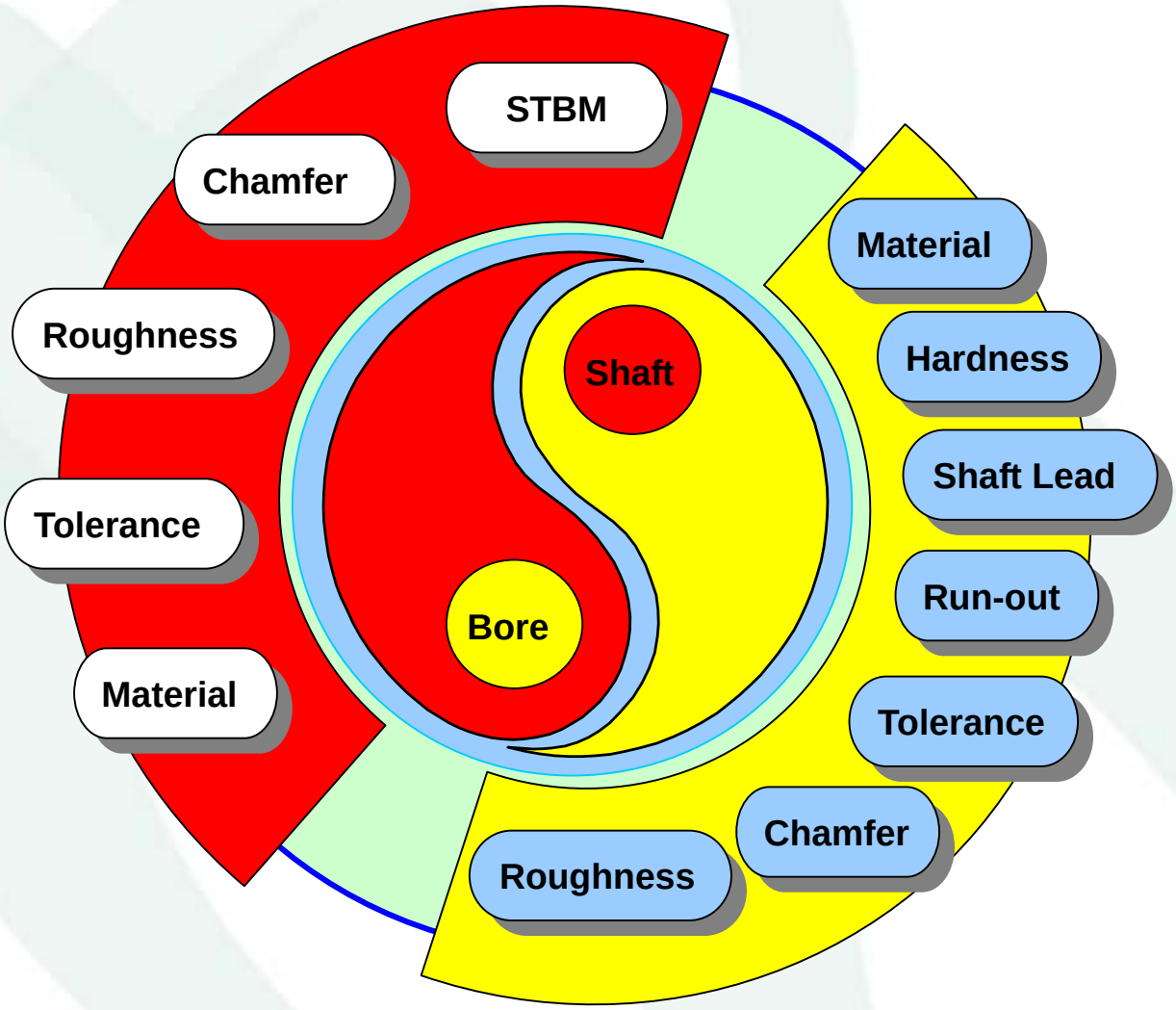
Chapter 6 Seal and Bore Recommendations

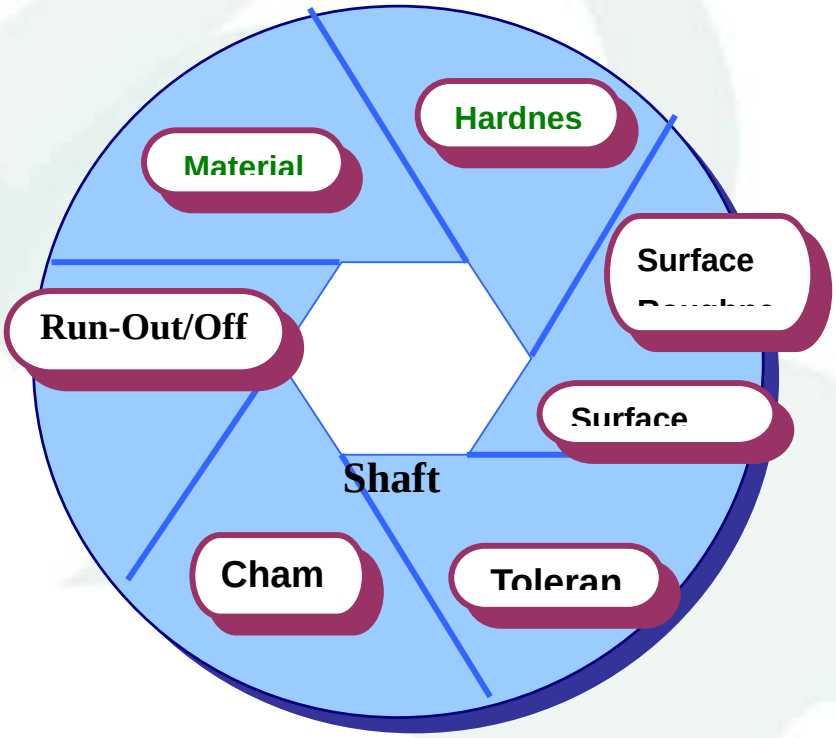
6.1 Installation requirement for shaft and bore

Shaft and bore design have a great influence on seal life. The figure below shows the essential factors for shaft and bore design.



6.2 Shaft:

In order to have a good sealing function, the shaft should be carefully examined. We must consider shaft material, surface roughness, hardness, chamfer, tolerance, run-out, and surface finish.



6.2.1 Material:

Seals perform best on a medium carbon steel or stainless steel shaft. Heat treatment or nitriding is especially recommended. To seal water at low surface velocity, stainless steel is more suitable.

6.2.2 Surface roughness:

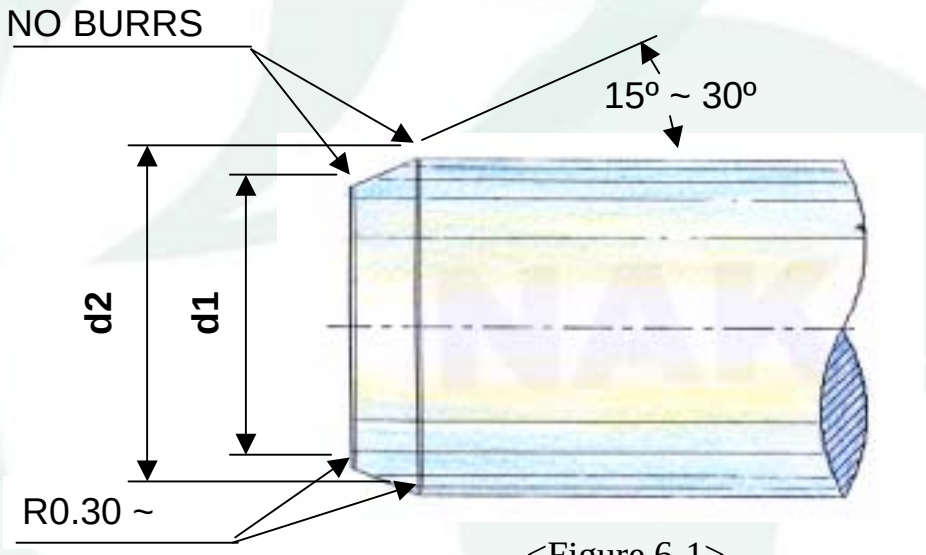
We recommend the shaft be machined to a surface roughness of R_a =0.2~0.8 μ m (R_z =1~5 μ m) R_{max}6.3 μ m. In the area of the contact surface, any rifling marks are not permitted.

6.2.3 Hardness:

In the area where the sealing lip contacts the shaft, we recommend that the minimum hardness is 45 HRC. Where lubrication is doubtful, abrasive matter is present of shaft speed is greater than 14 m/s 55 HRC is preferred.

6.2.4 Chamfer:

Chamfer design can guide seal lip to be installed on the proper position. We recommend the chamfer angle is 15° to 30°(Figure 6-1). Burrs on the chamfer is not allowed. The recommended size for chamfer is shown as Table 6-1.



<Figure 6-1>

Dimension	d2-d1	Dimension	d2-d1
≦ 10.00	1.5	50.01 ~ 70.00	4.0
10.01 ~ 20.00	2.0	70.01 ~ 95.00	4.5
20.01 ~ 30.00	2.5	95.01 ~ 130.00	5.5
30.01 ~ 40.00	3.0	130.01 ~ 240.00	7.0
40.01 ~ 50.00	3.5	240.01 ~ 500.00	11.0

<Table 6-1> Recommended size for chamfer

6.2.5 Tolerance:

The recommended tolerances that according to RMA and ISO are in <Table 6-2> and <Table 6-3>.

Shaft diameter	Tolerance
Up to 4.000	+/-0.003
4.001 ~ 6.000	+/-0.004
6.001 ~ 10.000	+/-0.005
10.001 以上	+/-0.006

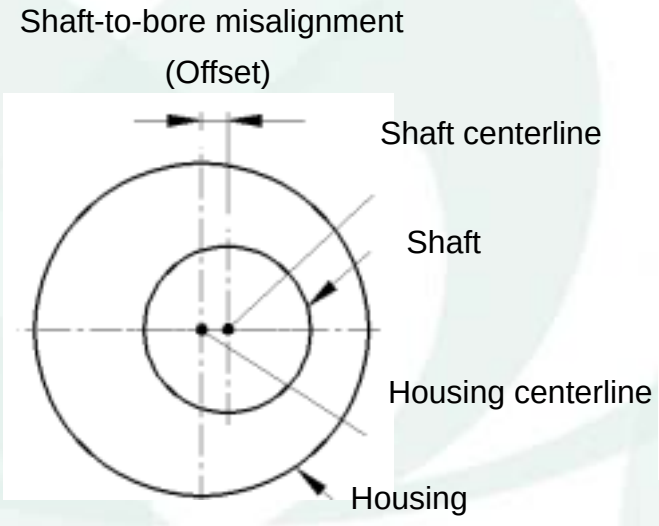
<Table 6-2>Shaft tolerance in imperial

Shaft diameter	Tolerance
Up to 3.00	+0.000/-0.060
3.01 ~ 6.00	+0.000/-0.075
6.01 ~ 10.00	+0.000/-0.090
10.01 ~ 18.00	+0.000/-0.110
18.01 ~ 30.00	+0.000/-0.130
30.01 ~ 50.00	+0.000/-0.160
50.01 ~ 80.00	+0.000/-0.190
80.01 ~ 120.00	+0.000/-0.220
120.01 ~ 180.00	+0.000/-0.250
180.01 ~ 250.00	+0.000/-0.290
250.01 ~ 315.00	+0.000/-0.320
315.01 ~ 400.00	+0.000/-0.360
400.01 ~ 500.00	+0.000/-0.400

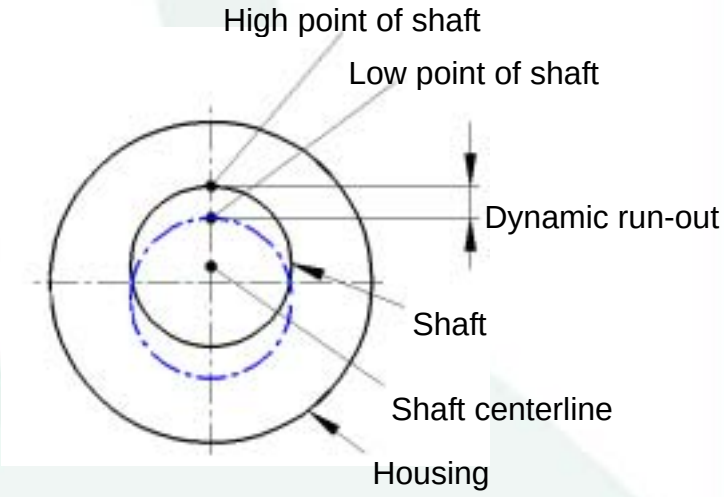
<Table 6-3> Shaft tolerance in metric

6.2.6 Eccentricity:

Two types of shaft eccentricity affect seal performance. They are dynamic run-out (double dynamic eccentricity) and offset (shaft to bore misalignment STBM or static eccentricity). The allowable eccentricity is referred in figure 6-2 and 6-3.



<Figure 6-2>



<Figure 6-3>

Figure 6-4 and Figure 6-5 illustrate the definitions and the limits about shaft configurations to eccentricity that can affect seal performance. The accompanying graphs show tolerable levels for each type.

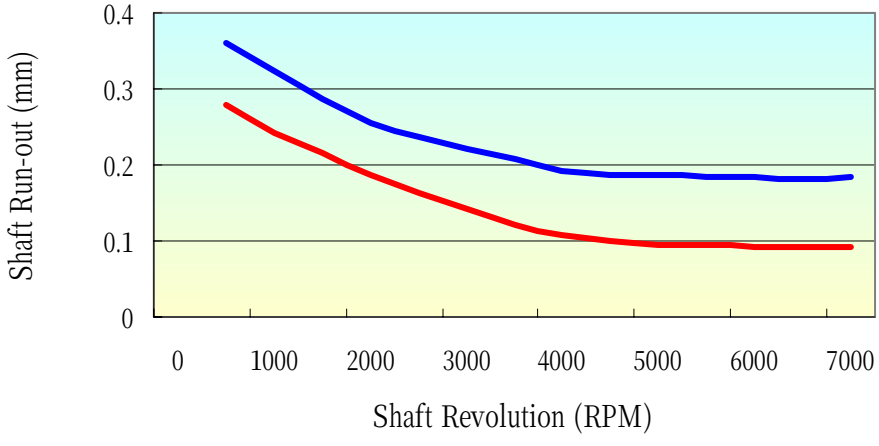
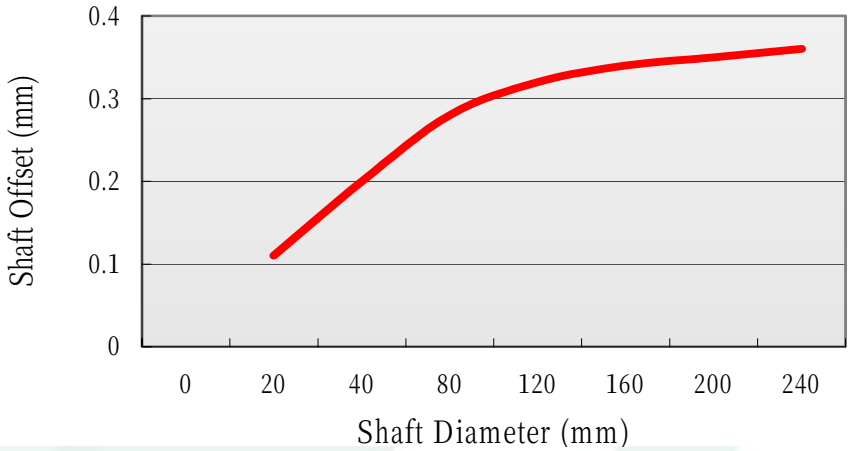


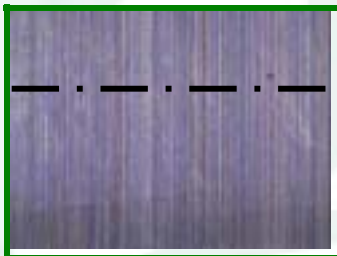
Figure 6-4



<Figure 6-5>

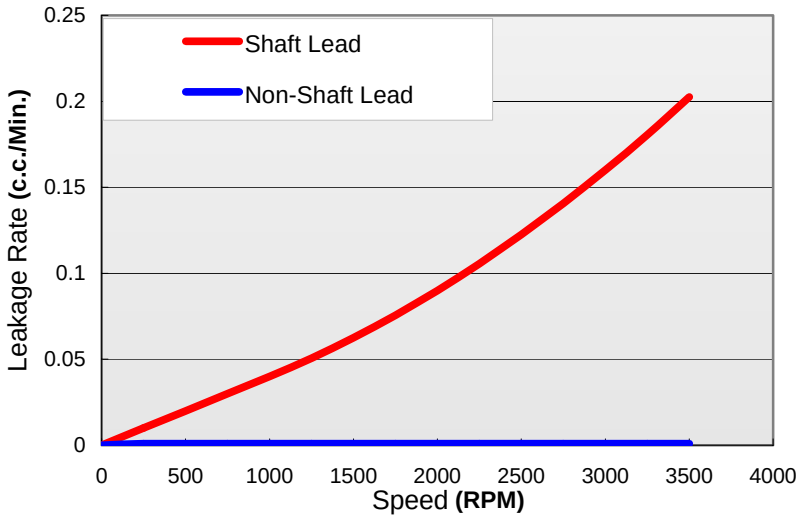
6.2.7 Finish:

Figure 6-6 shows the proper and improper surface finish.

 ○ Centerline Scale:	Proper surface finish. The finishing trace perpendicular to centerline
 ✗ Centerline Scale:	**Improper surface finish. The finishing trace incline, oil will leak in a certain rotating direction.**
 ✗ Centerline Scale:	**Improper surface finish. The finishing trace incline, oil will leak in a certain rotating direction.**
 ○ Centerline Scale:	Proper surface finish. The finishing trace perpendicular to centerline

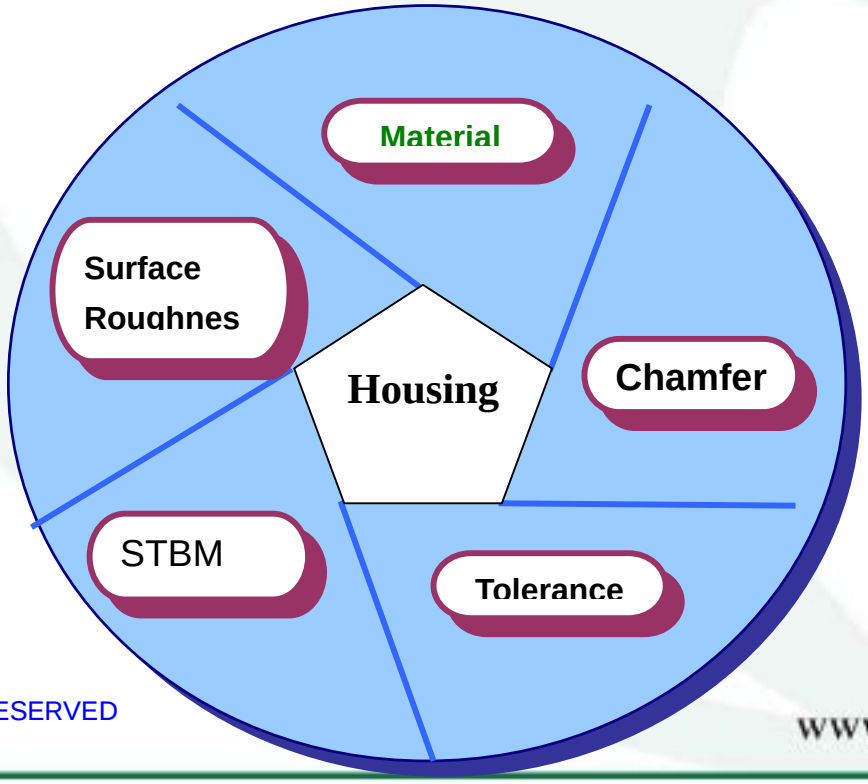
<Figure 6-6>

If the shaft finish trace is not perpendicular to centerline, which is so-called Shaft Lead, oil will leak in a certain rotating direction. Leakage rate: The figure below shows the Shaft Lead and Non-Shaft Lead leakage rate comparison.



6.3 Housing:

For optimum seal performance, consideration must also be given to the housing. We have to consider material, surface roughness, chamfer, and tolerance.



6.3.1 Material:

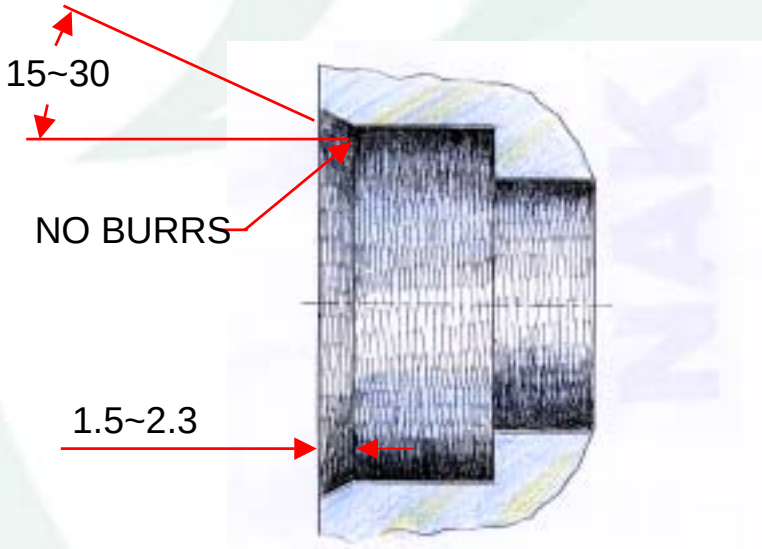
Steel and cast iron provide a good surface for both rubber and mental O.D. seals. For soft alloy (aluminum) housings, seals with rubber O.D. provide a better sealing capacity.

6.3.2 Roughness:

The housing inside diameter roughness is 10 μ inch Ra or 2.5 μ mRa for mental O.D. seals and 150 μ inch or 3.75 μ mRa for rubber covered O.D.

6.3.3 Chamfer:

Chamfer design ease installation. The recommended design is shown in <Figure 6-7>.



< Figure 6-7>

6.3.4 Tolerance:

Housing tolerances according to RMA and ISO is shown in <Table 6-4> and <Table 6-5>.

Bore diameter	Tolerance
Up to 3.000	+/-0.001
3.001 ~ 7.000	+/-0.0015
7.001 ~ 12.000	+/-0.002
12.001 ~ 20.000	+/-0.003
20.001 ~ 40.000	+/-0.004
40.001 ~ 60.000	+/-0.006

<Table 6-4>Housing tolerance in imperial

Bore diameter	Tolerance
Up to 10.00	+0.022/-0.000
10.01 ~ 18.00	+0.027/-0.000
18.01 ~ 30.00	+0.033/-0.000
30.01 ~ 50.00	+0.039/-0.000
50.01 ~ 80.00	+0.046/-0.000
80.01 ~ 120.00	+0.054/-0.000
120.01 ~ 180.00	+0.063/-0.000
180.01 ~ 250.00	+0.072/-0.000
250.01 ~ 315.00	+0.081/-0.000
315.01 ~ 400.00	+0.089/-0.000
400.01 ~ 500.00	+0.097/-0.000

<Table 6-5>Housing tolerance in metric