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Sleeve Type Half Bearings

RATIONALE

The technical report covers technology, products, or processes which are mature and not likely to change in the foreseeable future.

STABILIZED NOTICE

This document has been declared "Stabilized" by the SAE Powertrain Systems Group and will no longer be subjected to periodic reviews for currency. Users are responsible for verifying references and continued suitability of technical requirements. Newer technology may exist.

Foreword—This Document has not changed other than to put it into the new SAE Technical Standards Board Format.

1. Scope—This SAE Standard defines the normal dimensions, dimensioning practice, tolerances, specialized measurement techniques, and glossary of terms for bearing inserts commonly used in reciprocating machinery.

The standard sizes cover a range which permits a designer to employ, in proper proportion, the durability and lubrication requirements of each application, while utilizing the forming and machining practices common in manufacture of sleeve type half bearings.

Not included are considerations of hydrodynamic lubrication analysis or mechanical stress factors of associated machine structural parts which determine the nominal sizes to be used, selection of bearing material as related to load carrying capacity, and economics of manufacture. For information concerning materials, see SAE J459 and SAE J460.

These suggested sizes provide guidelines which may result in minimal costs of tooling but do not necessarily represent items which can be ordered from stock.

2. References

2.1 Applicable Publications—The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J459—Bearing and Bushing Alloys
SAE J460—Bearing and Bushing Alloys—Chemical Composition of SAE Bearing and Bushing Alloys

3. Definitions—(See Figure 1.)

3.1 Annular Oil Groove—A groove, uniform in cross section, through the entire 180 degree arc of the half shell, installed for the purpose of promoting oil flow from the center to the edges of the bearing and also for the creation of a constant and uniform oil supply from main journals to connecting rod journals by means of drilled passages in the crankshaft. Sometimes an annular oil groove is used near the end of a straight shell bearing for the purpose of draining oil away from the seal.

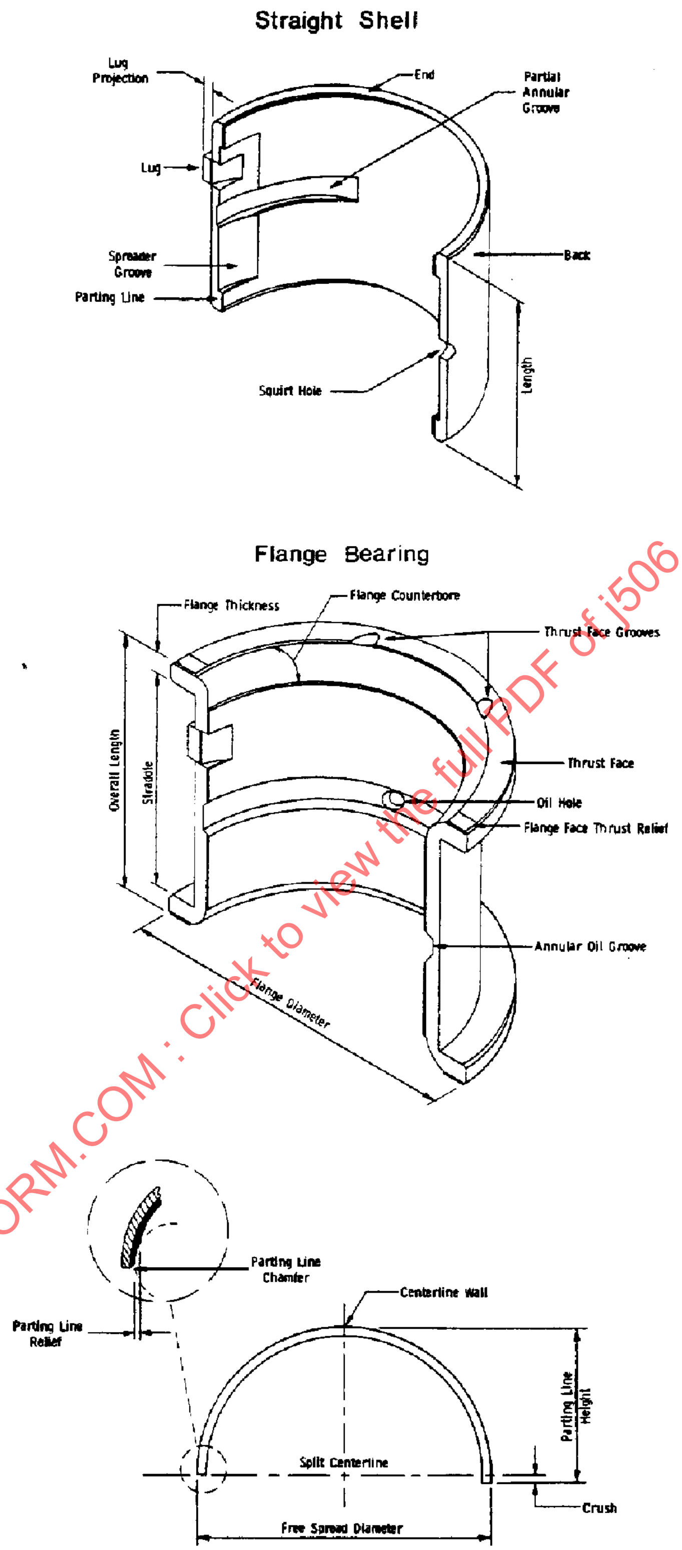


FIGURE 1—ILLUSTRATION OF COMMON BEARING CHARACTERISTICS AND TERMINOLOGY

3.2 Back—The steel OD of half shell bearings.

3.3 Bimetal—A type of bearing construction in which a single layer of bearing material is bonded to a steel backing. A common example of this is a babbitt bearing. (See Trimetal.)

3.4 Bore or Housing ID—The diametral size of the housing into which the bearing is assembled. The housing ID which supports and retains the bearing in assembly. (See Gage.)

3.5 Bore Distortion—The elastic deformation of the housing which occurs because of the stress imposed by interference fit between housing ID and assembled bearing OD. Magnitude of bore distortion is normally a small value, but because housings generally have nonuniform cross sections, adjustments to the concentricity of the bearing walls are made to accommodate various degrees of nonuniform outward displacement of the housing. These adjustments to the bearing wall are normally achieved by controlling bearing eccentricity. Also, frequently considered are distortions produced by external or inertial loads. (See Eccentricity.)

3.6 Centerline Wall—The bearing wall thickness at a location 90 degrees from the parting lines. Sometimes called vertical centerline.

3.7 Crush—The amount by which circumferential length of a half shell exceeds one half the circumference of the housing ID. This excess length ensures the interference fit which holds the mating half shells in place. (See Parting Line Height.)

3.8 Eccentricity—The gradual reduction in bearing wall thickness, normally from centerline wall to the parting line relief, which tends to create additional diametral clearance between the bearing and journal near the parting lines. The magnitude of eccentricity may vary as dictated by studies of bore distortion characteristics. Except in rare instances, eccentricity is positive, meaning that the wall thickness near the parting line is less than the wall thickness at the vertical centerline.

3.9 Ends—The surfaces or faces which determine the two planes that define the bearing length.

3.10 Flange Counterbore—Machined radius to aid in lubricant flow and clearance with crankshaft fillet.

3.11 Flange Diameter—The OD measurement of flanges in the assembled state. The maximum flange OD should not exceed 1.3 times the maximum housing ID if forming difficulties are to be avoided.

3.12 Flange Thickness—The thickness of the flange on a flange bearing.

3.13 Free Spread Diameter—The diametral dimension of the half shell bearing in its free state. Normally, this dimension will exceed the maximum housing ID by at least 0.5 mm (0.020 in) for straight shells, and by about one-tenth this amount for flange bearings. This deliberate increased diameter aids assembly by ensuring that each half shell will have sufficient friction within its intended housing to remain in place during engine assembly operations. Its exact values are not critical.

3.14 Gage Diameter—The numerical bore size which is equal to the high limit dimension of the housing ID.

3.15 Length—The overall axial dimension of the half bearing.

3.16 Lining—The bearing material which is bonded to the steel back.

3.17 Lug—The projection from the OD of the bearing half shell provided on straight shell bearings to ensure proper axial location of the half shell in the housing. It is sometimes referred to as a tang, notch, or nick. Lugs are not intended to secure the bearing against rotation within the housing. Crush does that. Lugs should be on one parting line only. Commonly, lugs on both half bearings are assembled on the same side of the housing.

3.18 Lug Projection—The dimension from the bearing back to the outside surface of the lug at the parting line.

3.19 Oil Hole—A hole through the bearing shell which is used to index with drilled oil passages in the bearing's housing. (See Squirt Hole.)

3.20 Overall Length—The dimension between thrust faces on a common flange bearing and equal to the maximum axial dimension of the bearing.

3.21 Overlay—A thin surface layer of soft bearing material on a harder lining material which, in turn, becomes an intermediate layer of high load capacity. Normally, overlays are deposited by electroplating, and have a nominal thickness of 0.025 mm (0.001 in) or less. The result is then a trimetal bearing. (See Trimetal.)

3.22 Partial Groove—This is a groove similar in nature and cross section to the full annular groove, generally for the purpose of extending the full annular groove into a mating half bearing but preventing its extension into the most heavily loaded portion of a main bearing.

3.23 Parting Line—The face or surface of the half shell which butts against a mating surface of another half shell to form a full round bearing.

3.24 Parting Line Chamfer—A small chamfer added to the inside surface of the parting line along the entire length of the bearing to eliminate sharp disturbances to the oil flow which could otherwise result from minor conditions of cap shift or misalignment.

3.25 Parting Line Height—A measurement of half shell circumference normally made with the parting lines of the bearing loaded in compression and with the back of the bearing seated and conforming to the ID of a precisely made inspection block which is normally equal in size to the gage diameter. The measured difference between parting line height and the inspection block radius equals the measured indicator crush. The load under which the bearing is measured is specified to be large enough to ensure adequate seating and reproducible measurements without causing permanent deformation of the bearing.

3.26 Parting Line Relief—The removal of bearing material near the parting line to aid smoothness of oil flow where the parting lines of the half shells butt against each other.

3.27 Spreader Groove—A cross groove, generally in a normally unloaded area, used to promote oil flow without increasing clearances.

3.28 Squirt Hole—A small cutout at parting line surface, sometimes used in rod bearings to provide a squirt of oil onto cylinder walls during operation.

3.29 Straddle—The dimension between the inside surfaces of the flanges on a flange bearing.

3.30 Thrust Face—That exterior portion of a flange bearing which runs against a mating thrust face of a shaft to control axial shaft movement and load.

3.31 Thrust Face Groove—A small groove incorporated into the thrust face for the purpose of promoting oil flow.

3.32 Trimetal—A type of bearing construction in which a heavy-duty bearing material (lining) is bonded to a steel back and then a thin layer of softer bearing material is applied to the ID of the high-strength bearing material. Normally, this surface layer is obtained by electroplating and is referred to as the overlay, or overlay plate. It is thin enough that the high strength of the intermediate layer determines the ultimate bearing strength from a fatigue standpoint. This type of bearing is normally used in heavy-duty applications. (See Bimetal.)

3.33 Wall—The total thickness of the bearing half shell which is the sum of the steel back thickness, lining thickness and, when applicable, overlay thickness. When given without other qualifications, it is normally assumed to be centerline wall.

4. Applications and General Considerations**—**Sleeve type half bearings, sometimes called thinwall bearings, are most commonly found in the connecting rod and main bearing positions of gasoline and diesel engines used in the automotive, construction equipment, and farm equipment industries. Normally, they are lubricated with oil which is supplied under pressure.

Much theoretical and experimental work has been done with respect to the operation of sleeve type bearings, and both bearing manufacturers and large volume users are familiar with the theories of hydrodynamic lubrication so they can perform the associated calculations with relative ease. The theory involves the development of pressures within an oil film as a result of a journal rotating inside the bearing. Shearing of the oil film generates heat; however, oil is supplied in sufficient quantity to control temperatures and viscosities. For a given set of operating conditions, calculations can be made for oil film thickness and expected operating temperatures. Sometimes, such calculations highlight potential problems and point the way for modification to the original design. Such changes can involve oil viscosity, oil supply pressure, geometry of the bearing, clearances, grooving, and other factors.

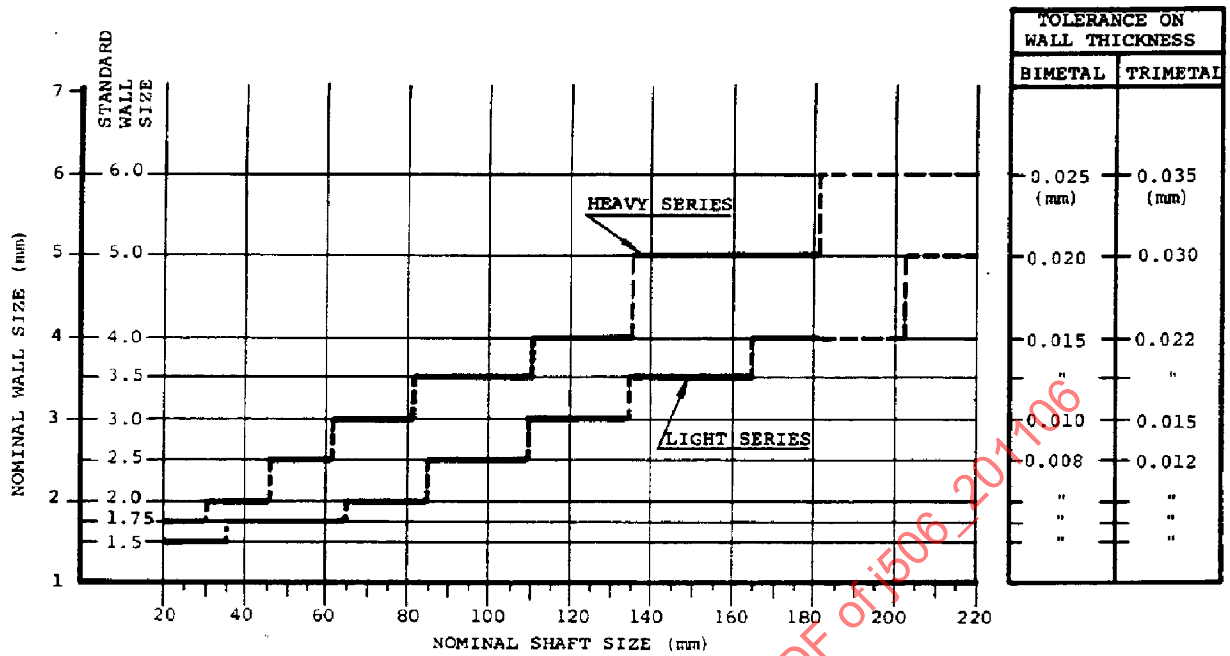
Mechanically, a thinwall bearing should be flexible and elastic in comparison with the housing. When the housing is made round and true in relation to mating parts, the designer can be confident that the bearing, with its relative flexibility, will conform to the housing, thereby ensuring desired shape and alignment. Also, this flexible characteristic permits the bearings to be economically made from material which generally is prepared as a continuous strip from which the bearings are blanked, formed, and precisely machined, providing a finished bearing of high quality and reliability.

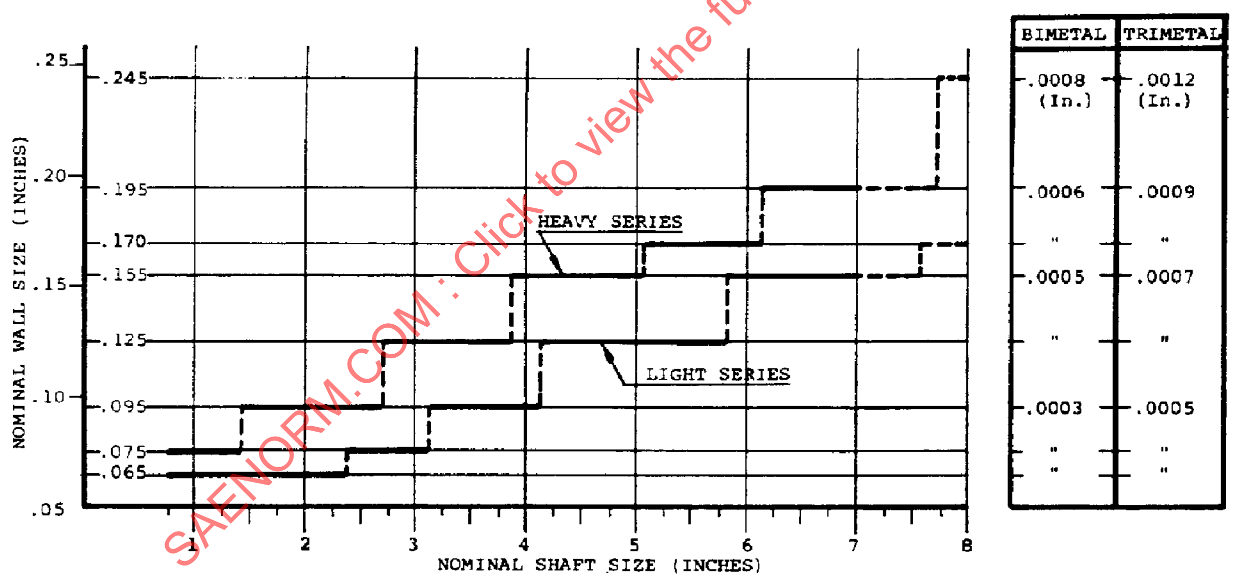
5. Wall Size Recommendations**—**Wall sizes for various shaft sizes are presented graphically in Figure 2. The recommended wall sizes are based on the most common bearing strip preparations.

Corresponding housing sizes can be easily determined by adding to nominal shaft size, two times the bearing wall plus the diametral clearance.

Regarding the selection of light or heavy series wall sizes, the following can be used as a guide:

a. SAE Light Series—Connecting rod bearings for passenger car and similar light-duty engines.
b. SAE Heavy Series—Main bearings for passenger car and similar light-duty engines. Connecting rod and main bearings for heavy-duty engines.
c. SAE Extra-Heavy Series—Main bearings for heavy-duty engines sometimes use the next heavier wall size for a given shaft size than SAE Heavy Series.





NOTE: Strip manufacturing practice may not be available from all manufacturers for some wall thicknesses above.

For shaft sizes over 180 mm (7.0 In.) designs are determined by individual case rather than by conformance to set practices.

FIGURE 2—BEARING WALL THICKNESS RECOMMENDATIONS

6. ***Standard Features and Tolerances***—The following standards generally are referred to from Figures 2, 3, and 4.

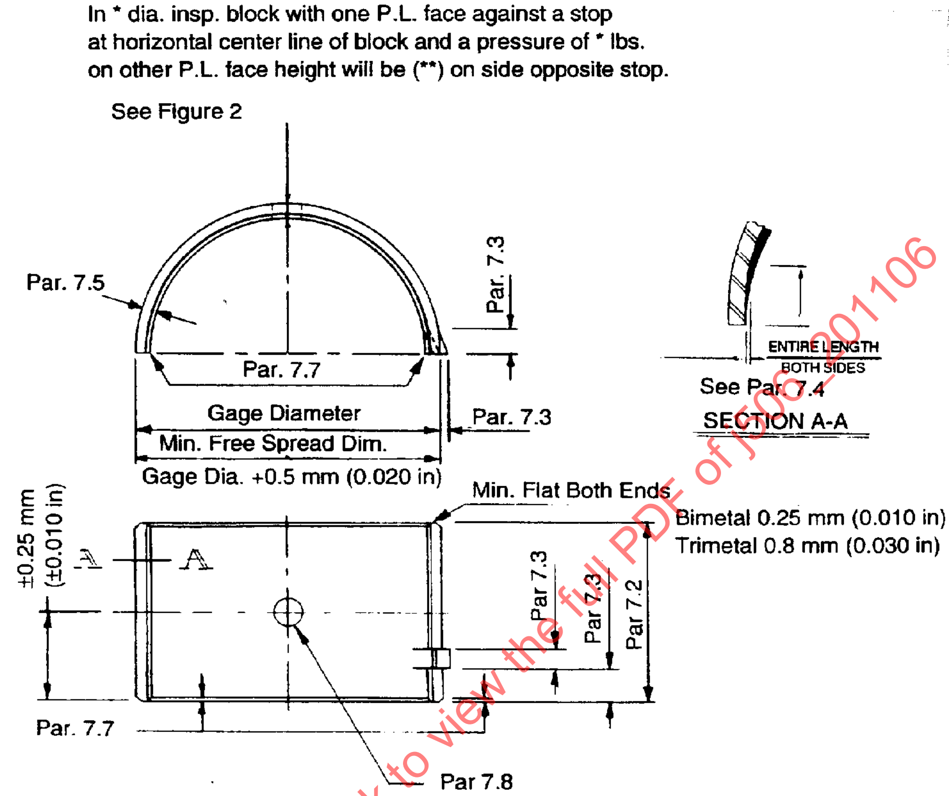
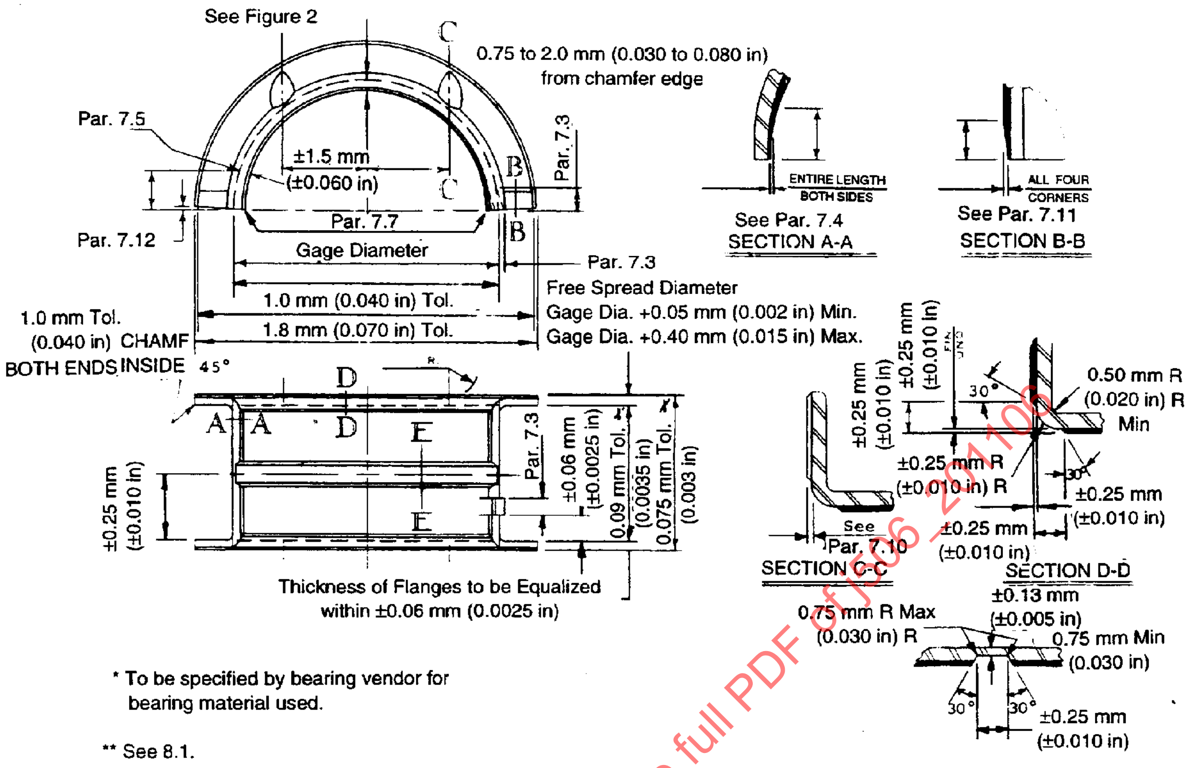


FIGURE 3—STANDARD TOLERANCES OF STRAIGHT SHELL BEARINGS



* To be specified by bearing vendor for bearing material used.

** See 8.1.

★ Measured in free state at a position just above tangent point of flange radius on bearing back.

Limits on angular oil hole locations ±1 degree, all other angles ±2 degrees

FIGURE 4—STANDARD TOLERANCES OF FLANGED BEARINGS

6.1 Wall Thickness—The tolerance on wall thickness will depend upon whether the bearing is bimetal or trimetal. Recommended values are shown in Figure 2.

6.2 Length—Bearing lengths will be determined by the application. Tolerances for various sizes are shown in Table 1.

TABLE 1A—BEARING LENGTH TOLERANCES (MM)

Shaft Dia.	Limits
20–120	+0 –0.25
125–260	+0 –0.50

TABLE 1B—BEARING LENGTH TOLERANCES (IN)

Shaft Dia.	Limits
0.75–5	+0 –0.010
5–10	+0 –0.020

6.3 Locating Lugs and Lug Slots—Dimensions of the locating lug and the notch in the housing should be as shown in Figures 5 and 6, and Tables 2, 3, and 4.

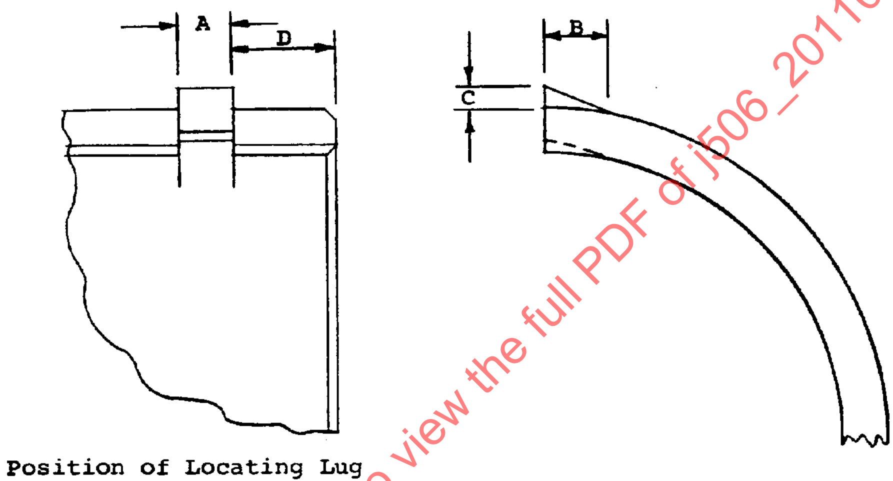


FIGURE 5—BEARING LUG DIMENSIONING

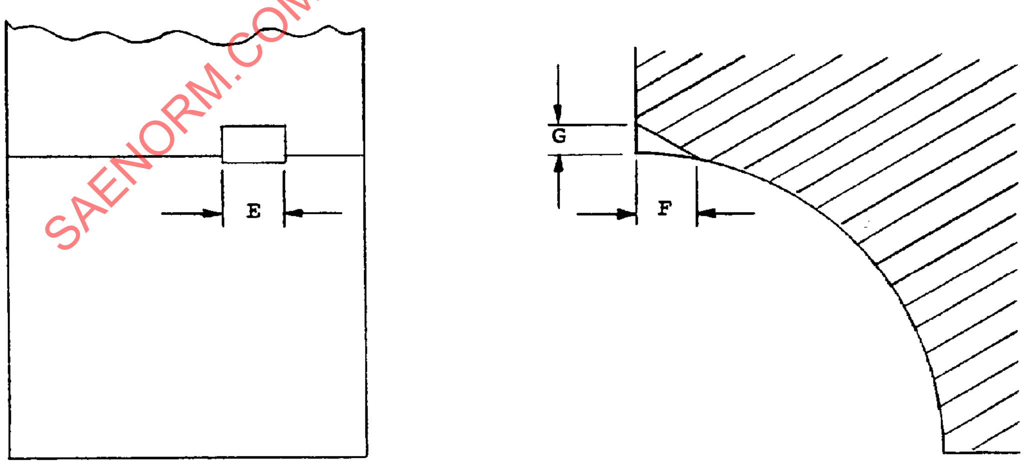


FIGURE 6—HOUSING LUG SLOT

TABLE 2A—RECOMMENDED LUG DIMENSIONS (mm)

Shaft Dia.	A	B	C
20– 40	4.45/ 4.57	3.0/4.0	0.8/1.1
40– 65	4.45/ 4.57	5.0/6.0	1.0/1.3
65– 85	6.00/ 6.20	5.0/6.0	1.2/1.5
85–200	9.20/ 9.35	8.0/9.0	1.5/1.65
200–260	12.00/12.50	8.0/9.0	1.5/1.65

TABLE 2B—RECOMMENDED LUG DIMENSIONS (in)

Shaft Dia.	A	B	C
0.75– 1.50	0.175/0.180	0.125/0.155	0.031/0.041
1.50– 2.50	0.175/0.180	0.190/0.220	0.031/0.041
2.50– 3.50	0.238/0.243	0.190/0.220	0.045/0.055
3.50– 7.50	0.363/0.368	0.310/0.340	0.055/0.065
7.50–10.00	0.488/0.493	0.310/0.340	0.055/0.065

TABLE 3A—TOLERANCE ON LUG LOCATION (mm)

Shaft Dia.	Limits on D
20–120	+0.15 –0
125–260	+0.20 –0

TABLE 3B—TOLERANCE ON LUG LOCATION (mm)

Shaft Dia.	Limits on D
0.75–5.0	+0.005 –0
5.0–10.0	+0.008 –0

TABLE 4A—TOLERANCES AND SIZES OF HOUSING LUG SLOTS (MM)

Shaft Dia.	E	F	G
20– 40	4.70– 4.82	5.60	1.57
40– 65	4.70– 4.82	7.15	1.78
65– 85	6.30– 6.42	7.15	1.98
85–200	9.48– 9.60	10.30	2.36
200–260	12.65–12.78	10.30	2.36

TABLE 4B—TOLERANCES AND SIZES OF HOUSING LUG SLOTS (IN)

Shaft Dia.	E	F	G
0.75– 1.50	0.185–0.190	0.219	0.062
1.50– 2.50	0.185–0.190	0.281	0.070
2.50– 3.50	0.248–0.253	0.281	0.078
3.50– 7.50	0.373–0.378	0.406	0.093
7.50–10.00	0.498–0.503	0.406	0.093

6.3.1 DIMENSIONING

6.3.1.1 The lug may be produced at the end of the bearing, in which case D = 0.

6.3.1.2 Where the lug is not at the end of the bearing, minimum D = 1.5 times wall thickness, but not less than 3 mm (0.125 in).

6.3.1.3 If there is a groove in the bearing, the edge of the lug must be 3 mm (0.125 in) minimum from the edge of the groove, or the edge of the lug may extend into the groove.

6.3.1.4 Normally, on ungrooved bearings, each lug of mating half shells will be offset from centerline by 1.5 mm (0.06 in) so the lugs will be at least 3 mm (0.125 in) apart at assembly.

6.3.1.5 On flange bearings, minimum dimension from inside edge of flange to nearest edge of lug should be 3 mm (0.125 in).

6.4 Parting Line Relief—Specifications in Figure 7 and Table 5. See Glossary.

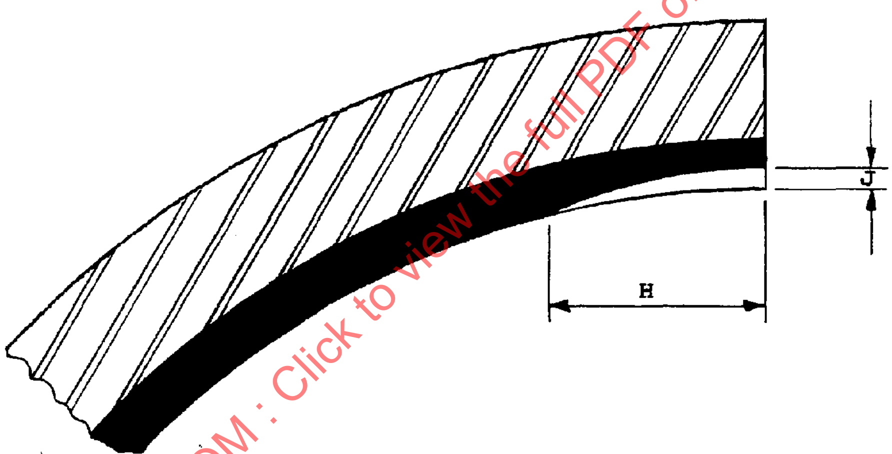


FIGURE 7—PARTING LINE RELIEF

TABLE 5A—SIZES OF PARTING LINE RELIEF (mm)

Shaft Dia.	H (Nom.)	J
20– 25	4.0	0.012–0.038
25– 41	4.0	0.025–0.050
41– 50	5.0	0.025–0.050
50– 65	5.5	0.025–0.050
65– 75	6.0	0.025–0.050
75– 86	7.8	0.025–0.050
86–105	9.7	0.025–0.050
105–125	11.0	0.025–0.050
125–145	23.0	0.050–0.080
145–170	26.0	0.050–0.080
170–200	30.5	0.050–0.080
200–260	35.0	0.050–0.080

TABLE 5B—SIZES OF PARTING LINE RELIEF (IN)

Shaft Dia.	H (Nom.)	J
0.75– 1.00	0.16	0.0005–0.0015
1.00– 1.63	0.16	0.001 –0.002
1.63– 2.00	0.19	0.001 –0.002
2.00– 2.50	0.22	0.001 –0.002
2.50– 2.90	0.25	0.001 –0.002
2.90– 3.40	0.31	0.001 –0.002
3.40– 4.15	0.38	0.001 –0.002
4.15– 5.00	0.44	0.001 –0.002
5.00– 5.75	0.90	0.002 –0.003
5.75– 6.75	1.02	0.002 –0.003
6.75– 7.75	1.20	0.002 –0.003
7.75–10.00	1.38	0.002 –0.003

6.5 **Eccentric Bore—**In most applications, bearings have eccentric bores, i.e., the wall thickness of the bearing is gradually reduced from the centerline wall to the parting lines. Eccentricity equals the difference between centerline wall and eccentric wall at height H. The tolerance on eccentricity shall be the same as the wall tolerance which varies with the total wall. See Figure 2. The position H at which eccentric wall is measured shall be in accordance with Table 6. See Glossary for comments on eccentricity.

TABLE 6A—LOCATION OF ECCENTRIC WALL MEASUREMENT (mm)

Shaft Dia.	Height H (Nom.)
20– 25	4.8
25– 41	6.4
41– 86	9.7
86–145	16.0
145–260	25.4

TABLE 6B—LOCATION OF ECCENTRIC WALL MEASUREMENT (in)

Shaft Dia.	Height H (Nom.)
0.75– 1.00	0.19
1.00– 1.63	0.25
1.63– 3.40	0.38
3.40– 5.75	0.62
5.75–10.00	1.00

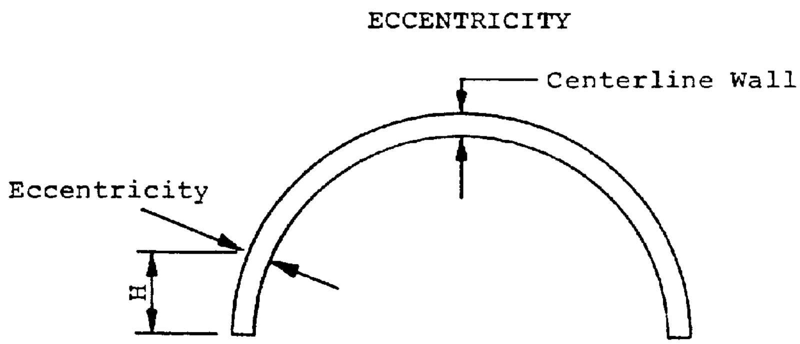


FIGURE 8—ECCENTRICITY

6.6 Groove Forms—Groove sizes are determined by functional requirements. The following points should be considered when specifying grooves:

6.6.1 Preferred groove form is shown in Figure 9. Table 7 shows suggested sizes.

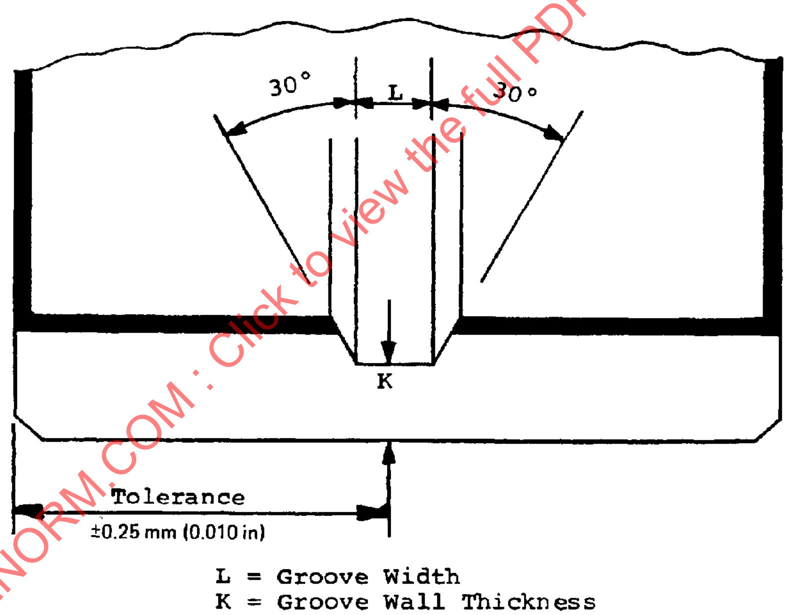


FIGURE 9—GROOVE DIMENSIONS

TABLE 7—STANDARD OIL GROOVE DIMENSIONS

Millimeters L	Inches L
1.50	0.057
2.00	0.071
2.50	0.094
3.00	0.125
4.00	0.155
5.00	0.187
6.00	0.235

6.6.2 For central annular grooves, the position should be specified as indicated in Figure 9.

6.6.3 The minimum wall thickness at the back of the groove should be the larger of the following two values:

a. 0.7 mm or 0.35 x bearing wall thickness (mm)
b. 0.028 in or 0.35 x bearing wall thickness (in)

The following limits, shown in Table 8, will apply to the size so determined. See Figure 9.

TABLE 8A—TOLERANCE ON WALL MEASUREMENT AT BASE OF GROOVE (mm)

Shaft Dia.	Limits on K
20–120	+0.20 –0
125–260	+0.35 –0

TABLE 8B—TOLERANCE ON WALL MEASUREMENT AT BASE OF GROOVE (in)

Shaft Dia.	Limits on K
0.75– 5.0	+0.008 –0
5.00–10.0	+0.014 –0

6.7 Chamfers—All sharp edges should be deburred. If machined chamfers are required, these are generally at 45 degrees with tolerance of ±0.3 mm (±0.010 in).

Parting line chamfers are generally 0.1/0.4 mm (0.005/0.015 in).

6.8 Oil Holes—Oil holes may be drilled or pierced before or after forming and are usually centrally located in the oil groove where applicable. All sharp edges should be removed.

Tolerance on the location of oil holes should be ±0.25 mm (±0.010 in) from the end of the bearing. Dimension the oil hole from the same end of the bearing that is used to dimension the lug.

6.9 Parting Line Height—Many factors must be considered in establishing recommended values for parting line height. For most applications, using cast iron or steel housings, Table 9 is satisfactory as a guideline.

After assembly of the bearings into the housing, then the actual total crush is the sum of: (a) indicator crush, (b) crush due to the load applied in the parting line height gage, (c) crush due to the housing bore being smaller than its maximum blueprint value.

See Section 8 for measurement procedures.

TABLE 9A—TYPICAL INDICATOR CRUSH (mm)

Dia.	Indicator Crush	Tolerance
20– 40	0.000	+0.038 –0
40– 90	0.013	+0.038 –0
90–110	0.025	+0.050 –0
110–150	0.038	+0.050 –0
150–200	0.050	+0.064 –0
200–260	0.076	+0.076 –0

TABLE 9B—TYPICAL INDICATOR CRUSH (in)

Dia.	Indicator Crush	Tolerance
0.75– 1.50	0.0000	+0.0015 –0
1.50– 3.50	0.0005	+0.0015 –0
3.50– 4.25	0.0010	+0.0020 –0
4.25– 6.00	0.0015	+0.0020 –0
6.00– 8.00	0.0020	+0.0025 –0
8.00–10.00	0.0030	+0.0030 –0