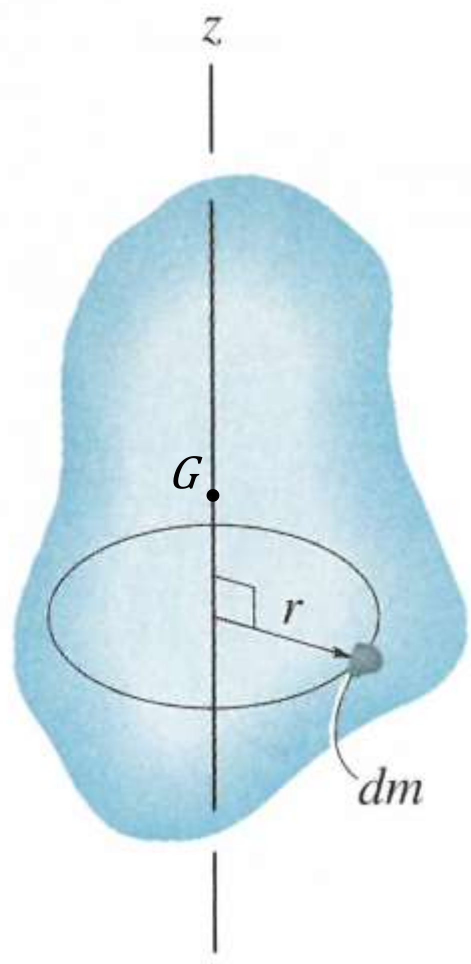
ELEVATOR DRIVE MACHINE DESIGN

ENGR 496/MCEN 4228
Advanced Machine Design

INERTIA



mass moment of inertia (WR^2)

$$I = \int_m r^2 \, dm \qquad \text{[lb-in}^2\text{]}$$

sum of moments applied to mass

$$\Sigma M_G = I_G \alpha$$

G = **center of mass**

INERTIA

sum of moments applied to mass

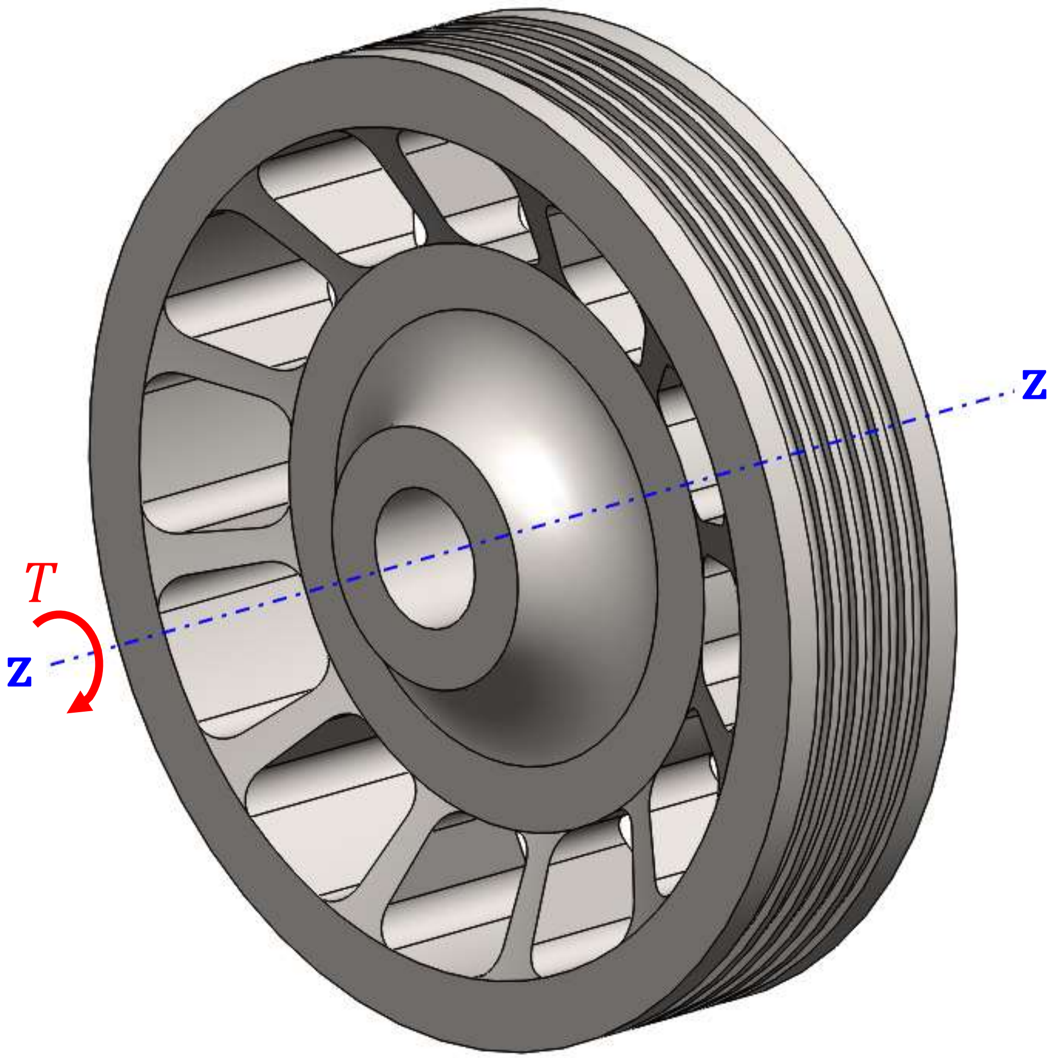
$$\Sigma M_G = I_G \alpha$$

$$T = I_z \alpha$$

$$T = I_z \frac{\omega_2 - \cancelto{0}{\omega_1}}{\Delta t}$$

$$T = I_z \frac{\omega_2}{\Delta t}$$

$$\Delta t = I_z \frac{\omega_2}{T}$$



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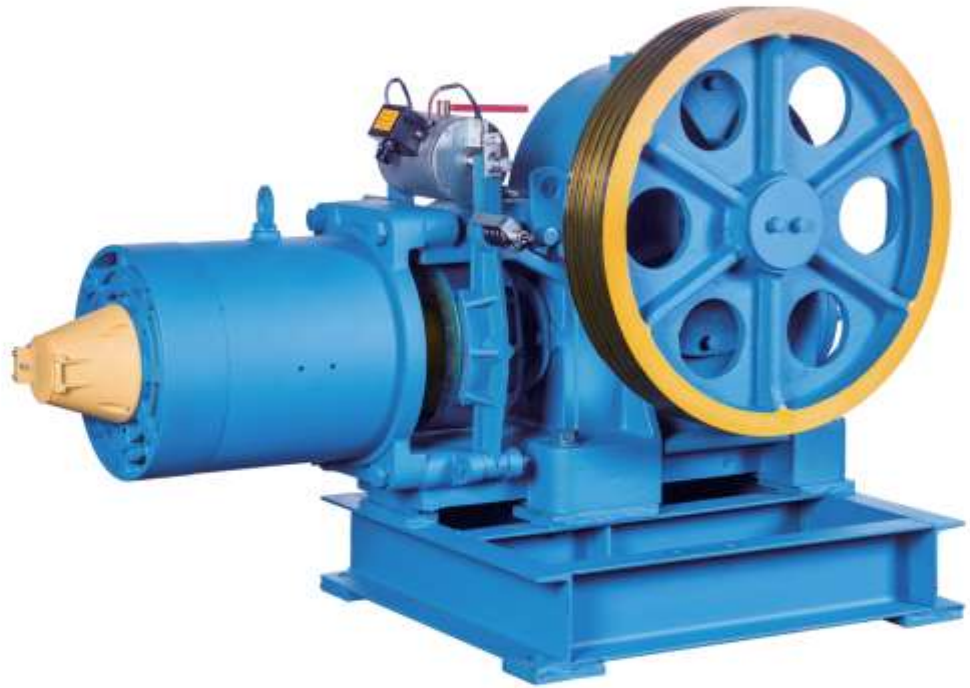
Torque required for angular acceleration of object

$$T = I_z \frac{\omega_2 - \omega_1}{\Delta t}$$



Delyord Worm Gears p. 4

Approximate WR^2 Values

Assuming uniform acceleration (or deceleration), the motor torque required to accelerate - or the brake torque required to decelerate - in a given time can be determined by the following:

$$T = \frac{WR^2_{WS} \times \Delta N}{3690t}$$

where

T	=	Torque in inch pounds
WR^2_{WS}	=	$lb\text{-}in^2$
ΔN	=	RPM change
t	=	Time in seconds

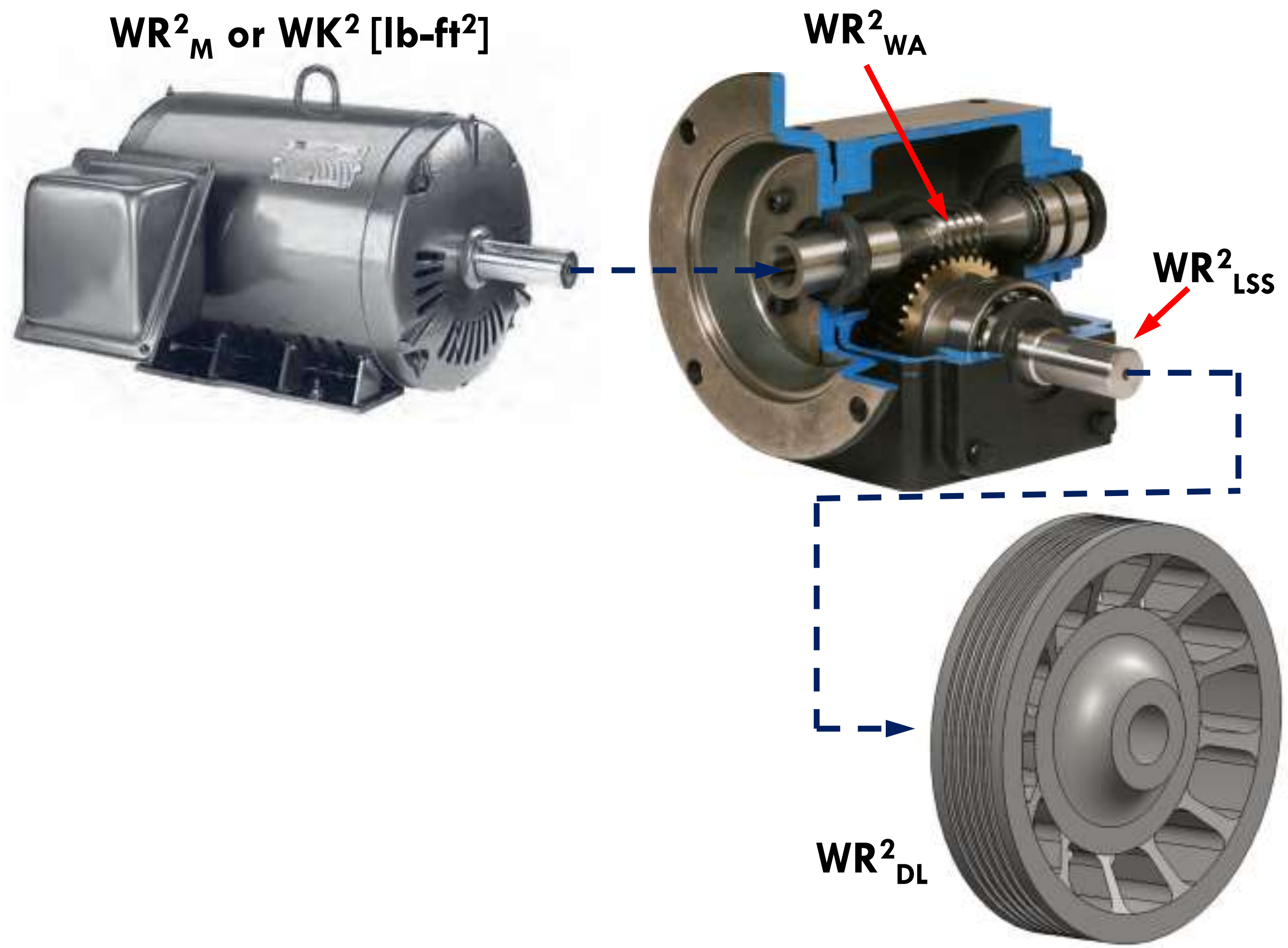
Listed in the table are approximate WR^2 values for standard single extended worm gear assemblies and standard low speed shaft assemblies for sets shown in this catalog.

$$WR^2_{WS} = \frac{WR^2_{LSS} + WR^2_{DL}}{(\text{ratio})^2} + WR^2_{WA} + WR^2_{M}$$

where

WR^2_{WS}	is	WR^2 of the system with respect to input shaft
WR^2_{LSS}	is	WR^2 of the reducer low speed shaft assembly
WR^2_{DL}	is	WR^2 of the driven load
WR^2_{WA}	is	WR^2 of the worm assembly
WR^2_{M}	is	WR^2 of the motor

INERTIA



Approximate WR² Values

Assuming uniform acceleration (or deceleration), the motor torque required to accelerate - or the brake torque required to decelerate - in a given time can be determined by the following:

$$T = \frac{WR^2_{WS} \times \Delta N}{3690t}$$

where

T	=	Torque in inch pounds
WR^2_{WS}	=	lb-in^2
ΔN	=	RPM change
t	=	Time in seconds

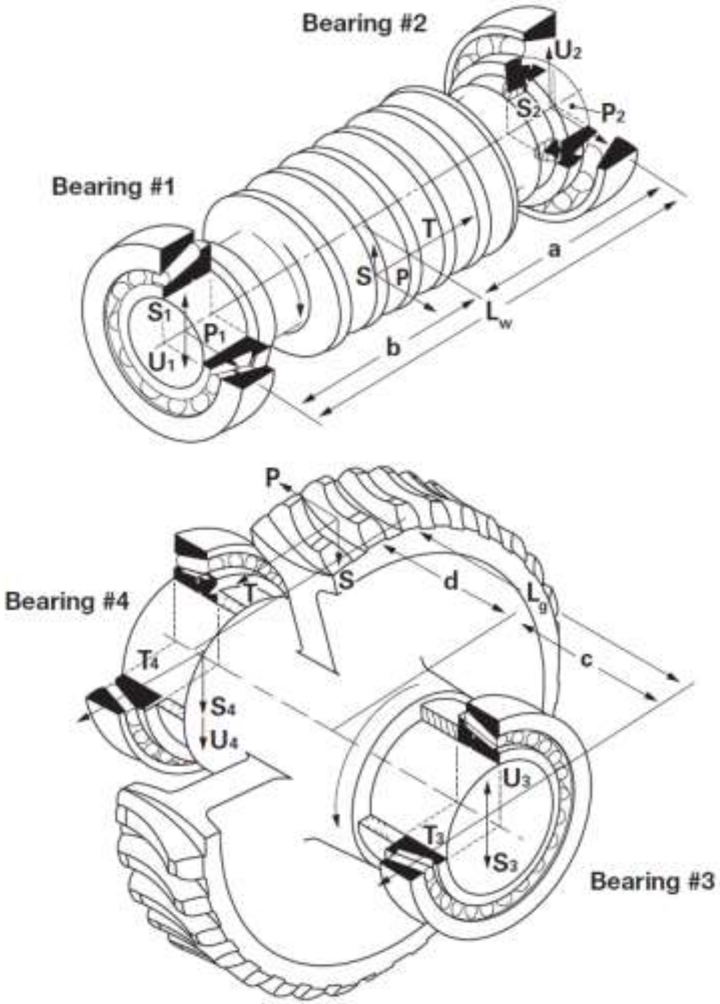
Listed in the table are approximate WR² values for standard single extended worm gear assemblies and standard low speed shaft assemblies for sets shown in this catalog.

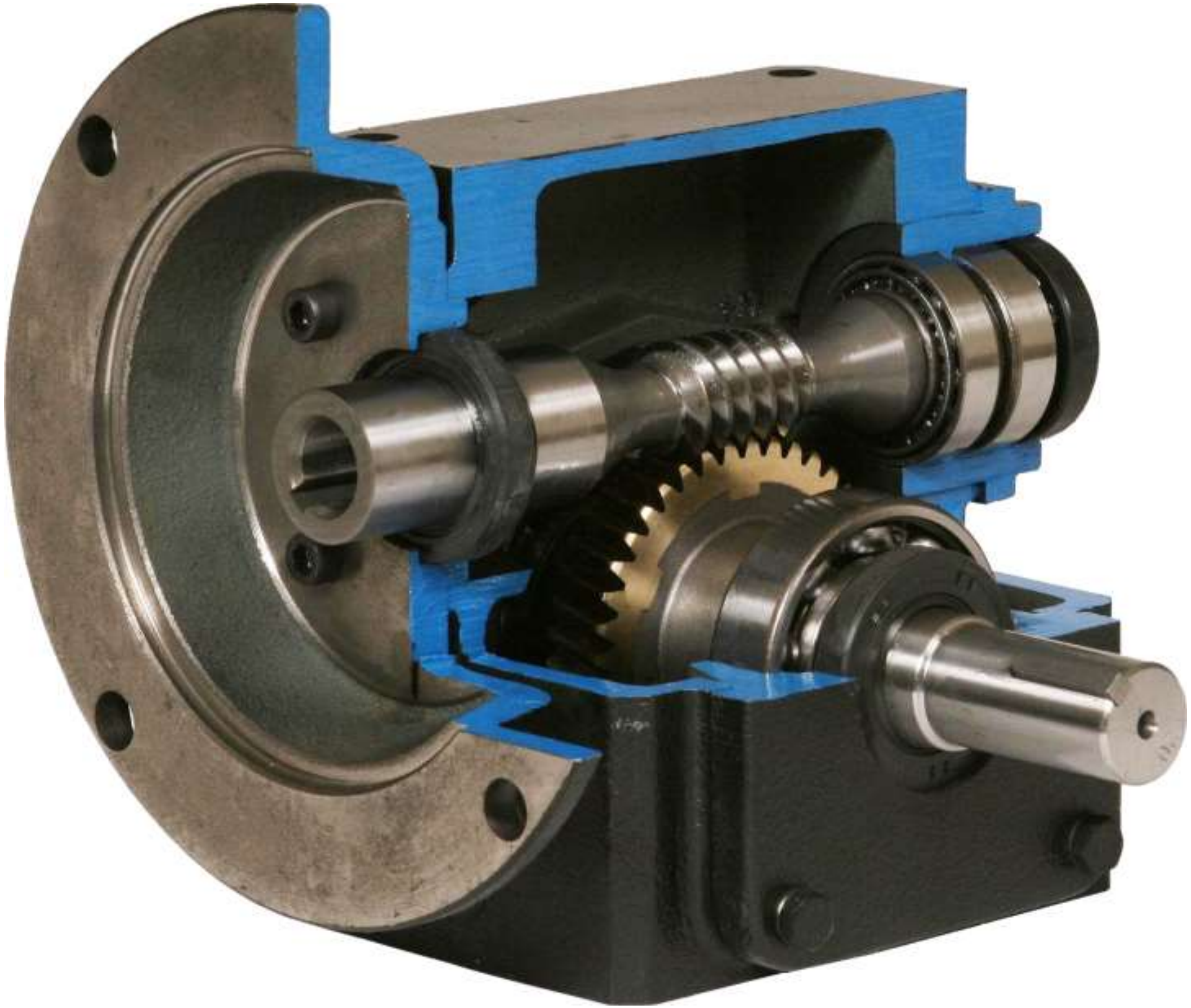
$$WR^2_{WS} = \frac{WR^2_{LSS} + WR^2_{DL}}{(\text{ratio})^2} + WR^2_{WA} + WR^2_M$$

where

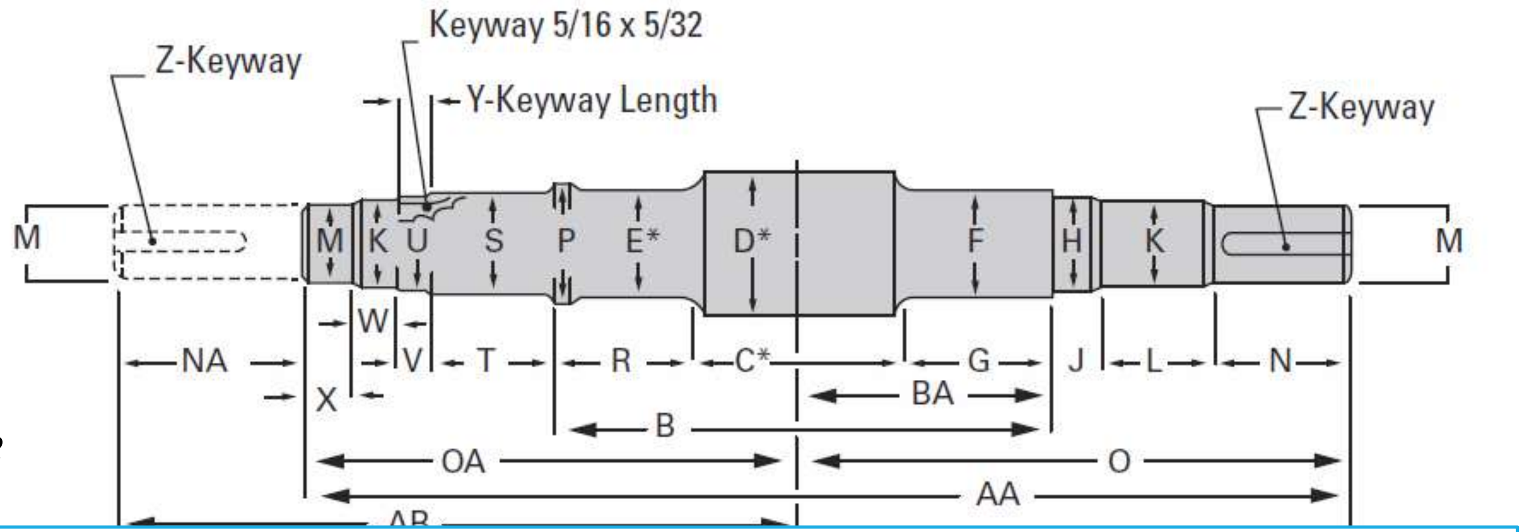
WR^2_{WS}	is	WR² of the system with respect to input shaft
WR^2_{LSS}	is	WR² of the reducer low speed shaft assembly
WR^2_{DL}	is	WR² of the driven load
WR^2_{WA}	is	WR² of the worm assembly
WR^2_M	is	WR² of the motor

WORM GEAR SET



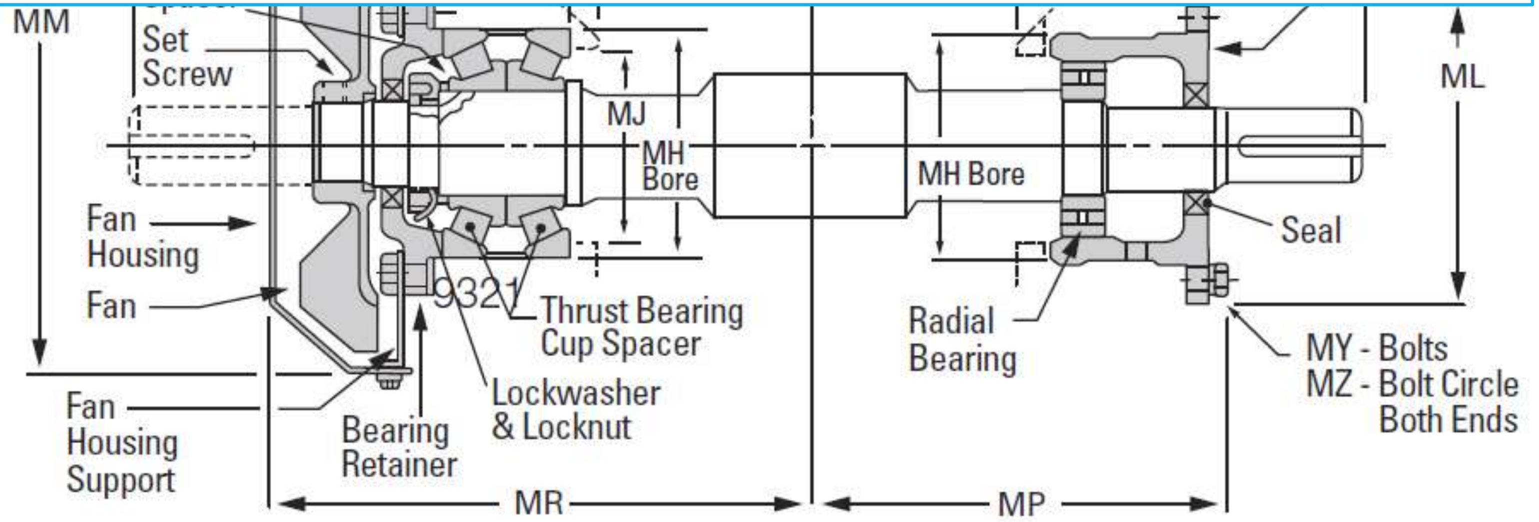


WORM SHAFT

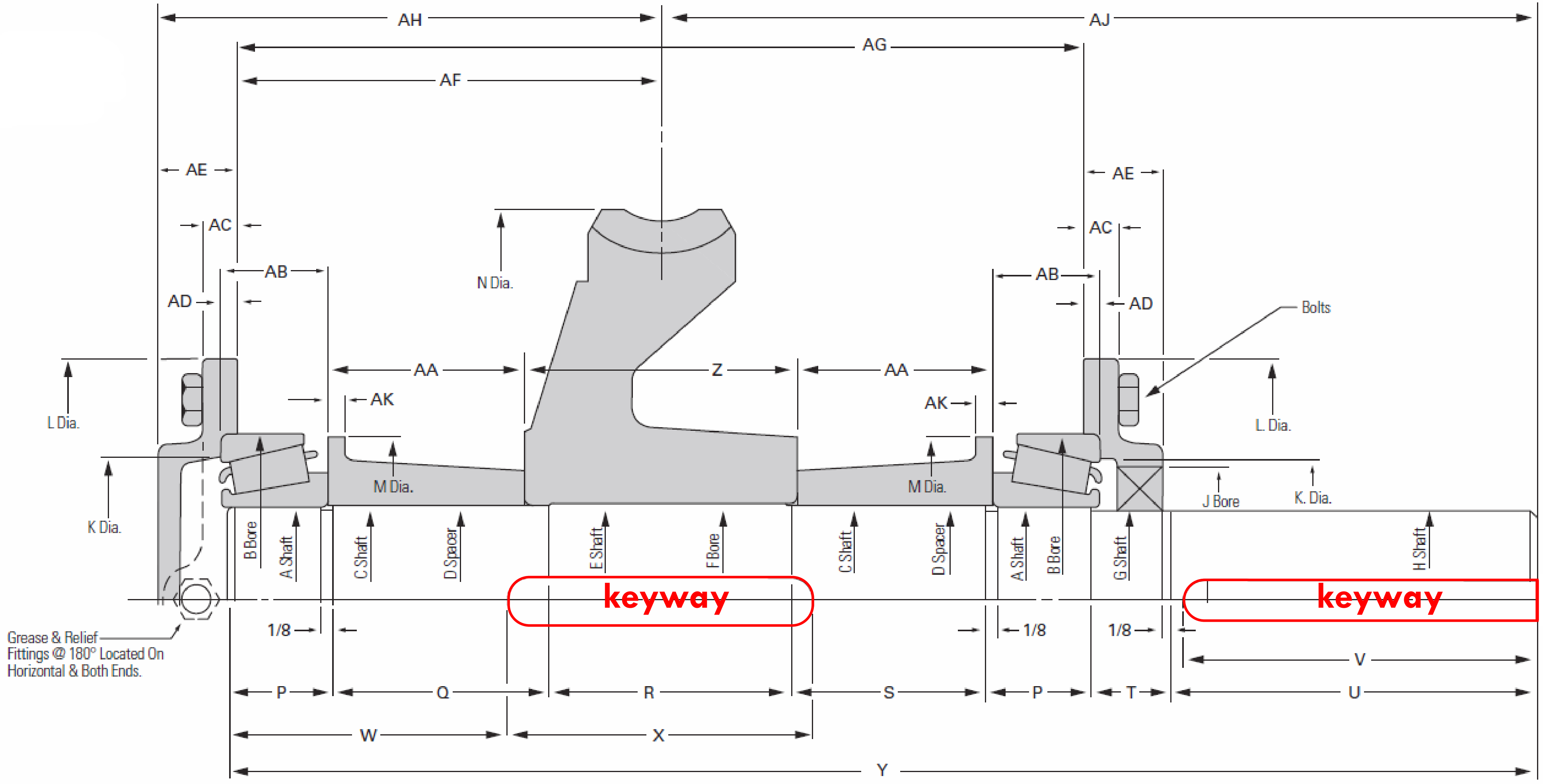


$$S_e = k_a k_b k_c k_d k_e k_f S_e'$$

$$\frac{1}{n} = \frac{16}{\pi d^3}\left\{\frac{1}{S_e}\left[4\left(K_f M_a\right)^2 + \cancel{3\left(K_{fs} T_a\right)^2}\right]^{1/2} + \frac{1}{S_y}\left[\cancel{4\left(K_f M_m\right)^2} + 3\left(K_{fs} T_m\right)^2\right]^{1/2}\right\}$$



GEAR SHAFT



AH
AJ
AG
AF
AE
AC
AB
AD
N Dia.
Bolts
L Dia.
AA
Z
AK
M Dia.
J Bore
K Dia.
B Bore
A Shaft
C Shaft
D Spacer
E Shaft
F Bore
G Shaft
H Shaft
keyway
keyway
1/8
Grease & Relief Fittings @ 180° Located On Horizontal & Both Ends.
P
Q
R
S
T
U
V
W
X
Y

BEARINGS

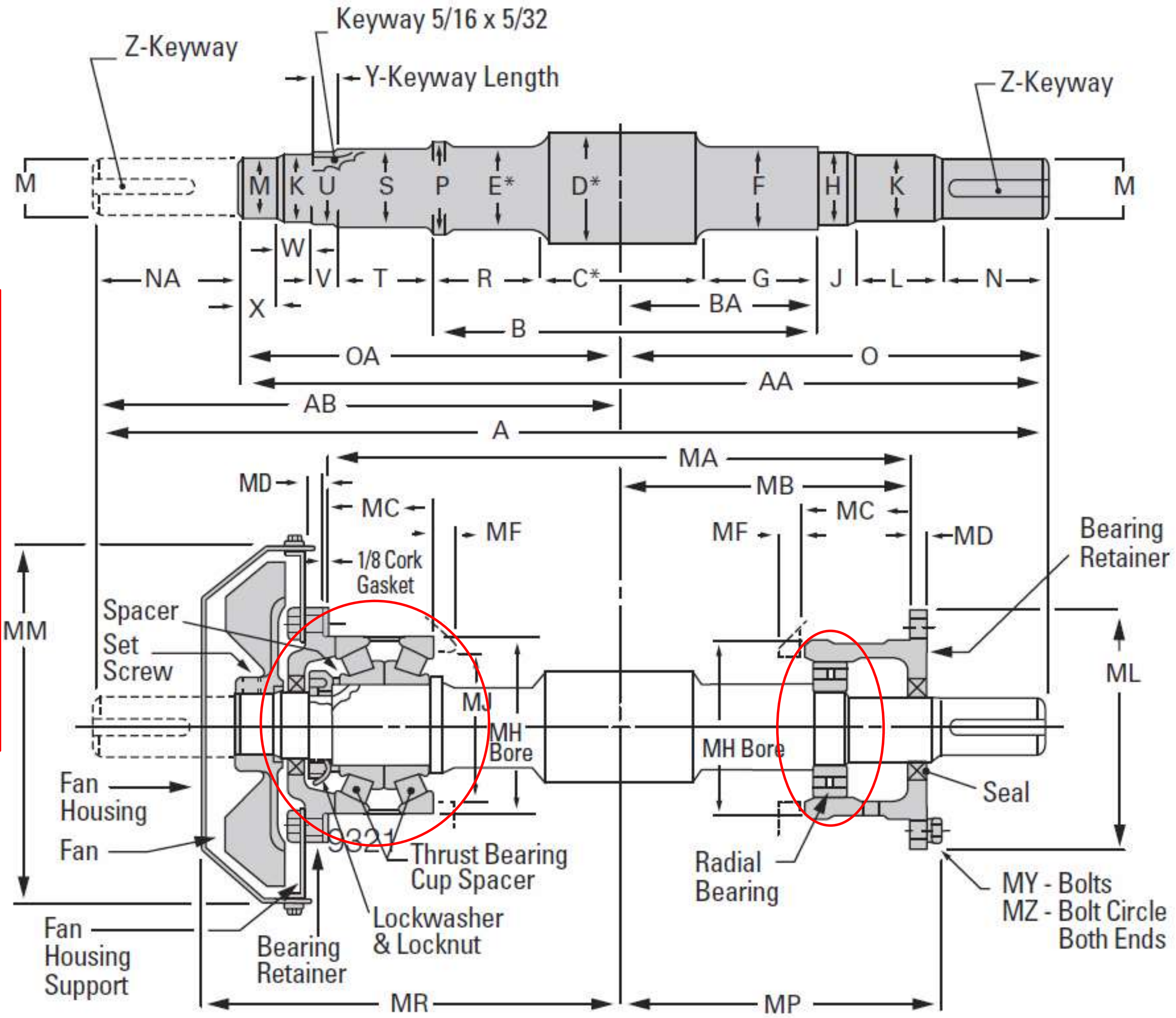
tapered roller bearing

double-row cylindrical roller bearing

WORM SHAFT

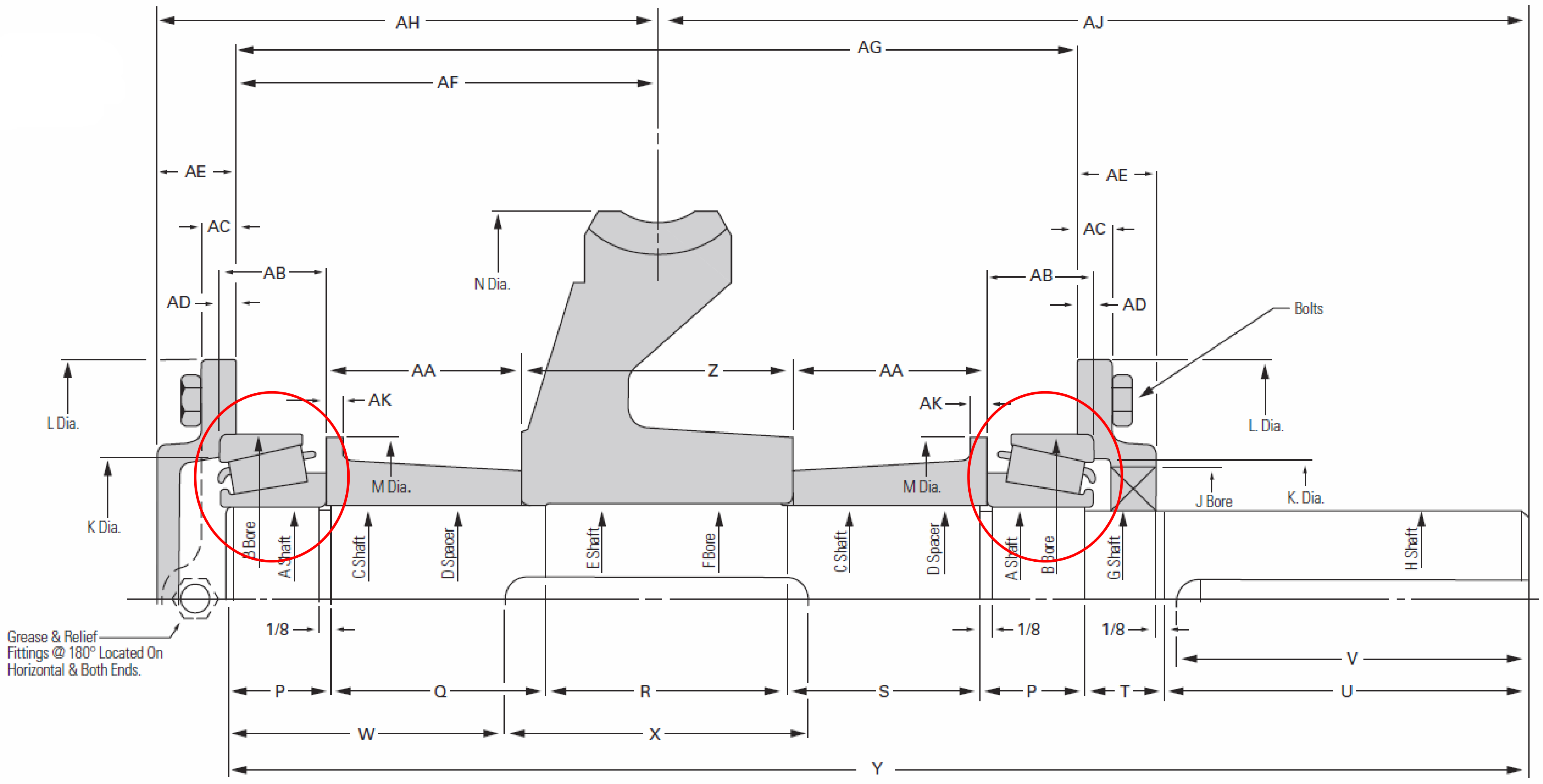
tapered roller bearing

double-row cylindrical roller bearing



GEAR SHAFT

tapered roller bearing



BEARINGS

Ch. 11

p. 566

$$F L^{1/a} = constant$$

F = radial load
L = life (in revolutions)
a = 3 for ball bearings, 10/3 for roller bearings (cylindrical and tapered roller)

$$F_R L_R^{1/a} = F_D L_D^{1/a}$$

$$C = F_R$$

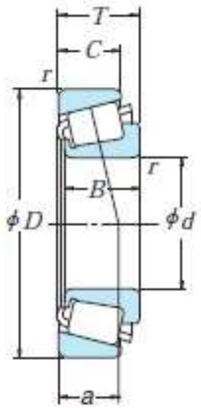
Catalog value (for 90% reliability)

BEARINGS

SINGLE-ROW TAPERED ROLLER BEARINGS (INCH DESIGN)

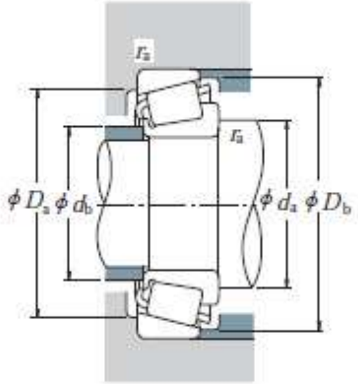
NSK

Bore Diameter 22.606 – 28.575 mm



Dynamic load rating (radial)

Static load rating (radial)



Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leq e$		$F_a/F_r > e$	
X	Y	X	Y
1	0	0.4	Y_1

Static Equivalent Load

$P_0 = 0.5F_r + Y_0 F_a$

When $F_r > 0.5F_r + Y_0 F_a$, use $P_0 = F_r$

The values of e, Y_1, and Y_0 are given in the table below.

Boundary Dimensions (mm)							Basic Load Ratings (N)		Basic Load Ratings (kgf)		Limiting Speeds (min^{-1})	
d	D	T	B	C	Cone r min.	Cup r min.	C_r	C_{0r}	C_r	C_{0r}	Grease	Oil
22.606	47.000	15.500	15.500	12.000	1.5	1.0	26 300	30 000	2 680	3 100	8 000	11 000
23.812	50.292	14.224	14.732	10.668	1.5	1.3	27 600	32 000	2 820	3 250	7 100	10 000
	56.896	19.368	19.837	15.875	0.8	1.3	38 000	40 500	3 900	4 150	7 100	9 500
24.000	55.000	25.000	25.000	21.000	2.0	2.0	49 500	55 000	5 050	5 650	7 100	9 500
24.981	51.994	15.011	14.260	12.700	1.5	1.3	26 000	27 900	2 650	2 840	7 500	10 000
	52.001	15.011	14.260	12.700	1.5	2.0	26 000	27 900	2 650	2 840	7 500	10 000
	62.000	16.002	16.566	14.288	1.5	1.5	37 000	39 500	3 750	4 000	6 300	8 500

Bearing Numbers		Abutment and Fillet Dimensions (mm)						Eff. Load Centers (mm)	Constant	Axial Load Factors		Mass (kg) approx.	
CONE	CUP	d_a	d_b	D_a	D_b	Cone r_a max.	Cup r_a max.	a	e	Y_1	Y_0	CONE	CUP
LM 72849	**LM 72810**	29	27	40.5	44.5	1.5	1	12.2	0.47	1.3	0.70	0.086	0.046
† L 44640	**† L 44610**	30.5	28.5	44.5	47	1.5	1.3	10.9	0.37	1.6	0.88	0.097	0.039
1779	**1729**	29.5	28.5	49	51	0.8	1.3	12.2	0.31	2.0	1.1	0.143	0.102
▲JHM 33449	**▲JHM 33410**	35	30	47	52	2	2	15.8	0.35	1.7	0.93	0.181	0.107
07098	**07204**	31	29	45	48	1.5	1.3	12.1	0.40	1.5	0.82	0.085	0.061
07098	**07205**	31	29	44.5	48	1.5	2	12.1	0.40	1.5	0.82	0.085	0.061
17098	**17244**	33	30.5	54	57	1.5	1.5	12.8	0.38	1.6	0.86	0.165	0.091