

SKF Pulp & Paper Practices

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Update yourself with the SKF Drive-Up Method program

As a junior application engineer, I remember spending many hours with a rig practising different mounting methods. I wasn't alone as I was supervised by two technicians with more than 40 years of experience mounting self-aligning bearings. Despite the fact that I had suitable tools and methods to mount bearings properly, these men were my reference.

It's completely understandable that people want to rely on the mounting method to get the right fit on the spherical roller bearings and CARB toroidal roller bearings used in pulp and paper applications with tapered bores. After all, previous issues of SKF Pulp & Paper Practices have shown that the consequences of getting this wrong can be both significant and expensive.

In many cases, bearing failures are caused by fit problems as a result of the mounting

method used combined with lack of experience among the fitters. I remember well a case involving two medium-sized spherical roller bearings which had to be mounted three times on the same machine in the space of ten days. On the first two occasions, they were mounted by the mill's maintenance staff using the feeler gauge method. The first attempt resulted in an overheating alarm due to uncontrolled radial preload; the second one with noise and shaft wear due to a too loose fit. After this, the SKF Drive-up Method was used and the bearings they mounted have now been in operation for more than seven years. Following this, the method was also adopted by other sites in the customer's company as they understood the need for higher accuracy and repeatability.

In this issue of SKF Pulp & Paper Practices, you'll be shown how to use SKF Drive-up

Method program on your computer and smartphone to help you mount bearings in a simple, accurate and quick way. It is my reference and preferred method. I hope it becomes yours too.



Regards,
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The SKF Drive-up Method program

In this issue of SKF Pulp & Paper Practices, I will give all the information needed to use SKF Drive-up Method programs and do very easy calculations, but before reading further, please look at issue 3 of SKF Pulp & Paper Practices for background information on the SKF Drive-up Method and issue 17 for a step-by-step guide to mounting with lots of photographs and tips.

I recommend having two versions of the SKF Drive-up Method program; one on your computer and one on your smartphone for quick calculations on site (see figures 1 and 2). The computer version is complete and user-friendly when you're in the office since all the necessary information, input data and calculation result are in one window (see the

right hand window on figure 1). The smart-phone version is useful on site, but please make sure that you protect your phone properly. Mine has a good quality protective cover, so I don't hesitate to handle it when my hands are covered in grease or oil. I simply clean it afterwards with olive oil and then washing up liquid before rinsing it under the tap. You should, of course, check your cover manufacturer's instructions before using my approach to avoid damaging your phone.

The SKF Drive-up Method web page can be found at <http://www.skf.com/group/knowledge-centre/engineering-tools/skf-driveupmethodcalculation.html>. It has all the information you need to download the program.

In the rest of this issue, I will show you how to use the computer version of the SKF Drive-up Method program. Once you understand and are familiar with that, the smart-phone version is straightforward. I'm using the same bearing example that I used in issue 17 of SKF Pulp & Paper Practices i.e. an SKF 22320 EK spherical roller bearing mounted directly on the tapered seat of a plain shaft.

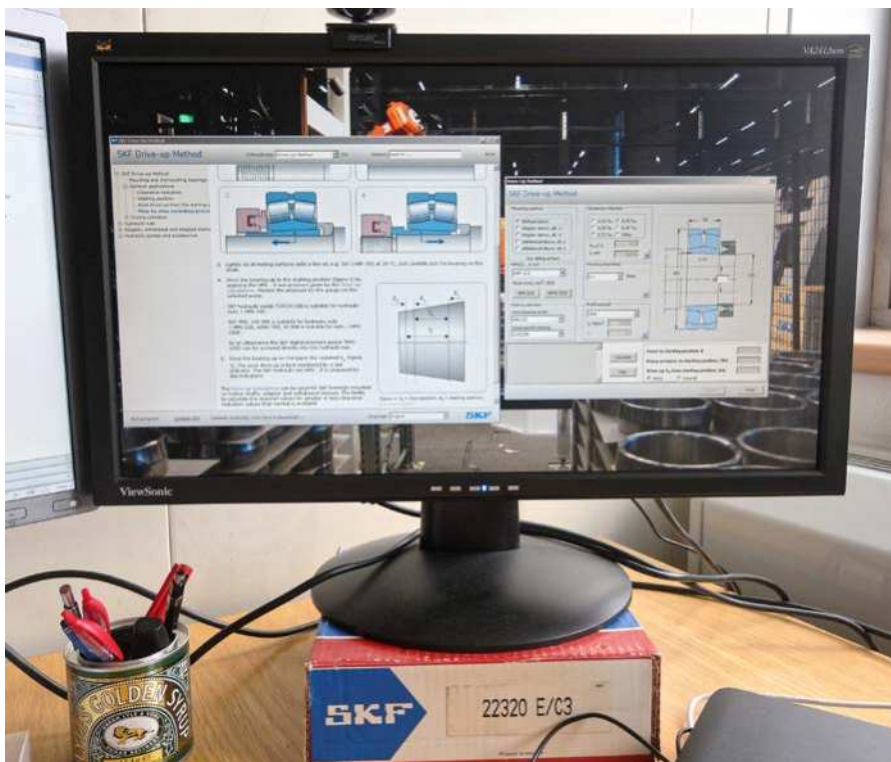


Fig. 1: SKF Drive-up Method program for computers running Windows

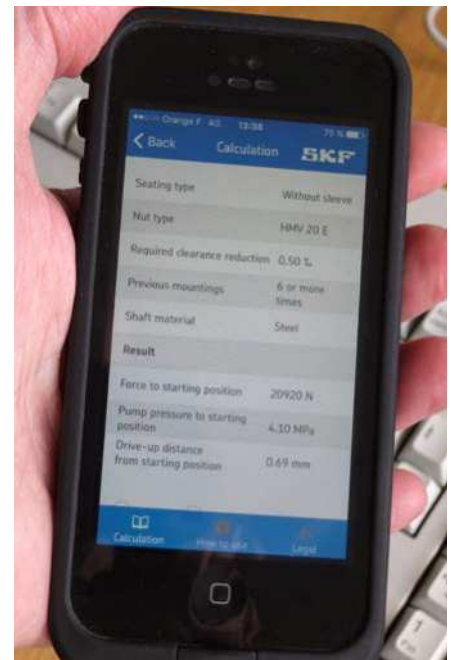


Fig 2: SKF Drive-up Method program for smartphones, running under iOS or Android

Once you have downloaded and launched the SKF Drive-up Method program, there is plenty of information available. The part that interests us for the purposes of this issue of SKF Pulp & Paper Practices are the calculations to ascertain the pump pressure to the starting position and the final axial drive-up. This is contained in a new window that launches when you click “Go” in the program (see figure 3).

Once the calculation window opens, you should choose the bearing type and series (see figure 4).

Note that the software includes some acronyms e.g. SRB for spherical roller bearing and SABB for self-aligning ball bearing. Since the bearing used in our example is a 22320 EK spherical roller bearing, SRB 223 is selected.

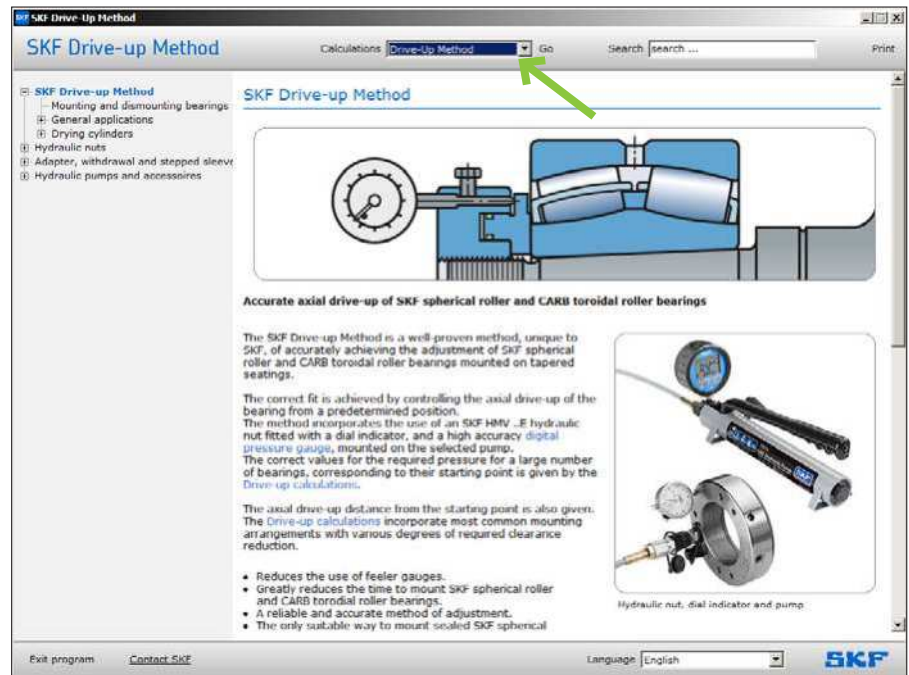


Fig 3: Click on “Go” to open the calculation window

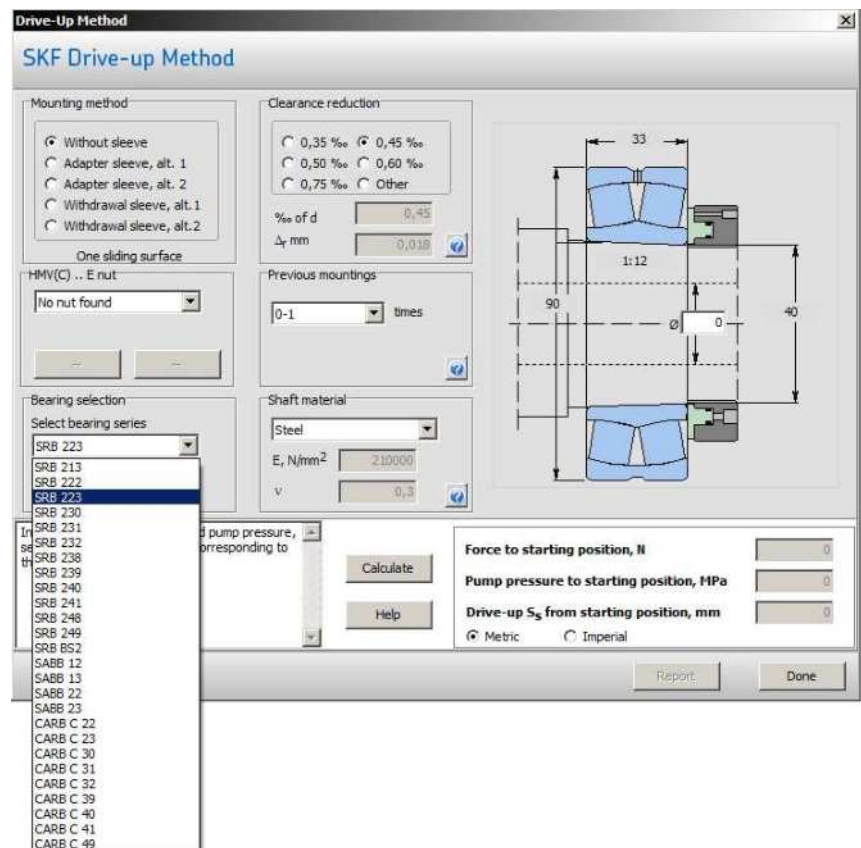


Fig 4: Choose the bearing type and series

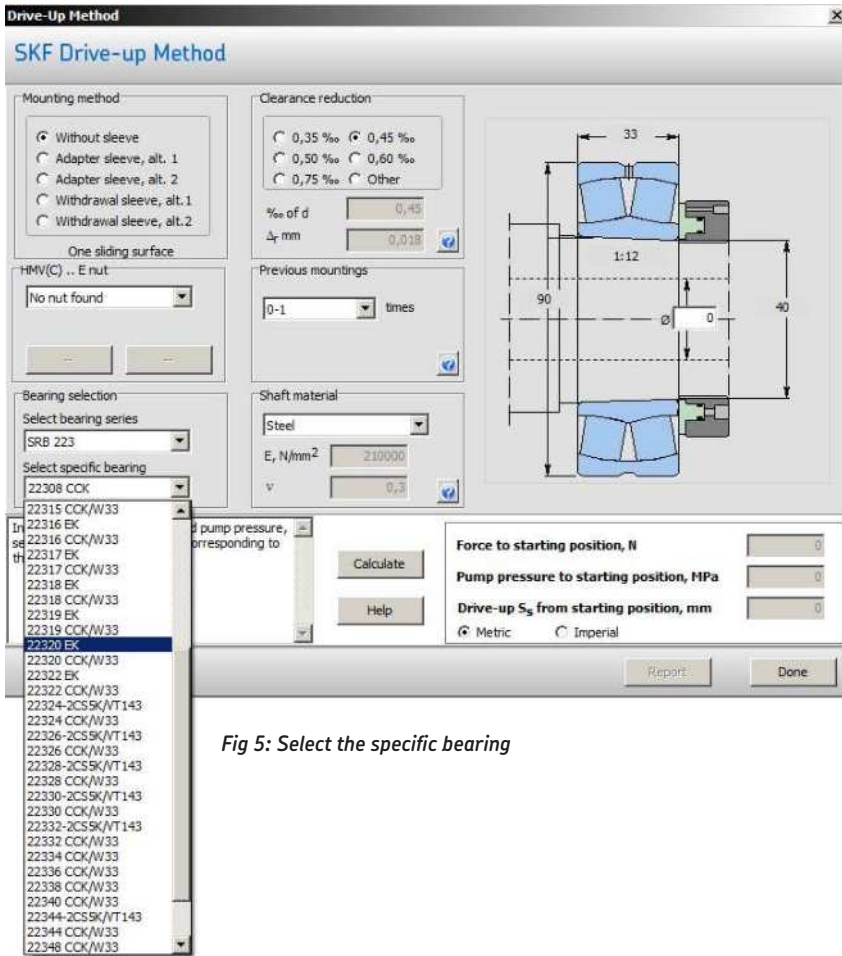


Fig 5: Select the specific bearing

Then select the specific bearing from the drop-down list (see **figure 5**)

Important notes:

- 1 The program is only valid for SKF bearings that appear in the drop-down list. The reason for this is that for a drive-up value, the real tight fit value and clearance reduction will depend on the bearing internal design (inner ring width, thickness etc.). This is why there is the choice between two generations of the 22320; the old design 22320 CCK/W33 and the newer 22320 EK. For SKF bearings that are not listed, please contact your local SKF application engineering department.
- 2 Select 22320 EK regardless of the variant of the bearing e.g. 22320 EK/C3, 22320 EK/C4. This is not an issue as popular variants used in the paper industry such as C3, C4, C5, C08, C083, C084, HA3, VQ424, VA460, L4B, L5DA, W5xx etc. all have inner rings with the same dimensions. If you have any doubts, please contact your local SKF application engineering department.

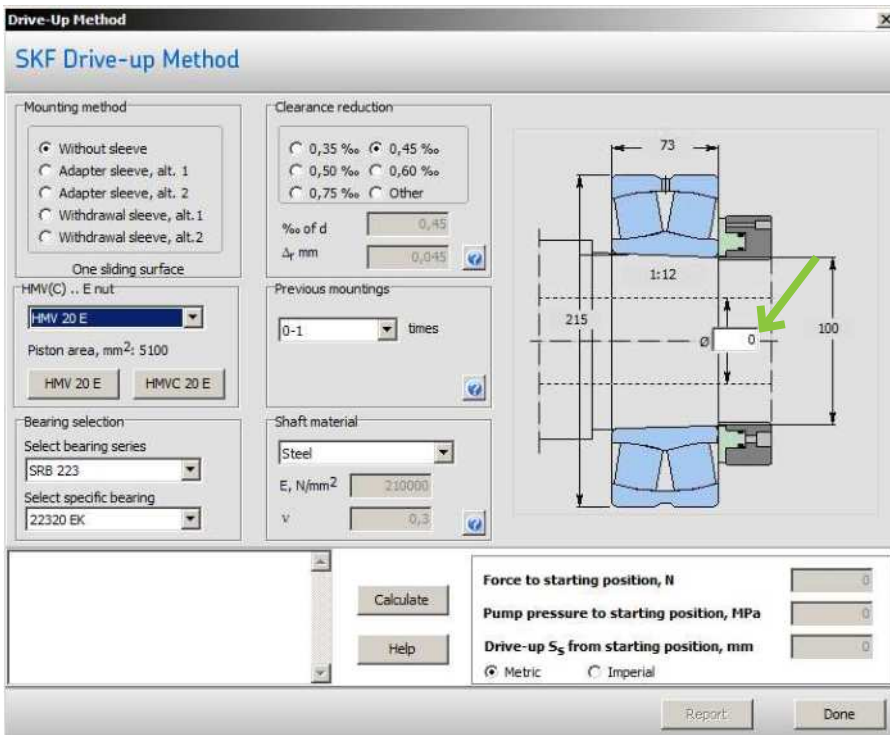


Fig 6: The field in the software to enter the shaft bore diameter

If the shaft has a bore, enter the bore diameter in the box indicated by the green arrow (see **figure 6**). Note that bores with diameters less than half of the outer diameter of the shaft under the bearing have very little influence. In such cases, I often leave the value as zero, except when doing a report.

If the bore value either underneath or close to the bearing varies and the maximum diameter of the bore is larger than half of the shaft outer diameter under the bearing, then the bearing could be unevenly supported (see **figure 7**). I recommend contacting your local SKF application engineering department in such cases.

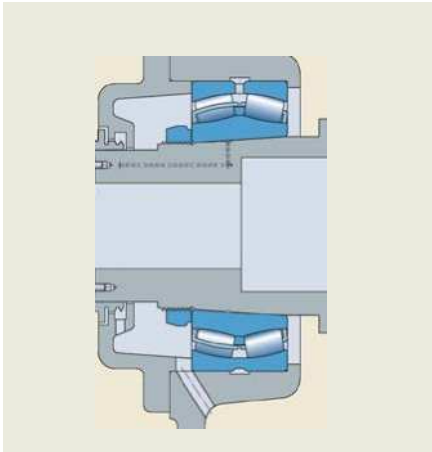


Fig 7: Design error, bearing is unevenly supported

Fig. 8: The “Adapter sleeve, alt 1” option

Note that the program includes a “Mounting method” area with the choice of five different options. This is important as it has an influence on the number of sliding surfaces and thus the pump pressure to the starting position, the final drive-up distance and the choice of hydraulic nut.

Figure 6 shows the “Without sleeve” option. The bearing is mounted directly on a tapered seat and there is one sliding surface.

Figure 8 shows the “Adapter sleeve, alt 1” option. The sleeve doesn’t move relative to the shaft and the bearing is driven up the sleeve. There is also one sliding surface in this case.

Figure 9 shows the “Adapter sleeve, alt 2” option. The sleeve is pulled underneath the bearing, but the bearing doesn’t move relative to the shaft. In this case, there are two sliding surfaces.

Fig. 9: The “Adapter sleeve, alt 2” option

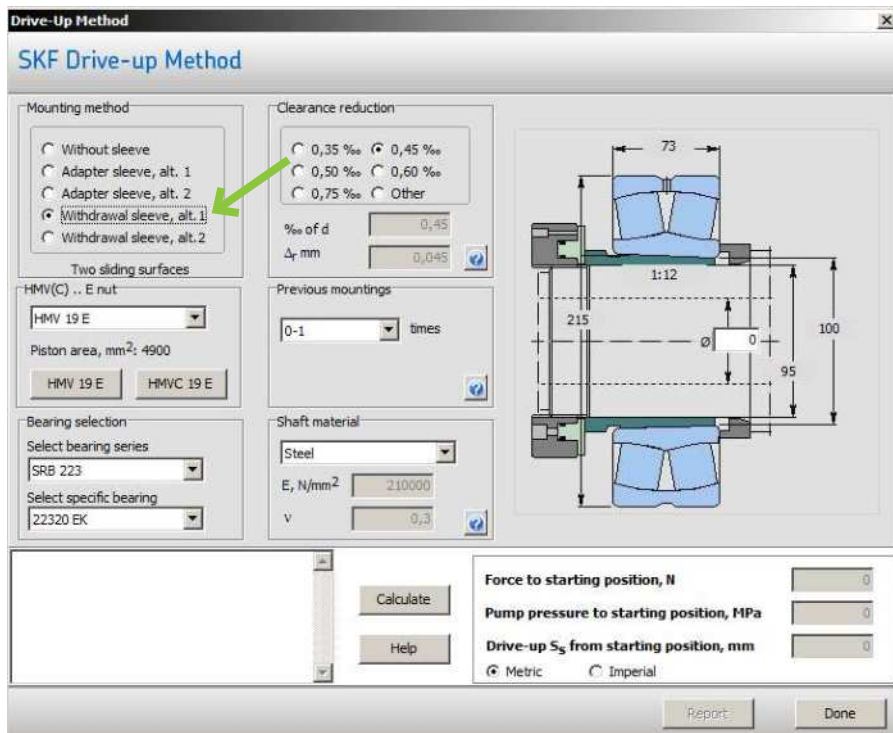


Figure 10: The “Withdrawal sleeve, alt 1” option

Figure 10 shows the “Withdrawal sleeve, alt 1” option. The sleeve is pushed underneath the bearing, while the bearing doesn’t move relative to the shaft. There are two sliding surfaces.

Figure 11 shows the “Withdrawal sleeve, alt 2” option. The sleeve is pushed underneath the bearing, while the bearing doesn’t move relative to the shaft. There are two sliding surfaces.

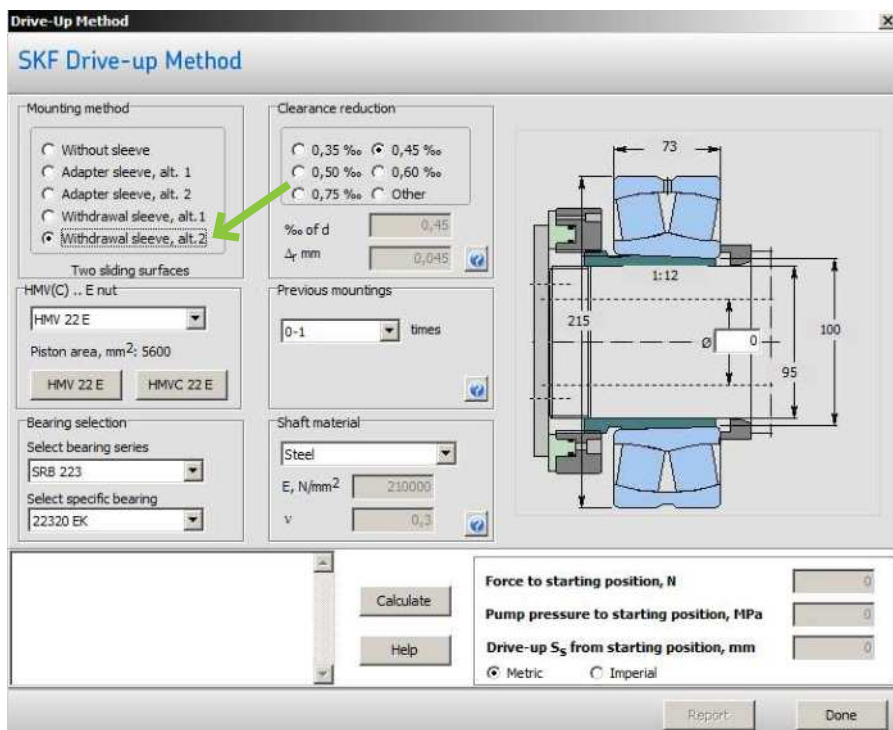


Fig. 11: The “Withdrawal sleeve, alt 2” option

Please note that the hydraulic nut size is chosen by default by the program. When the SKF hydraulic nut is mounted on the SKF sleeve, as in figures 8, 9 and 11, the nut size corresponds to the sleeve size normally used, even if the sleeve has a special bore or is a split one. The nut thread has to match the sleeve thread.

In the case of figures 6 and 10, the hydraulic nut can have different sizes depending on the shaft diameter on which the nut is positioned. I have seen several cases in which between bearing (or withdrawal sleeve) and nut, there is a spacer and the shaft diameter under the nut is smaller than the shaft diameter under the bearing (or under the sleeve). Figure 12, which shows a refiner arrangement, is one example. In that example, if the spacer between the nut and the withdrawal sleeve shown on the drawing is used, the starting position given by the Drive-up Method program might be wrong due to the friction of the spacer (with its O-rings) on the shaft. A tube with a bigger bore, centred so there’s no contact with the shaft, should replace the spacer during bearing drive-up.

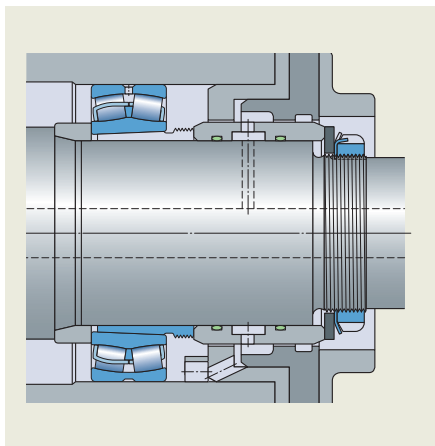


Fig 12: Hydraulic nut to push the withdrawal sleeve will be of much smaller size than the one proposed by default in the SKF Drive-up Method program

A suitable hydraulic nut should be selected from a drop-down list (see **figure 13**). Later on, I will explain what you should do if the hydraulic nut that you need is not included in the list.

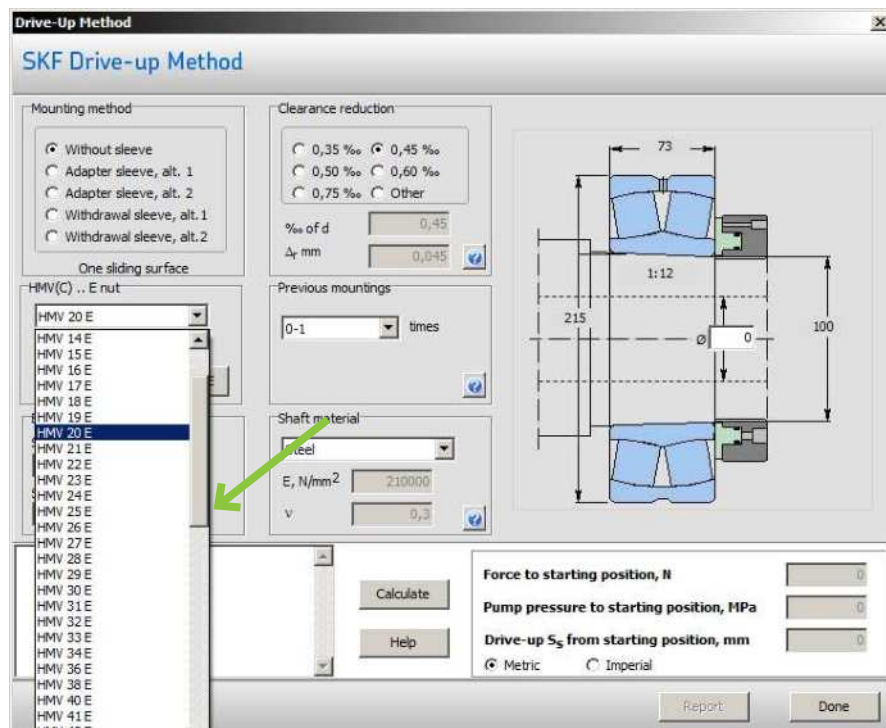


Fig. 13: Drop-down list for selection of a suitable hydraulic nut

The next step is to choose a fit by selecting a radial internal clearance reduction (see **figure 14**). To prevent any misunderstanding, it is shown simply because many people are used to measuring clearance reduction with feeler gauges. In reality, the purpose of the bearing drive-up is to have the correct fit for the application, not the correct clearance. Anyway, if the final clearance is inadequate, you should choose a bearing with a different clearance class.

For spherical roller bearings and CARB, by default, 0,45 % of the bearing bore diameter is indicated. SKF recommends 0,50 %, as shown in figure 14, for the pulp & paper industry. For self-aligning ball bearings, the default value is 0,35 %.

Clearance reduction Δ_r in mm is automatically calculated.

Reminder 1:

Clearance reduction of 0,50 % of the bearing bore diameter means that for a bearing having a bore of 1 000 mm, the clearance reduction is 0,500 mm.

- 200 mm (a 23040 CCK/C4W33 for example), the clearance reduction is 0,100 mm
- 100 mm (our example with the 22320 EK), the clearance reduction is 0,050 mm

Reminder 2:

Some applications need higher clearance reduction (tighter fits) than the general recommendations. In paper industry applications, this is mainly due to high loads and/or journals with large bores. I recommend reading issue 16 of SKF Pulp & Paper Practices, but in general the common reasons are:

- heavy loads
- hollow shafts with very large bores
- applications where the bearing inner ring can be considerably warmer than the shaft
- damaged shafts i.e. out of tolerance (not a long term solution)
- experience from identical or similar applications
- special requirements for residual clearance

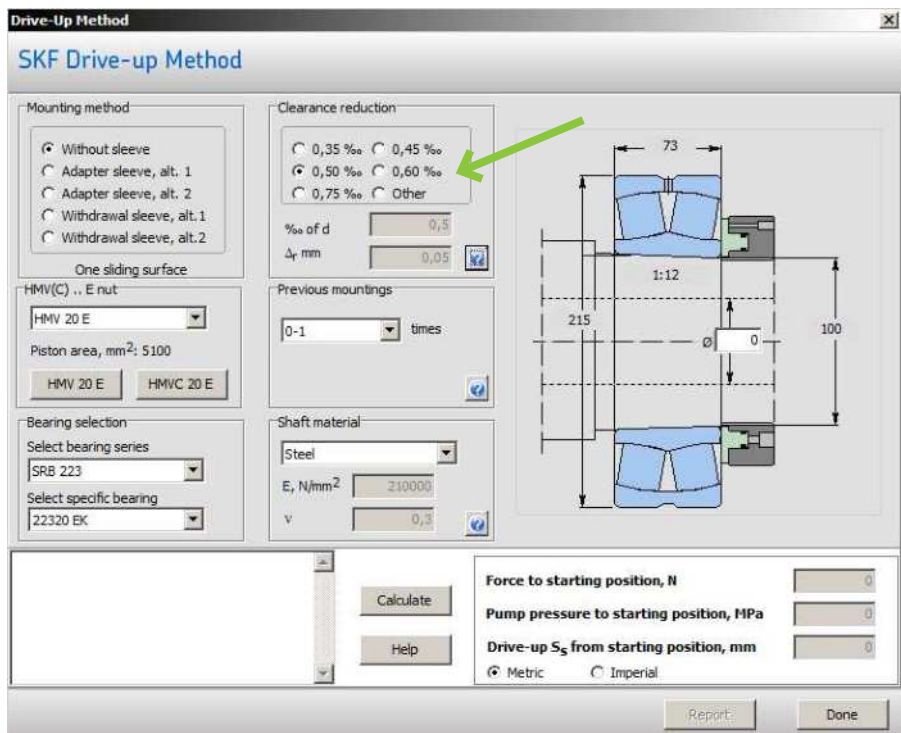


Fig. 14: The clearance reduction box

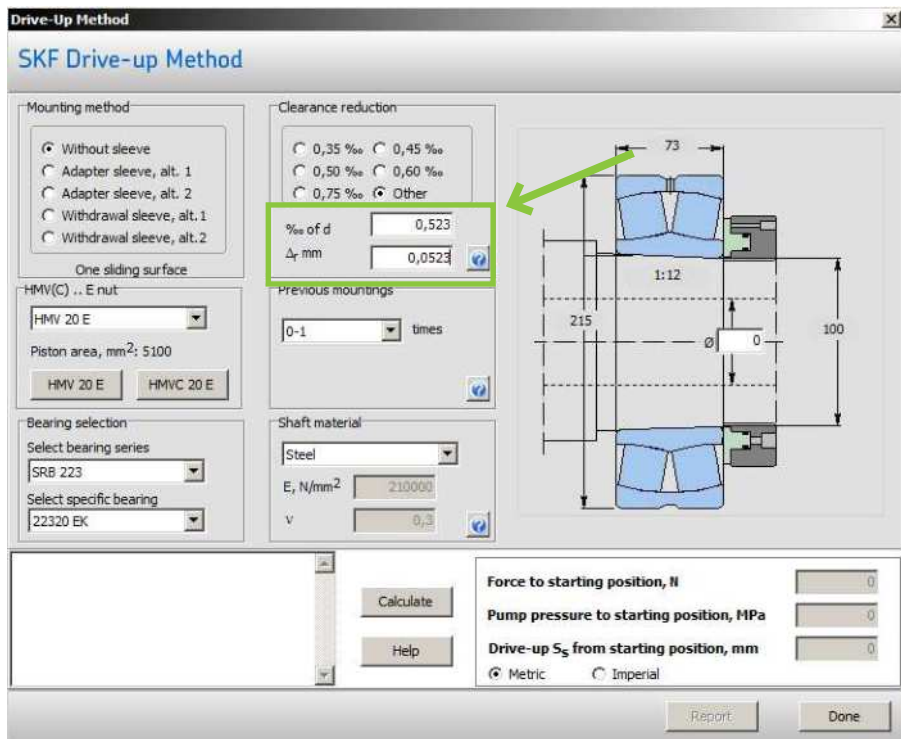


Fig. 15: It is possible to enter a custom clearance reduction value

Please note that the program lets you enter your own clearance reduction if you want to. Just check "Other" and it will be possible to enter custom values for clearance reduction in mm or in % of the bearing bore diameter (see figure 15).

I use this feature as, being trained and having done bearing mounting before the SKF Drive-up Method was commonly used by SKF, I have some clearance reduction rules of thumb in my mind based on old clearance reduction tables. I strongly recommend that you do not do the same unless you have some experience. I also use this feature so that I can use the SKF Drive-up Method values for some clearance reduction values given in the tables of the SKF rolling bearings catalogue or used by a customer for a particular application. For example, the clearance reduction values given for 22320 EK in the SKF rolling bearings catalogue is between 0,040 and 0,050 mm. The program will then be able to give me the SKF Drive-up Method values for the minimum and maximum recommended clearance reduction for the 22320 EK:

- for 0,040 mm clearance reduction, the pump pressure for starting position would be 4,1 MPa and the final drive-up of 0,519 mm
- for 0,050 mm clearance reduction, the pump pressure for starting position would be 4,1 MPa and the final drive-up of 0,686 mm

The reason why the number of “Previous mountings” is shown in **figure 16** is that mating surfaces are smoothed when a bearing is mounted. When this happens, the tight fit reduction is less due to the smoothing.

In theory, the number of previous mountings is the number of mounting with the same shaft (and sleeve) and the same bearing. However, in real life this is rarely the case. Damaged bearings are replaced by new ones and shafts/journals aren't repaired if they are still in reasonably good condition. Large size bearings on press rolls are often dismantled, checked and mounted again, but not always on the same press roll. As such, we have to find a pragmatic rule.

- 1 If we take the example of the 22320 EK mounted on the training rig, the SKF Drive-up Method values would be 4,1 MPa and 0,727 mm for new shaft and new bearing (previous mountings set to 0-1 times) and 4,1 MPa and 0,686 mm after more than 5 mountings and dismantlings during training (previous mountings set to 6 or more). If I change the clearance reduction to have final drive-up value of 0,727 mm with 6 or more previous mountings, or if I change the clearance reduction to have final drive up value of 0,686 mm with 0-1 previous mountings, there is then only less than 0,003 mm difference in clearance reduction from original requested value.
- 2 Smoothing has more influence on the final tight fit for small bearings than for large bearings for which it is negligible.
- 3 Smoothing also has more influence when there are two sliding surfaces (see **figures 9, 10 and 11**) than when there is just one (see **figures 6 and 8**).
- 4 The bearing seat has higher roughness than the bearing bore. This means that the shaft has more influence than the bearing.

So, to make it simple, the number of “Previous mountings” can be considered to be the number of times any bearing was mounted on the same shaft/journal (and sleeve) since it was new.

The screenshot shows the SKF Drive-up Method software window. The 'Previous mountings' dropdown menu is highlighted with a green arrow, showing options: 0-1, 2, 3, 4, 5, and 6 or more. The 'Clearance reduction' section shows radio buttons for 0,35 ‰, 0,45 ‰, 0,50 ‰ (selected), 0,60 ‰, 0,75 ‰, and Other. The 'Bearing selection' section shows 'SRB 223' and '22320 EK'. The 'Force to starting position, N' is 0, 'Pump pressure to starting position, MPa' is 0, and 'Drive-up S₂ from starting position, mm' is 0. The 'Report' and 'Done' buttons are at the bottom right.

Fig 16: The number of previous mountings

The rule then becomes:

- a With the exception of small bearings (bore diameter below 100 mm) running in severe operating conditions (high load, high speed), leave the “Previous mountings” set at 0-1 times.
- b For bearing bores below 100 mm, it will depend on the seat surface and operating conditions, but I quite often leave it set to 0-1 times as well.
- c For small bearings, always replace the sleeve with a new one.
- d Any error will be much lower than if you are mounting with feeler gauges anyway.

SKF Drive-up Method

Mounting method

- ☒ Without sleeve
- ☐ Adapter sleeve, alt. 1
- ☐ Adapter sleeve, alt. 2
- ☐ Withdrawal sleeve, alt. 1
- ☐ Withdrawal sleeve, alt. 2

One sliding surface

HMV(C) .. E nut

HMV 20 E

Piston area, mm²: 5100

HMV 20 E HMVC 20 E

Bearing selection

Select bearing series

SRB 223

Select specific bearing

22320 EK

Clearance reduction

- ☐ 0,35 ‰
- ☒ 0,50 ‰
- ☐ 0,45 ‰
- ☐ 0,60 ‰
- ☐ 0,75 ‰
- ☐ Other

% of d 0,5

Δr mm 0,05

Previous mountings

6 or more times

Shaft material

Steel

Steel

Nodular iron

Cast iron

Other

Force to starting position, N 0

Pump pressure to starting position, MPA 0

Drive-up S_5 from starting position, mm 0

☒ Metric ☐ Imperial

Calculate Help

Report Done

Fig. 17: Shaft material drop-down list

Next, the correct shaft material should be selected (see **figure 17**). In my training rig case, this would result in the following final drive-up values:

- 0,686 mm for a steel shaft
- 0,708 mm for a nodular iron shaft
- 0,769 mm for a cast iron shaft

SKF Drive-up Method

Mounting method

- ☒ Without sleeve
- ☐ Adapter sleeve, alt. 1
- ☐ Adapter sleeve, alt. 2
- ☐ Withdrawal sleeve, alt. 1
- ☐ Withdrawal sleeve, alt. 2

One sliding surface

HMV(C) .. E nut

HMV 20 E

Piston area, mm²: 5100

HMV 20 E HMVC 20 E

Bearing selection

Select bearing series

SRB 223

Select specific bearing

22320 EK

Clearance reduction

- ☐ 0,35 ‰
- ☒ 0,50 ‰
- ☐ 0,45 ‰
- ☐ 0,60 ‰
- ☐ 0,75 ‰
- ☐ Other

% of d 0,5

Δr mm 0,05

Previous mountings

6 or more times

Shaft material

Other

E, N/mm² 210000

ν 0,3

Force to starting position, N 0

Pump pressure to starting position, MPA 0

Drive-up S_5 from starting position, mm 0

☒ Metric ☐ Imperial

Calculate Help

Report Done

Other material can be selected. Choose “other”, and you can enter the modulus of elasticity E (N/mm²) and the Poisson's ratio ν (see **figure 18**).

Fig. 18: Other shaft material can be selected

Once you've entered all the necessary information, click on "Calculate" to get the results (see figure 19)

Drive-Up Method

SKF Drive-up Method

Mounting method

- ☒ Without sleeve
- ☐ Adapter sleeve, alt. 1
- ☐ Adapter sleeve, alt. 2
- ☐ Withdrawal sleeve, alt. 1
- ☐ Withdrawal sleeve, alt. 2

One sliding surface

HMV(C) .. E nut

HMV 20 E

Piston area, mm²: 5100

HMV 20 E HMVC 20 E

Bearing selection

Select bearing series

SRB 223

Select specific bearing

22320 EK

Clearance reduction

- ☐ 0,35 ‰
- ☐ 0,45 ‰
- ☒ 0,50 ‰
- ☐ 0,60 ‰
- ☐ 0,75 ‰
- ☐ Other

‰ of d 0,5

Δ_r mm 0,05

Previous mountings

6 or more times

Shaft material

Steel

E, N/mm² 210000

V 0,3

Calculation OK

Calculate

Help

Force to starting position, N 20920

Pump pressure to starting position, MPa 4,1

Drive-up S_g from starting position, mm 0,686

☒ Metric ☐ Imperial

Report Done

Fig. 19: Press the calculate button and get your results shown in the yellow boxes

If you are using a SKF hydraulic nut HMV.. E (or HMVC..E), the force to starting position (20 920 N in the example) is just for information and you do not need to bother about it.

If you are not using a SKF HMV(C)..E hydraulic nut, the force to starting position is an important output since the pump pressure to starting position may be wrong. To avoid confusion, in that case choose “No nut found” from the drop-down list so that no pump pressure calculation will be made (see **figure 20**). The pump pressure to starting position can be calculated knowing the force to starting position and the hydraulic nut piston surface using $P = F/S$.

Let's suppose we have a hydraulic nut from a competitor with a piston surface equal to 4 900 mm².

$$F = 20\,920\text{ N}$$

$$S = 4\,900\text{ mm}^2$$

$$F/S = 20\,920/4\,900 = 4,27\text{ MPa}$$

Pump pressure to starting position is then equal to 4,27 MPa. The final drive-up, 0,686 mm, remains the same.

Fig. 20: No pump pressure result when a nut is not found in the drop-down list

Figure 21 shows the comment box or warning box. Comments only appear if there is a risky situation such as :

- 1 too high tight fit that could induce too high hoop stress in the bearing inner ring, reducing its fatigue life and increasing the risk of fracture
- 2 too high tight fit that reduces a lot the initial radial clearance, thus the bearing may operate with insufficient clearance and run into an uncontrolled preload situation with overheating and/or overload

Note that I had to change the requested clearance reduction in figure to show comments. If I hadn't, the box would show “Calculation OK”.

Fig. 21: Important information is shown in the comment box

SKF Drive-up method

01/02/2016

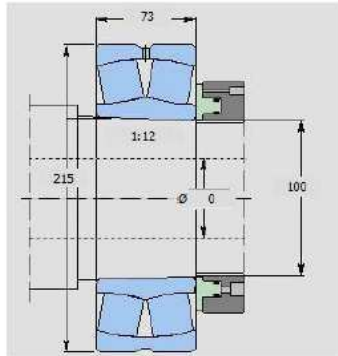
Every care has been taken to ensure the accuracy of the information in this system but no liability can be accepted by SKF for any errors or omissions.

Input	
Mounting	Bearing directly on shaft One sliding surface
Number of previous mountings	6 or more (of the same bearing on the same shaft and sleeve)
Required clearance reduction, mm	0,05
Shaft material	Steel ($E=210000 \text{ N/mm}^2$ $v=0,30$)
Results	
Force to starting position	20920 N = 4703 lbf
Pump pressure to starting position	4,10 MPa = 595 psi using HMV 20 E/HMVC 20 E
Drive-up distance from starting position	0,686 mm = 0,027 inch

Notes

1. Calculation OK

Bearing: 22320 EK



Now that you have the SKF Drive-up Method values, you can create reports, like those shown in **figures 22** and **23**, by clicking the "Report" button on the bottom right. The reports summarize the inputs, the results and give information on suitable SKF tools. There is also space for notes that should be taken during bearing mounting for traceability reasons.

The smartphone version is very similar. There are some very small differences e.g. the report that doesn't have space for notes during mounting and the "Report" button is called "Save pdf" etc.

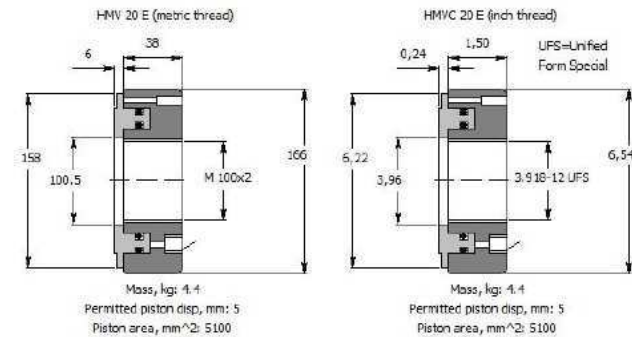
Both versions of the SKF Drive-up Method program are very user-friendly. I hope you'll try it and, like many other people, find that it makes the feeler gauge method obsolete.

Philippe Gachet
Senior technical consultant
SKF Pulp & Paper global segment
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Fig 22: page 1 of report

HMV



Suitable tools	
Hydraulic nut	HMV 20 E/HMVC 20 E
Hydraulic pump with special pressure gauge	SKF 729124 DU for nuts <= HMV 54E SKF TMJL 100DU for nuts <= HMV 92E SKF TMJL 50DU for nuts <= HMV 200E
Dial indicator	SKF TMCD 5P or SKF TMCD 10R

Mounting procedure

1. Lightly oil all mating surfaces with a thin oil, e.g. SKF LHM 300 at 20°C.
2. Drive the bearing up to the starting position by applying correct pump pressure or force.
3. Drive the bearing up on the taper the required distance while measuring the axial movement of the HMV piston.

Complete bearing designation	
Machine no	
Position	
Mounted by	
Date	

Fig 23: page 2 of report

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