilateral load of the lip.

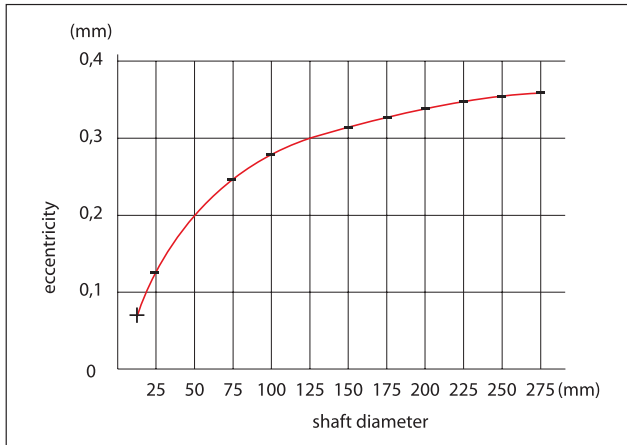


figure 9 permissible eccentricity

**shaft misalignment**

shaft misalignment should as far as possible be avoided or kept at a minimum, max. 0.25 mm.

**axial movement**

axial movement, inclusive what can be considered as normal bearing play, should be within  $\pm 0.1$  mm. the cassette seal will function at larger movements, however this may cause a larger wear on support lugs and in the end shorter lifetime.

**pressure**

any difference in pressure from one side of the seal to the other should be avoided. since the seal is developed for ventilated applications, a pressure difference will in the end lead to a decreased lifetime or leakage. in some applications, a pressure difference up to 0.05 MPa could be accepted, but tests should be carried out for each case.

**speed**

the permissible speed of rotation at sealing point for the various seal designs stated below, assumes normal running conditions, e.g. oil retention and no pressure differential across the seal.

type of seal	max. surface speed (m/s)
R90	10
R91	4
R92	15

**start-/operating torque**

due to transferred assembly forces inside the special oil seal, the special oil seal absorbs higher torque than a standard radial seal. see also the installation part.

**HRV - additional dirt seal**

the HRV seal is an all-rubber seal. it is designed for use as complementary seal for the R90, in dirty applications such as off-road. the main sealing is against small particles such as dust, but also dirt and splash. since the sealing action is axially, it can absorb some axial displacement.

the HRV seal is bonded directly to the outer case of the R90. the design is similar to the FORSHEDA V-ring with a body and a flexible conical shaped sealing lip with an integral resilient "hinge".

the HRV seal rotates, due to the outer case being press fitted into the bore, and seals axially against a stationary counter face. during rotation the sealing lip rubs against the counterface under a contact pressure calculated to achieve a sealing function. the HRV seal also operates as a deflector ring, and its centrifugal action contributes to a good sealing function. due to the centrifugal force, the contact pressure of the lip decreases with increase in speed. the contact pressure also varies with the fitted width.

the counterface for the HRV seal can consist of a suitable surface on the existing hardware or a steel casing adapted to suit the specification for the seal counterface.

the HRV seal:

- seals against outer medium like dirt and dust
- has a deflecting function due to the centrifugal force



the requirements on the counterface against which the sealing lip works are rather low. the requirements are more or less determined by the medium to be sealed. a finish-turned, polished surface with a surface roughness of Ra 1.6 to 2.0  $\mu\text{m}$  is normally adequate. for sealing against liquid and dirt, Ra 0.8 to 1.6  $\mu\text{m}$  is recommended. however, the character of the surface is of greater importance than the actual surface roughness value. for turned surfaces, it is recommended to buff the surface with fine emery cloth to remove any sharp peaks, which could tear the rubber surface apart and destroy the sealing function and shorten seal life time.

it is also necessary to ensure that the counterface is perpendicular to the shaft, flat and free from scratch marks and other damage within the sealing area. this is especially important when sealing fluids and fine particles.

to achieve the full effect of the deflector action, the HRV seal should be designed in a relatively open space.

the fitted width dimension will be stated on the corresponding product drawing.

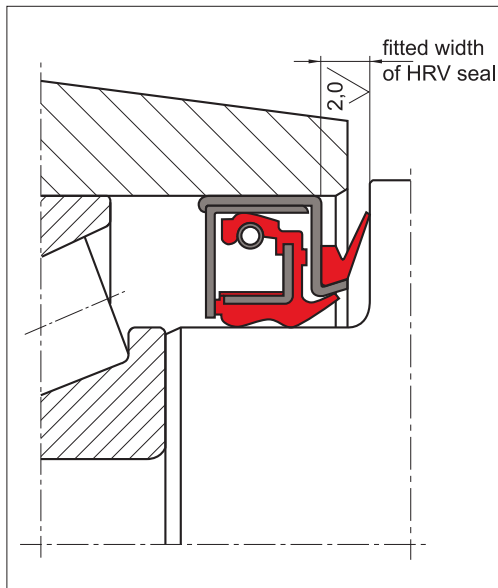


figure 10 R90 with HRV seal

### installation

as the special oil seal incorporate all functions as seal, shaft counterface and dust protection, there is no need for extra components as exchangeable shaft sleeves or dirt protection.

this means fewer parts to stock and handle.

when handling and fitting traditional shaft seals there is always a risk for damaging the shaft surface or sealing lips and for improper installation. as the special oil seal is fully enclosed the vital sealing components cannot be touched or damaged during the installation.

### R90 and R91

when the bearing has been installed the seal is simply pressed into the hub bore. the seal shall be oriented with the side marked "oil side" facing the interior of the hub. it is recommended to oil the inside rubber covered surface of the seal and also the shaft, to decrease the force necessary for assembly. if the special oil seal is equipped with the additional dirt protection this shall be greased prior to fitting. the complete hub is then entered over the axle spindle. normally the locking nuts for the bearing are used to drive the hub home. the special oil seal automatically takes the right position on the shaft and no axial support is required provided no over pressure will be built up during operation.

during the start-up phase, some leakage of grease as well as smoke formation may occur. this is a result of the generation of frictional heat between the metal cases and support lugs, and does not influence the function and service life of the seal.

if, on the other hand, the seal has been misaligned during installation, or jammed against the bore, this may lead to that the support lugs are in too close contact with the metal cases, and may be worn out or torn away at the start-up phase. the seal must in these cases always be replaced before start-up. when repairing of the wheel hub becomes necessary, a new seal shall always be installed.

### R92

the R92 seal must be installed onto a shaft or a sleeve by a special assembly tool. the seal shall be oriented with the side marked "oil side" facing the inside of the gearbox. the shaft must then be assembled so the oil side of the seal is entering the housing bore. if the shaft is hollow, the assembly tool should be designed with a guiding column.



for pinion applications on trucks, when a separate end carrier is used, the seal is simply pressed onto the end carrier in a first step of assembling. the end carrier is then entering the splines on the pinion shaft and then a locking nut is used to drive the end carrier and the seal into the right position.

the force required to assemble a R92 seal onto the shaft is between 20 to 50 kN, while assembly into the housing bore requires about 1.0 kN. the value of assembly force depends on surface structure for shaft resp. housing bore as well as the tolerances. it is recommended to oil the outer rubber covered surface of the seal and also the housing bore, to decrease the force necessary for assembly.

during the start-up phase, eventually some leakage of grease and smoke formation may occur. this is a result of the generation of frictional heat between the metal cases and the support lugs of rubber, and does not influence on the function and service life of the seal.

if the seal is jammed or damaged in some way during installation, the seal must be replaced before start up.

if the construction is disassembled for any reason, a new seal should be installed.

further instructions for assembling can be found on separate assembly instruction sheets available from your local seal-mart office.

### dismantling and replacement

as all the necessary functions are integrated in the special oil seal the complete sealing arrangement is re-newed. the shaft to be sealed is unaffected by wear and once it has been cleaned and possible corrosion and dirt have been removed a new seal can be fitted again.

the special oil seal may be provided with a sealant on the metal casing when it is installed into the housing. take care that the sealant do not flow into the seal or is smeared onto the rubber surface as this may impede the function of the seal. the sealant can reduce the risk of static leakage due to small imperfections on the surface.

### storage

as the service life of bearings and other machine parts depends on how well the seals perform, seals should be handled with caution. unfavourable storage conditions or improper handling will most likely lead to a change of their physical properties. this can lead to a shortening of life, or failure, for example as a result of hardening or softening, cracking or other surface damages. these changes can be the result of one particular factor or a combination of factors, like oxygen, ozone, heat, light, moisture, solvents etc. storing the seals under load can lead to permanent deformation of the elastomer. on the other hand, properly stored elastomer products retain their properties for several years.

as the sensitive sealing lips and counter faces are well protected inside the special oil seal casing, there is less risk of mechanical damages and influence of dirt and dust in comparison to many other seal types.

### cleaning

if cleaning of special oil seal is necessary, use a damp duster and allow the seals to dry off at room temperature. solvents, sharp-edged objects and abrasives should not be used.

### seal & housing recommendations

*please note that we are able to produce those profiles to your specific need or any non standard housing. for detail measurements, please see seal-mart catalog...*

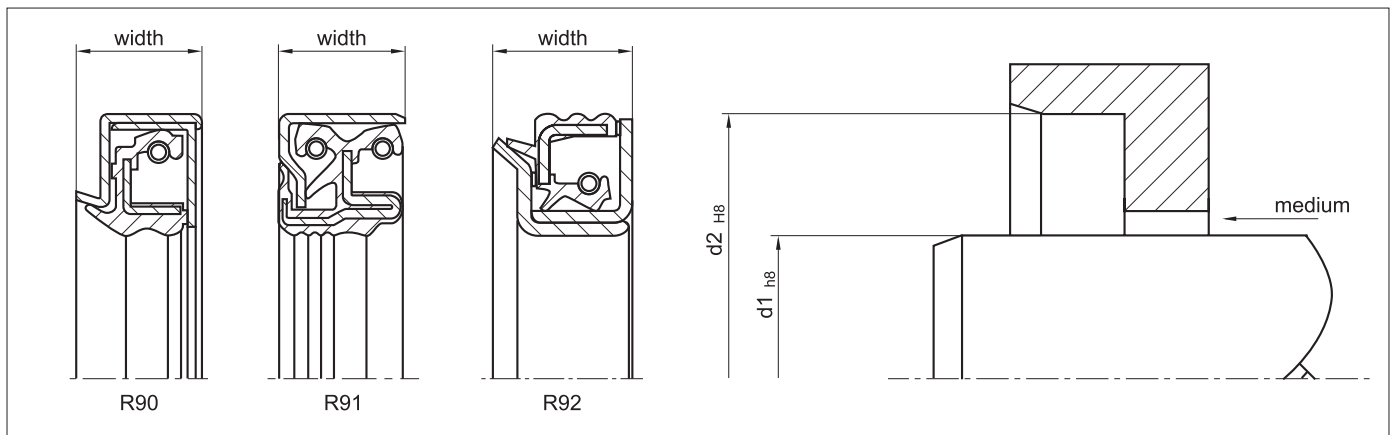


figure 4 installation drawing

*don't hesitate to contact our technical department for further information or for special requirements (temperature, speed etc.), so that suitable materials and/or designs can be recommended.*