Spicer® Driveshafts

DANA SPICER®
Drivetrain Products

Application Guidelines

DSAG0200

September 2007

Driveline Sizing

Critical Speed

Center Bearing Mounting

Driveline Analysis

Appendix

Specifying a Spicer Driveline

Driveline Specification Criteria

Prime Factors:

- Net torque input
- Baseline duty cycle
    - On-highway tractor - 80,000 lbs. GCW
- Modifiers (+/- factors)
    - Duty cycle (vocation)
    - Gross Vehicle Weight (GVW/GCW)
    - Rear axle ratio
    - Universal joint working angle

Application Definitions

- Domestic applications - restricted to the continental United States and Canada.
    - On-highway - operation on well-maintained, concrete and asphalt roadways including turnpikes, interstates, and state routes with not more than 10% off-highway operation.
    - Off-highway - operation on unimproved dirt or gravel roads, as well as, poorly maintained paved roads, more than 10% of the time.
    - Line haul - operation on well maintained concrete and asphalt roadways including turnpikes, interstates, and state routes 100% of the time.
- Export applications - outside of the continental United States and Canada.

    Driveline sizing for export applications is based on Maximum Driveshaft Torque **only** (see “Calculating Maximum Driveshaft Torque (Export Applications)” on page 5).

Calculating Maximum Low Gear Torque

Step 1 - Low Gear Torque Calculation

LGT = T x TLGR x TE x SR x TCR x C

LGT = Maximum Driveshaft Low Gear Torque

T = Net Engine Torque or 95% of the Gross Engine Torque

TLGR = Transmission Low Gear Ratio (forward)*

TE = Transmission Efficiency (automatic = 0.8; manual = 0.85)

SR = Torque Converter Stall Ratio (if applicable)

TCR = Transfer Case Ratio (if applicable)

C = Transfer Case Efficiency (if applicable, 0.95)

* Some applications require deep reduction transmissions for speed-controlled operations such as paving and pouring. In these applications it may be more appropriate to use the second lowest forward transmission ratio to calculate the Maximum Low Gear Torque. To use the second lowest forward gear ratio to calculate LGT, **all three** of the following conditions must be met:

1. Lowest forward gear ratio numerically greater than 16:1.
2. Split between the lowest forward gear ratio and the second lowest forward gear ratio is greater than 50%.
3. Startability Index must be greater than 25 (see below calculation).

Startability Index Calculation

SI = (T x TR x AR x TCR x 942.4) / (RR x GCW)

SI = Startability Index

T = Engine Clutch Engagement Torque at 800 RPM

TR = Transmission Second Lowest Forward Gear Ratio

AR = Axle Ratio

TCR = Transfer Case Ratio (if applicable)

RR = Tire Rolling Radius (in)

GCW = Maximum Gross Combination Weight (lbs)

Step 2 - Wheel Slip Calculation

WST = (.71 x W x RR) / (11.4 x AR)

WST = Wheel Slip Torque Applied to the Driveshaft

W = Axle Capacity (lbs)

RR = Tire Rolling Radius (in)

AR = Axle Ratio

Step 3 - Gradeability Calculation

Calculate the torque required for 25% gradeability.

Note: For Linehaul applications with 3.10 axle ratio or numerically larger only.

GT = (.265 x RR x GVW) / (11.4 x AR)

GT = Net Driveline Torque at 25% Gradeability

RR = Tire Rolling Radius (in)

GVW = Gross Vehicle Weight (lbs)

AR = Axle Ratio

Step 4 - Overall Low Gear Ratio Calculation

OLGR = TLGR x SR x TCR

OLGR = Overall Low Gear Ratio

TLGR = Transmission Low Gear Ratio

SR = Torque Converter Stall Ratio (if applicable)

TCR = Transfer Case Ratio (if applicable)

Step 5 - Driveline Series Selection

To select a driveline series:

1. Use the torque determined from Steps 1, 2, and 3 with the overall low gear ratio (OLGR) from Step 4 to find the applicable series for each torque value.
2. Find the appropriate driveline series for SPL or Ten Series using the “Application Guidelines” on page 6 & 7.
3. Use the smallest series for the main driveline series, as determined from Steps 1, 2, and 3.

Note: The selected driveline series can not be more than one series smaller than the series selected from Step 1 (LGT).

Step 6 - Specifying the Interaxle Driveline (if applicable)

To specify the interaxle driveline, use:

1. 60% of the Driveline Series Selection torque from Step 5 and the OLGR from Step 4.
2. Find the appropriate interaxle driveline series for SPL or Ten Series using the “Application Guidelines” on page 6 & 7.

Note: High angle (45°) interaxle driveshafts are available in SPL-170 and 1710 Series only.

Calculating Maximum Driveshaft Torque (Export Applications)

Step 1 - Low Gear Torque Calculation

LGT = T x TLGR x TE x SR x TCR x C

LGT = Maximum Driveshaft Low Gear Torque

T = Net Engine Torque or 95% of the Gross Engine Torque

TLGR = Transmission Low Gear Ratio (forward)

TE = Transmission Efficiency (automatic = 0.8; manual = 0.85)

SR = Torque Converter Stall Ratio (if applicable)

TCR = Transfer Case Ratio (if applicable)

C = Transfer Case Efficiency (if applicable, 0.95)

Step 2 - Overall Low Gear Ratio Calculation

OLGR = TLGR x SR x TCR

OLGR = Overall Low Gear Ratio

TLGR = Transmission Low Gear Ratio

SR = Torque Converter Stall Ratio (if applicable)

TCR = Transfer Case Ratio (if applicable)

Step 3 - Driveline Series Selection

To select a driveline series:

1. Use the torque determined from Step 1 with the overall low gear ratio (OLGR) from Step 2 to find the applicable series from the appropriate Driveline Sizing graph. See "Application Guidelines" for more information.

Step 4 - Specifying the Interaxle Driveline (if applicable)

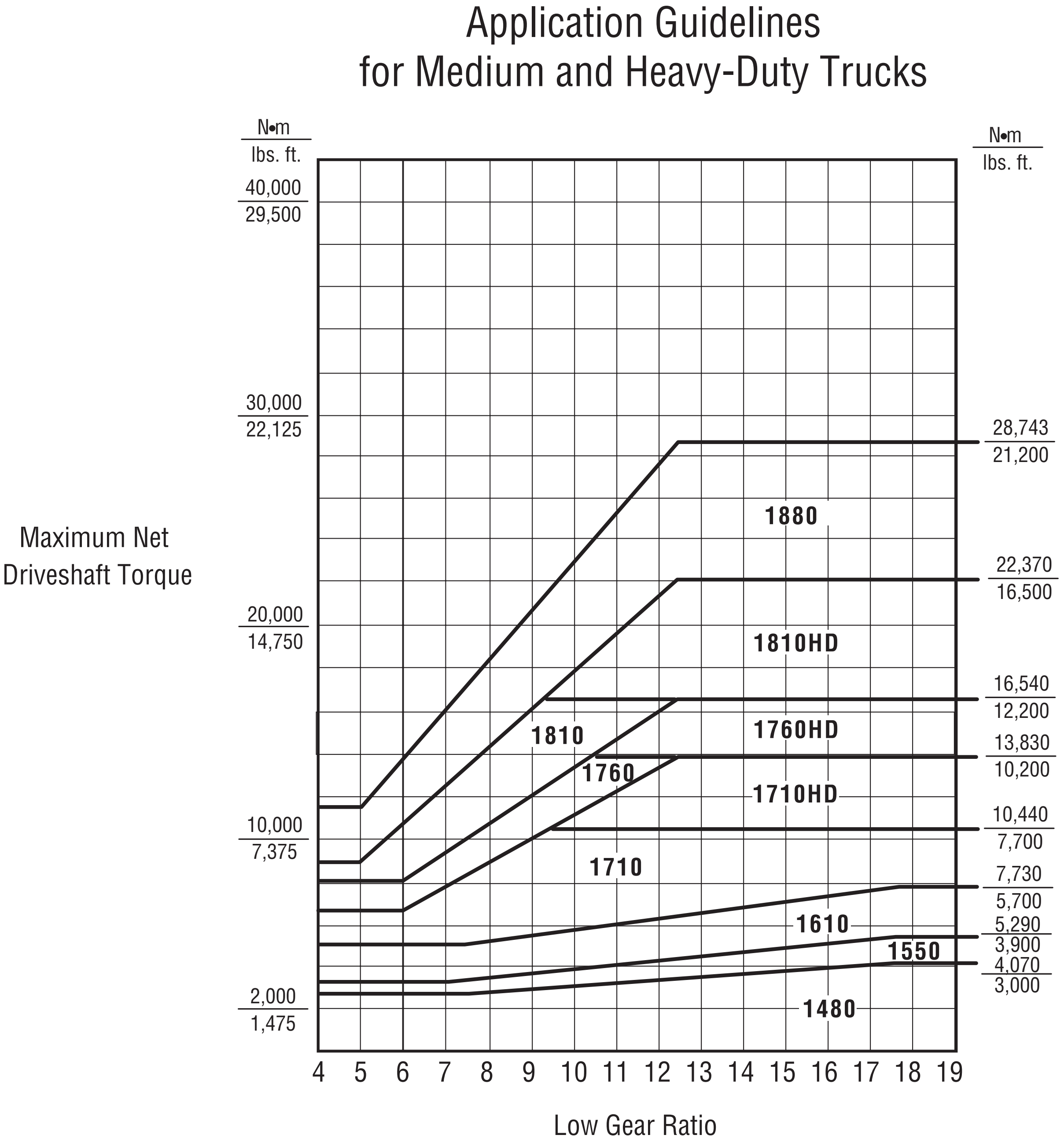
To specify the interaxle driveline, use:

1. 60% of the Driveline Series Selection torque from Step 3 and the OLGR from Step 2.
2. Find the appropriate interaxle driveline series for SPL or Ten Series using the “Application Guidelines” on page 6 & 7.

Note: High angle (45°) interaxle driveshafts are available in SPL-170 and 1710 Series only.

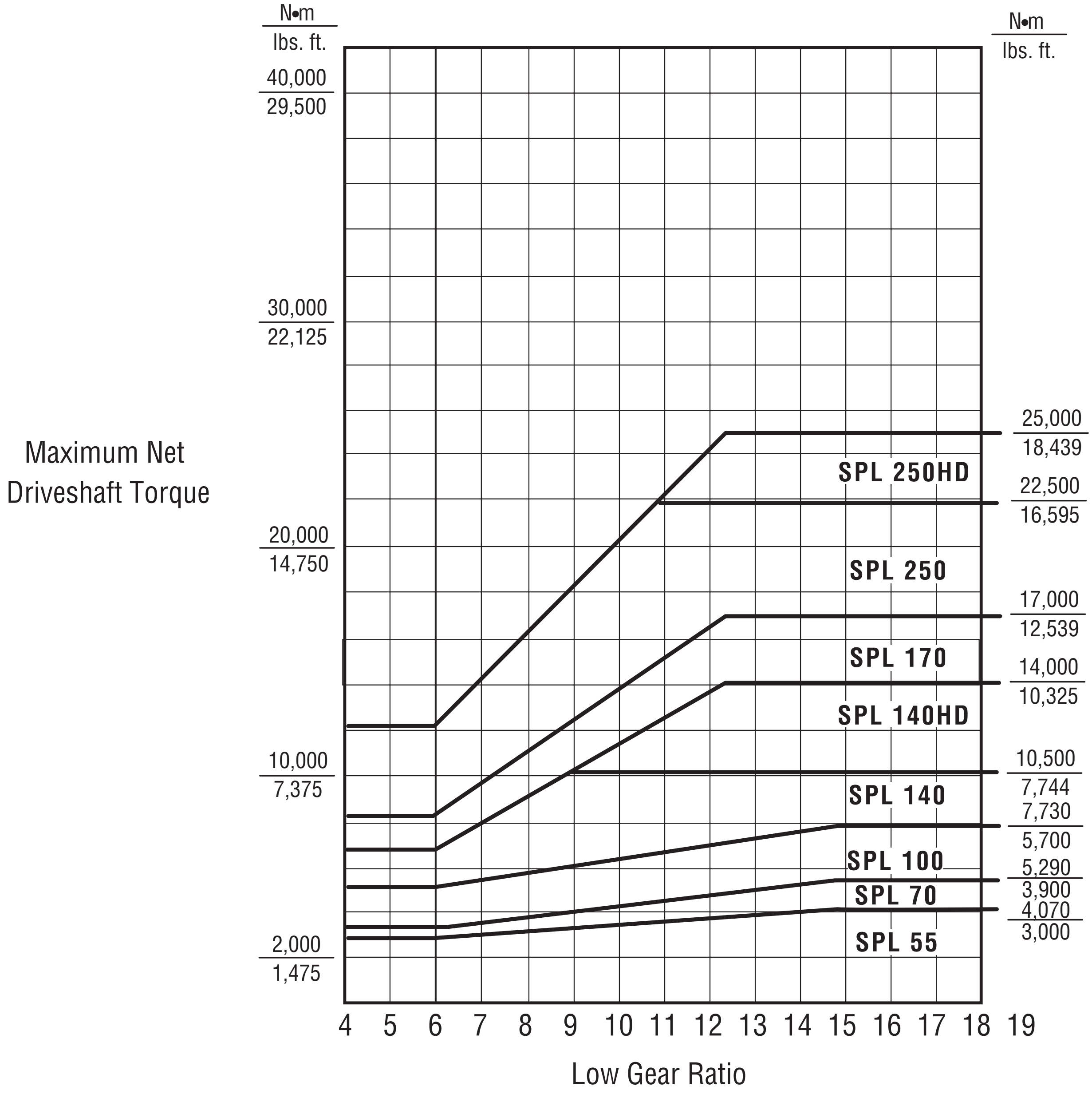
Application Guidelines

10 Series Graph



SPL Graph

Application Guidelines
for Medium and Heavy-Duty Trucks



Critical Speed

Critical speed is defined as: The speed at which the rotational speed of the driveshaft coincides with the natural frequency of the shaft.

Standard Equation

$$CS = 30\pi \sqrt{\frac{E \times 386.4\,(O^2 + I^2)}{P \times L^4 \times 16}}$$

CS = Critical Speed

E = Modulus of tubing material (psi)

O* = Outside Diameter of Tubing (in)

I* = Inside Diameter of Tubing (in)

P = Density of Tubing Material (lbs/in^3)

L = Distance Between Journal Cross Centers (in)

* Refer to “Spicer Standard Tube Sizes” on page 19 for tube dimensions.

Material Properties

Material	**Modulus**	**Density**	**E/P x 386.4**
Steel	30.00 x 10^6	0.2830	41.0 x 10^9
Aluminum	10.30 x 10^6	0.0980	39.4 x 10^9

Simplified Equations

Steel:

$$CS = \frac{4.769 \times 10^6}{L^2} \sqrt{O^2 + I^2}$$

Aluminum:

$$CS = \frac{4.748 \times 10^6}{L^2} \sqrt{O^2 + I^2}$$

CS = Critical Speed

L = Distance Between Journal Cross Centers (in)

O = Outside Diameter of Tubing (in)

I = Inside Diameter of Tubing (in)

Note: The theoretical values and the simplified equation values are the same for the material constants provided.

Adjusted Critical Speed

ACS = TC x CF x SF

ACS = Adjusted Critical Speed
TC = Theoretical Critical
CF = Correction Factor
SF = Safety Factor

Suggested factors for Adjusted Critical Speed:

Safety Factor = 0.75
Correction Factor
  Outboard Slip = 0.92
  Inboard Slip = 0.75

Maximum Driveshaft Length

Refer to the TMC Recommended Practice RP610A Chart 3 for maximum driveshaft length vs. RPM guidelines.

The general length limitations are as follows:

Tube O.D.	**Maximum Length ***
3.0 in.	60 in.
3.5 in.	65 in.
4.0 in.	70 in.
4.2 in.	72 in.
4.3 in.	73 in.
4.5 in.	75 in.
5.0 in.	80 in.

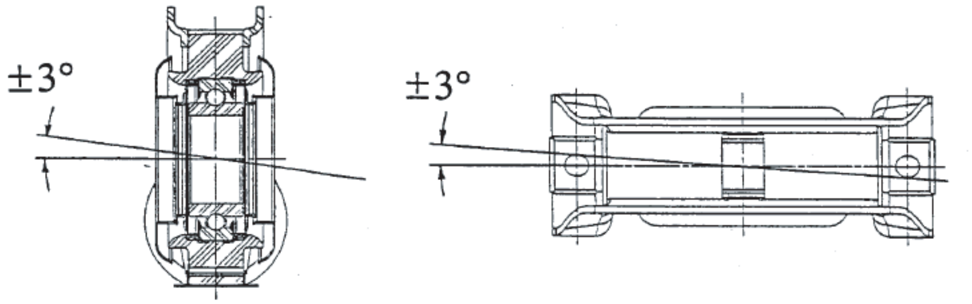
***** Installed length u-joint center to u-joint center.

Center Bearing Mounting

Spicer heavy duty center bearings must be mounted within 3° of perpendicular to the coupling shaft centerline as shown in Figure 1 below **OR** the center bearing assembly must not operate at a linear offset greater than 1/8" as shown in Figure 2.

Note: The Spicer "XC" center bearing may be mounted up to +/- 10° of perpendicular to the coupling shaft centerline as shown in the side view of Figure 1.

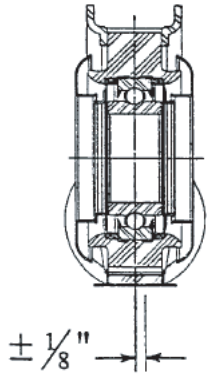
Figure 1



Side View

Top View

Figure 2



Side View

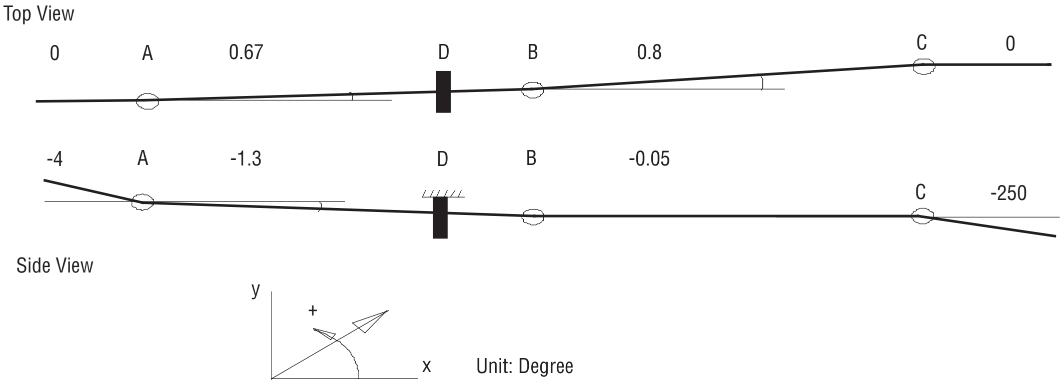
Driveline Analysis

Design Criteria

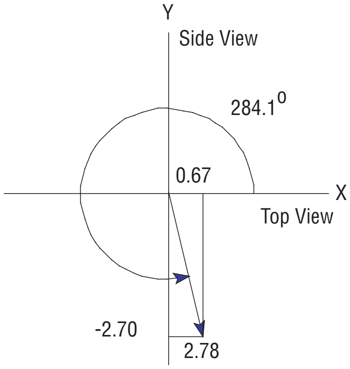
- Torsional Vibration
- Inertial Vibration
- Center Bearing Loading

Torsional and Inertial Excitation

Driveline Layout



Calculate Joint Angles



View from Rear of Driveline

To find the true joint angle of each joint, first find the top-view and side-view angles of each joint. The top-view angle of Joint A is equal to 0.67 - 0.00 = 0.67 and the side-view joint angle of Joint A is equal to (-4.0) - (-1.3) = -2.70. By putting the top-view angle (0.67) to the X-axis and the side-view angle (-2.70) to the Y-axis, the true joint angle of Joint A is equal to $2.78 \angle 284.1$ degrees.

Note: The true joint angle is a vector: the 2.78 degrees is the magnitude and the 284.1 degree is the argument. The true joint angles of joints A, B, and C are shown in the following chart.

	Trans U-joint (A) degrees	**U-joint (B) degrees**	**Axle U-joint (C) degrees**
Joint Angle - Top View	0.67	0.13	-0.80
Joint Angle - Side View	-2.70	-1.25	2.45
True Joint Angle Θ	2.78	1.26	2.58
Plane of True Joint Angle ϕ	284.10	276.01	108.29

Calculate Torsional and Inertia Excitation

Calculate the torsional effect:

$$\Theta_{res} = \sqrt{(|\Theta_1|\_\phi_1)^2 + (|\Theta_2|\_(\phi_2 - 90° - \delta_1))^2 + (|\Theta_3|\_(\phi_3 - \delta_2 - \delta_1))^2}$$

(1) When δ_1= 0 deg, δ_2= 0 deg.

$$= \sqrt{(2.78\_284.1°)^2 + (1.26\_(276.01 - 90)°)^2 + (2.58\_108.29°)^2}$$
$$= \sqrt{(7.7284\_-151.8°) + (1.5876\_12.02°) + (6.6564\_-143.42)}$$
$$= \sqrt{(12.8667\_-145.4°)}$$
$$= 3.5870°\_-72.75°$$
$$3.3405x\ 10^{-6}(2368rpm)^2(3.5870°)^2 = 241.0154\frac{rad}{\sec^2}$$

(2) When δ_1= 0 deg, δ_2= 90 deg.

$$= \sqrt{(2.78\_284.1°)^2 + (1.26\_(276.01 - 90)°)^2 + (2.58\_(108.29 - 90)°)^2}$$
$$= \sqrt{(7.7284\_-151.8°) + (1.5876\_12.02°) + (6.6564\_36.58)}$$
$$= \sqrt{(0.65124\_82.32°)}$$
$$= 0.80699°\_41.162°$$
$$3.3405x\ 10^{-6}(2368rpm)^2(0.80699°)^2 = 12.1988\frac{rad}{\sec^2}$$

(3) When δ_1= 90 deg, δ_2= 90 deg.

$$= \sqrt{(2.78\_284.1°)^2 + (1.26\_(276.01 - 90 - 90)°)^2 + (2.58\_(108.29 - 90 - 90)°)^2}$$
$$= \sqrt{(7.7284\_-151.8°) + (1.5876\_-167.98°) + (6.6564\_-143.42)}$$
$$= \sqrt{(15.847236\_149.89°)}$$
$$= 3.98085°\_-74.94°$$
$$3.3405x\ 10^{-6}(2368rpm)^2(3.98085°)^2 = 296.84\frac{rad}{\sec^2}$$

(4) When δ_1= 90 deg, δ_2= 0 deg.

$$= \sqrt{(2.78\_284.1^\circ)^2 + (1.26\_(276.01 - 90 - 90)^\circ)^2 + (2.58\_(108.29 - 90)^\circ)^2}$$
$$= \sqrt{(7.7284\_-151.8^\circ) + (1.5876\_-167.98^\circ) + (6.6564\_36.58)}$$
$$= \sqrt{(3.018639\_-179.699^\circ)}$$
$$= 1.737423^\circ\_-89.84^\circ$$
$$3.3405x\ 10^{-6} (2368rpm)^2 (1.737423^\circ)^2 = 56.54 \frac{rad}{\sec^2}$$

Calculate the inertia drive effects:

$$\Theta_D = \sqrt{2(|\Theta_1|\_\phi_1)^2 + (|\Theta_2|\_(\phi_2 - 90^\circ - \delta_1))^2}$$

(1) When δ_1= 0 deg, δ_2= 0 deg or δ_1= 0 deg, δ_2= 90 deg.

$$= \sqrt{2(2.78\_284.1^\circ)^2 + (1.26\_(276.01 - 90)^\circ)^2}$$
$$= \sqrt{(15.4568\_-151.8^\circ) + (1.5876\_12.02^\circ)}$$
$$= \sqrt{(13.939105\_-149.98^\circ)}$$
$$= 3.733511^\circ\_-74.99^\circ$$
$$3.3405x\ 10^{-6} (2368rpm)^2 (3.733511^\circ)^2 = 261.10 \frac{rad}{\sec^2}$$

(2) When δ_1= 90 deg, δ_2= 90 deg or δ_1= 90 deg, δ_2= 0 deg.

$$= \sqrt{2(2.78\_284.1^\circ)^2 + (1.26\_(276.01 - 90 - 90)^\circ)^2}$$
$$= \sqrt{(15.4568\_-151.8^\circ) + (1.5876\_-167.98^\circ)}$$
$$= \sqrt{(16.987278\_-153.29^\circ)}$$
$$= 4.12156^\circ\_-76.64^\circ$$
$$3.3405x\ 10^{-6} (2368rpm)^2 (4.12156^\circ)^2 = 318.19 \frac{rad}{\sec^2}$$

Calculate the inertia coast effects:

$$\Theta_C = \sqrt{2(|\Theta_3|\_\phi_3)^2 + (|\Theta_2|\_(\phi_2 + 90^\circ + \delta_2))^2}$$

(1) When δ_1= 0 deg, δ_2= 0 deg or δ_1= 90 deg, δ_2= 0 deg.

$$= \sqrt{2(2.58\_108.29^\circ)^2 + (1.26\_(276.01 + 90)^\circ)^2}$$
$$= \sqrt{(13.3128\_-143.42^\circ) + (1.5876\_12.02^\circ)}$$
$$= \sqrt{(11.887165\_-140.24^\circ)}$$
$$= 3.44777\_-70.11^\circ$$
$$3.3405x\ 10^{-6} (2368rpm)^2 (3.44777^\circ)^2 = 222.66 \frac{rad}{\sec^2}$$

(2) When δ_1= 0 deg, δ_2= 90 deg or δ_1= 90 deg, δ_2= 90 deg.

$$= \sqrt{2(2.58\angle 108.29^\circ)^2 + (1.26\angle(276.01+90+90)^\circ)^2}$$

$$= \sqrt{(13.3128\angle -143.42^\circ) + (1.5876\angle -167.98^\circ)}$$

$$= \sqrt{(14.77151\angle -145.98^\circ)}$$

$$= 3.84337\angle -72.99^\circ$$

$$3.3405x\ 10^{-6}(2368rpm)^2(3.84337^\circ)^2 = 276.69\frac{rad}{\sec^2}$$

Note: The recommended torsional excitation level is 300 rad/sec^2 or less. The recommended inertia excitation level is 1000 rad/sec^2 or less.

Calculate the torque fluctuations:

The mass moment of inertia of the following items are approximately equal to:

	lbf-in-sec^2
Transmission	2.33
Axle	2.53
1760 Driveshaft	1.3

(1) The torque fluctuation at the axle end is:

$$\begin{aligned} T_{axle} &= T_{torsional,axle} + T_{inertia,drive} \\ &= J_{axle\ \ torsional} + J_{driveshaft\ \ drive} \\ &= (2.53)(241.01) + (1.3)(261.10) \\ &= 949.18in\text{-}lb \\ &= 79.1ft\text{-}lb \end{aligned}$$

(2) The torque fluctuation at the transmission end is:

$$\begin{aligned} T_{transmission} &= T_{torsional,transmission} + T_{inertia,coast} \\ &= J_{transmission\ \ torsional} + J_{driveshaft\ \ coast} \\ &= (2.33)(241.01) + (1.3)(222.66) \\ &= 851.01in\text{-}lb \\ &= 70.92ft\text{-}lb \end{aligned}$$

Center Bearing Loading

Calculate Static / Dynamic Center Bearing Load

Static

$$= \frac{1}{2}\frac{T}{AB-DB}\left\{\sin a^\circ \angle(\phi_a+90)^\circ + \left(\tan b^\circ - \frac{AB}{BC}\sin b^\circ\right)\angle(\phi_b+90)^\circ + \frac{AB}{BC}\tan c^\circ \angle(\phi_c-90)^\circ\right\}$$

$$= \frac{1}{2}\frac{12214x12}{(40.-6.2)}\{\sin 2.78^\circ \angle(284.1+90)^\circ$$

$$+ \left(\tan 1.26^\circ - \frac{40.}{44.34}\sin 1.26^\circ\right)\angle(276.01+90)^\circ$$

$$+ \frac{40.}{44.34}\tan 2.58^\circ \angle(108.29-90)^\circ\}$$

$$= 2168.1657\{(0.0485\angle 374.1^\circ)+(0.0022\angle 366.01^\circ)+(0.0406\angle 18.29^\circ)\}$$

$$= 2168.1657(0.0912\angle 15.77^\circ)$$

$$= 197.7738 lbs \angle 15.77^\circ$$

Dynamic

$$= \frac{1}{2}\frac{T}{AB-DB}\left\{\sin a^\circ \angle(90-\phi_a)^\circ + \left(\tan b^\circ + \frac{AB}{BC}\sin b\right)\angle(90-\phi_b+2\delta_1)^\circ + \frac{AB}{BC}\tan c^\circ \angle(90-\phi_c+2\delta_1+2\delta_2)^\circ\right\}$$

(1) When δ_1= 0 deg, δ_2= 0 deg.

$$= \frac{1}{2}\frac{12214x12}{(40.-6.2)}\{\sin 2.78^\circ \angle(90-284.1)^\circ$$

$$+ \left(\tan 1.26^\circ + \frac{40.}{44.34}\sin 1.26^\circ\right)\angle(90-276.01)^\circ$$

$$+ \frac{40.}{44.34}\tan 2.58^\circ \angle(90-108.29)^\circ\}$$

$$= 2168.1657\{(0.0485\angle -194.1^\circ)+(0.0418\angle -186.01^\circ)+(0.0406\angle -18.29^\circ)\}$$

$$= 2168.1657(0.0502\angle 176.^\circ)$$

$$= 108.7635 lbs \angle 176.^\circ$$

(2) When δ_1= 0 deg, δ_2= 90 deg.

$$= \frac{1}{2}\frac{12214x12}{(40.-6.2)}\{\sin 2.78° \_ (90-284.1)°$$

$$+ (\tan 1.26° + \frac{40.}{44.34}\sin 1.26°)\_ (90-276.01)°$$

$$+ \frac{40.}{44.34} \tan 2.58° \_ (90-108.29+2x90)° \}$$

$$= 2168.1657\{(0.0485\_ -194.1°)+(0.0418\_ -186.01°)+(0.0406\_ 161.71°)\}$$

$$= 2168.1657(0.1305\_ 167.18°)$$

$$= 282.9240lbs \quad \_ 167.18°$$

(3) When δ_1= 90 deg, δ_2= 90 deg.

$$= \frac{1}{2}\frac{12214x12}{(40.-6.2)}\{\sin 2.78° \_ (90-284.1)°$$

$$+ (\tan 1.26° + \frac{40.}{44.34}\sin 1.26°)\_ (90-276.01+2x90)°$$

$$+ \frac{40.}{44.34} \tan 2.58° \_ (90-108.29)° \}$$

$$= 2168.1657\{(0.0485\_ -194.1°)+(0.0418\_ -6.01°)+(0.0406\_ -18.29°)\}$$

$$= 2168.1657(0.0336\_ -9.11°)$$

$$= 72.8115lbs \quad \_ -9.11°$$

(4) When δ_1= 90 deg, δ_2= 0 deg.

$$= \frac{1}{2}\frac{12214x12}{(40.-6.2)}\{\sin 2.78° \_ (90-284.1)°$$

$$+ (\tan 1.26° + \frac{40.}{44.34}\sin 1.26°)\_ (90-276.01+2x90)°$$

$$+ \frac{40.}{44.34} \tan 2.58° \_ (90-108.29+2x90)° \}$$

$$= 2168.1657\{(0.0485\_ -194.1°)+(0.0418\_ -6.01°)+(0.0406\_ -161.71°)\}$$

$$= 2168.1657(0.0484\_ 155.36°)$$

$$= 105.03326lbs \quad \_ 155.36°$$

Center Bearing Loads

Design	**Static Load**	**Dynamic Load**
Solid Rubber	500 lbs.	500 lbs.
Semi-Slotted Rubber	250 lbs.	250 lbs.
Slotted Rubber	100 lbs.	100 lbs.

Application Form

Heavy / Medium-Duty Applications

Company: ______ Contact: ______

Email: ______ Date: ______

Phone: ______ Fax: ______

Vocation: ______ Vehicle Make: ______ Vehicle Model: ______

Weight - Empty: ______ GVW Total: ______

GVW (Front): ______ GVW (Rear): ______ GCW: ______

Tires - Size: ______ Make: ______ Rolling Radius: ______

Engine - Make: ______ Model: ______ Displacement: ______

Net Torque: ______ At Speed: ______ Net H.P.: ______ At Speed: ______

Gross Torque: ______ At Speed: ______ Gross H.P.: ______ At Speed: ______

Maximum Operating Speed (including engine over speed): ______

Trans - Make: ______ Model: ______

Ratios - Forward (including overdrive): ______ Reverse: ______

Torque Converter - Make: ______ Model:______ Stall Ratio: ______

Auxiliary - Make: ______ Model:______ Ratios: ______

Transfer Case - Make: ______ Model:______ Ratios: ______

Torque Split Ratio - Front: ______ Rear: ______

Axle Make - Front:______ Model:______ Ratios: ______

Make - Front:______ Model:______ Ratios: ______

B_{10} Life Expectancy:______

Vehicle Duty Cycle: ______

Description of Vehicle Function: ______

______

______

Signed: ______

Title: ______

Spicer Engineer: ______ Phone: ______

Email: ______ Fax: ______

Heavy / Medium-Duty Applications

APPLICATION PROPOSAL

Vehicle Position	Series	Dana Part Number
Transmission to Rear Axle		
Transmission to Auxiliary		
Auxiliary to Rear Axle		
Transmission to Mid Bearing		
Mid Bearing to Rear Axle		
Interaxle		
Wheel Drive		

Vehicle Application Sketch

Plan View

Side View

Proposed By: ______________________________

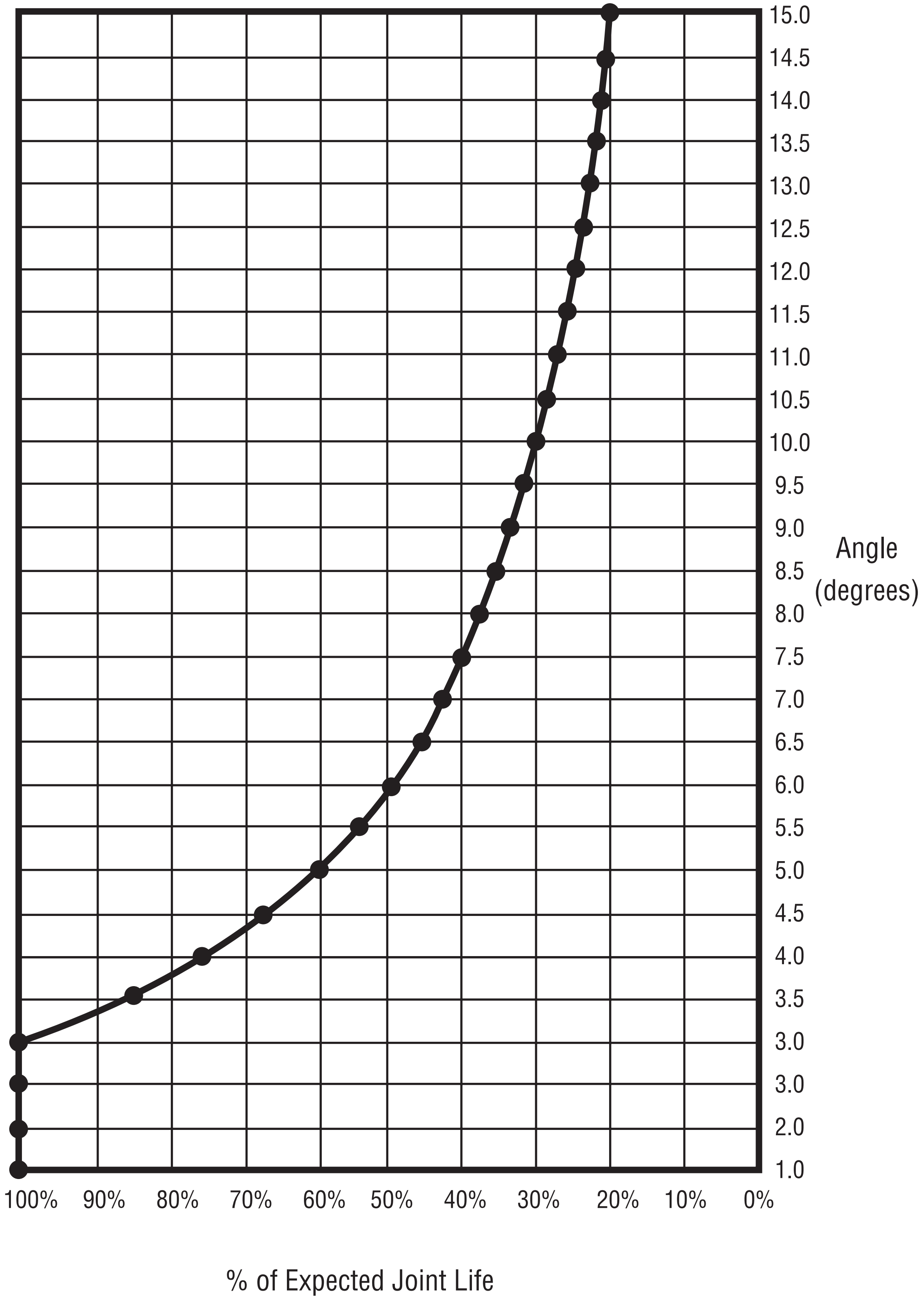
Signed: ______________________________

Title: ______________________________

Spicer Standard Tube Sizes

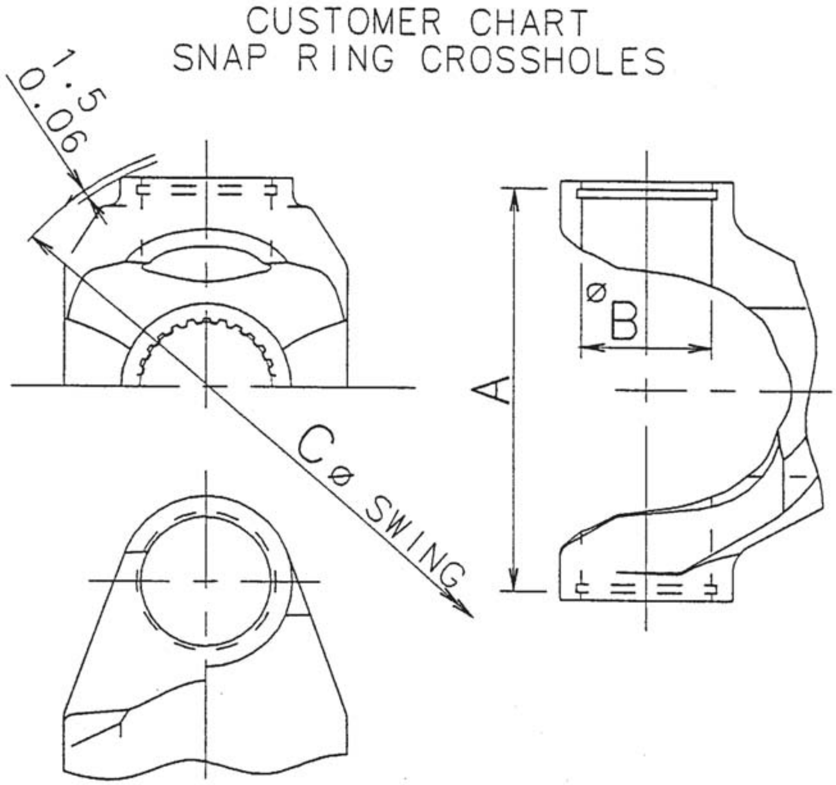
Series	Tube Size (in)	Dana Part Number	Torque Rating (lbs. ft.)	Tube JAEL (lbs. ft.)
1610	4.00 x .134	32-30-52	5,700	8,600
1710	4.00 x .134	32-30-52	7,700	8,600
1710 HD	4.09 x .180	32-30-72	10,200	13,925
1760	4.00 x .134	32-30-92	10,200	10,435
1760 HD	4.09 x .180	32-30-72	12,200	13,925
1810	4.50 x .134	36-30-62	12,200	13,065
1810 HD	4.59 x .180	36-30-102	16,500	17,935
SPL 90	4.00 x .095	32-30-12	4,900	6,300
SPL 100	4.00 x .095	32-30-12	5,700	6,300
SPL 140	4.21 x .138	100-30-3	7,744	11,010
SPL 140 HD	4.33 x .197	100-30-5	10,325	16,519
SPL 170	4.96 x .118	120-30-3	12,539	13,185
SPL 170 HD	5.06 x .167	120-30-4	12,539	19,617
SPL 170 I/A	4.72 x .197	110-30-5	12,539	19,875
SPL 250	5.06 x .167	120-30-4	16,595	19,617
SPL 250 HD	5.12 x .197	120-30-5	18,439	23,555

Joint Life vs. Joint Angle



Charts

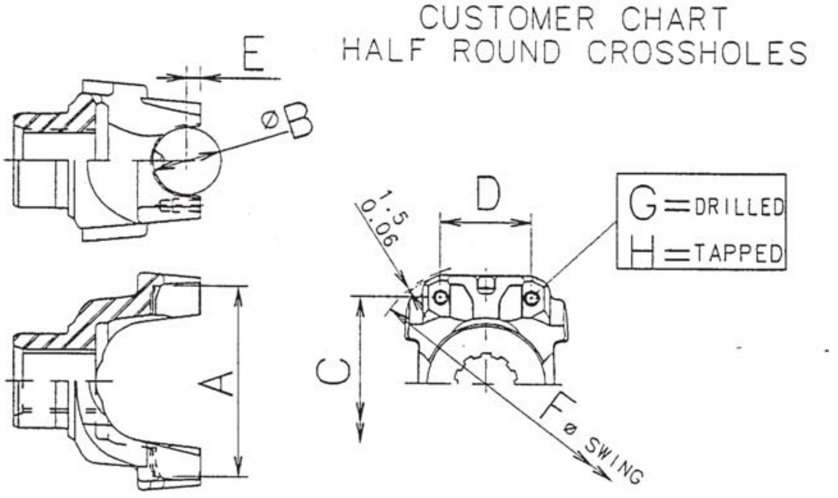
Snap Ring Cross Holes



Type	Series	A (mm / in)	B (mm / in)	C* (mm / in)
Snap Ring Construction	1210	65.0 / 2.56	26.9 / 1.06	79.2 / 3.12
	1280 / 1310	84.8 / 3.34	26.9 / 1.06	96.8 / 3.81
	1330	95.0 / 3.74	26.9 / 1.06	106.4 / 4.19
	1350	95.0 / 3.74	30.2 / 1.19	108.0 / 4.25
	1410	109.2 / 4.30	30.2 / 1.19	124.0 / 4.88
	1480 / SPL 55	109.2 / 4.30	34.8 / 1.37	124.0 / 4.88
	1550 / SPL 70	129.0 / 5.08	34.8 / 1.37	144.5 / 5.69
	SPL 90 / SPL 100	130.6 / 5.14	41.1 / 1.62	149.4 / 5.88
	1650	146.8 / 5.78	41.1 / 1.62	165.1 / 6.50

* Swing diameter clears yoke by 1.5 mm / 0.06 in.

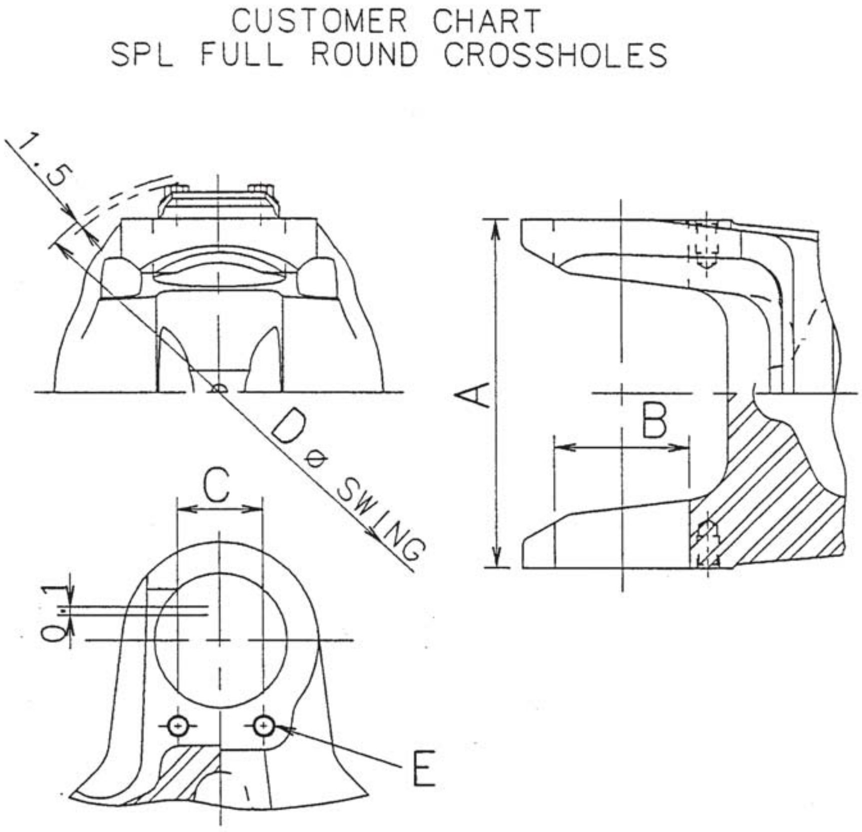
Half Round Cross Holes



Type	Series	A (mm / in)	B (mm / in)	C (mm / in)	D (mm / in)	E (mm / in)	F* (mm / in)	G (mm / in)	H
U-bolt Design	1210	62.0 / 2.44	26.9 / 1.06	56.4 / 2.22	35.8 / 1.41	0.8 / 0.03	87.4 / 3.44	8.4 / 0.33	-
	1280/1310	81.8 / 3.22	26.9 / 1.06	73.9 / 2.91	35.8 / 1.41	0.8 / 0.03	101.6 / 4.00	8.4 / 0.33	-
	1330	91.9 / 3.62	26.9 / 1.06	84.1 / 3.31	35.8 / 1.41	0.8 / 0.03	115.8 / 4.56	8.4 / 0.33	-
	1350	91.9 / 3.62	30.2 / 1.19	81.0 / 3.19	42.2 / 1.66	0.8 / 0.03	115.8 / 4.56	9.9 / 0.39	-
	1410	106.4 / 4.19	30.2 / 1.19	95.2 / 3.75	42.2 / 1.66	0.8 / 0.03	125.5 / 4.94	9.9 / 0.39	-
	1480	106.4 / 4.19	35.1 / 1.38	93.7 / 3.69	48.5 / 1.91	0.8 / 0.03	134.9 / 5.31	11.7 / 0.46	-
	1550	126.2 / 4.97	35.1 / 1.38	113.5 / 4.47	48.5 / 1.91	0.8 / 0.03	152.4 / 6.00	11.7 / 0.46	-
Bearing Strap Tapped Hole	1210	62.0 / 2.44	26.9 / 1.06	53.8 / 2.12	40.1 / 1.58	0.8 / 0.03	87.4 / 3.44	-	0.25 - 28
	1280/1310	81.8 / 3.22	26.9 / 1.06	73.9 / 2.91	40.1 / 1.58	0.8 / 0.03	101.6 / 4.00	-	0.25 - 28
	1330	91.9 / 3.62	26.9 / 1.06	84.1 / 3.31	40.1 / 1.58	0.8 / 0.03	115.8 / 4.56	-	0.25 - 28
	1350	91.9 / 3.62	30.2 / 1.19	81.0 / 3.19	45.7 / 1.80	0.8 / 0.03	115.8 / 4.56	-	0.312 - 24
	1410	106.4 / 4.19	30.2 / 1.19	95.2 / 3.75	45.7 / 1.80	0.8 / 0.03	125.5 / 4.94	-	0.312 - 24
	1480	106.4 / 4.19	35.1 / 1.38	93.7 / 3.69	53.8 / 2.12	0.8 / 0.03	134.9 / 5.31	-	0.375 - 24
	1550	126.2 / 4.97	35.1 / 1.38	113.5 / 4.47	53.8 / 2.12	0.8 / 0.03	152.4 / 6.00	-	0.375 - 24
	1610	134.9 / 5.31	47.8 / 1.88	122.2 / 4.81	63.5 / 2.50	9.7 / 0.38	171.4 / 6.75	-	0.375 - 24
	1710	157.2 / 6.19	49.3 / 1.94	142.0 / 5.59	71.4 / 2.81	7.9 / 0.31	190.5 / 7.50	-	0.50 - 20
	1760	180.1 / 7.09	49.3 / 1.94	165.1 / 6.50	71.4 / 2.81	7.9 / 0.31	212.9 / 8.38	-	0.50 - 20
	1810	194.1 / 7.64	49.3 / 1.94	179.1 / 7.05	71.4 / 2.81	7.9 / 0.31	228.6 / 9.00	-	0.50 - 20
Bearing Strap Thru-Hole	1410	106.4 / 4.19	30.2 / 1.19	95.2 / 3.75	45.7 / 1.80	0.8 / 0.03	125.5 / 4.94	8.4 / 0.33	-
	1480	106.4 / 4.19	35.1 / 1.38	93.7 / 3.69	53.8 / 2.12	0.8 / 0.03	134.9 / 5.31	9.9 / 0.39	-
	1550	126.2 / 4.97	35.1 / 1.38	113.5 / 4.47	53.8 / 2.12	0.8 / 0.03	152.4 / 6.00	9.9 / 0.39	-

* Swing diameter clears yoke by 1.5 mm / 0.06 in.

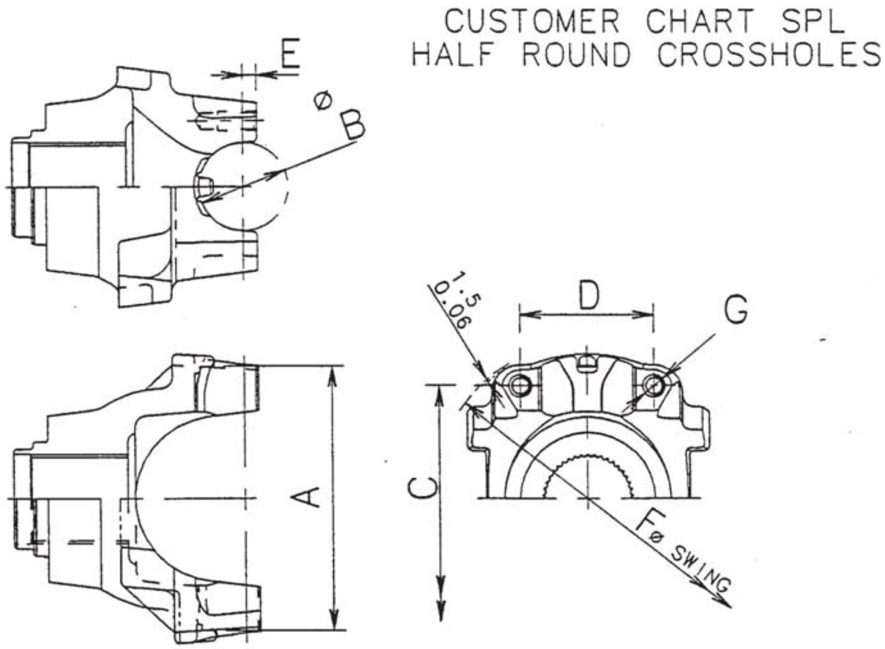
SPL Full Round Cross Holes



Type	Series	A (mm)	B (mm)	C (mm)	D * (mm)	E (mm)
SPL	SPL 140	128	49	32	160	M8 x 1.00
Full	SPL 170	153	55	32	185	M8 x 1.00
Round	SPL 250	152	60	32	184	M8 x 1.00

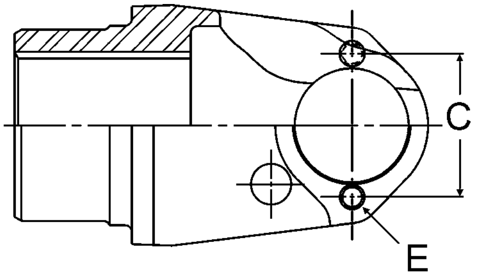
* Swing diameter clears yoke by 1.5 mm.

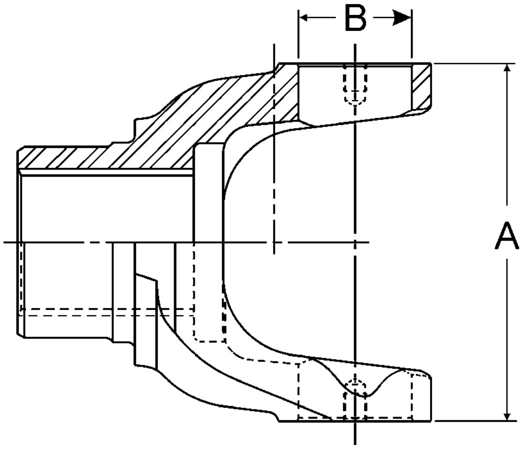
SPL Half Round Cross Holes

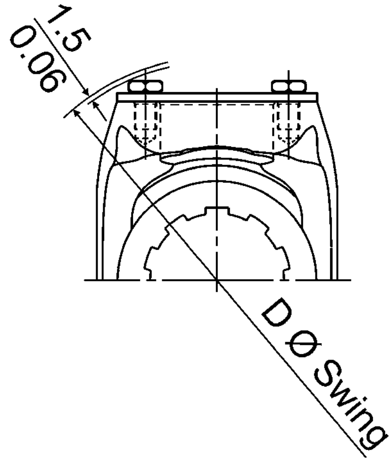


Type	Series	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)	F * (mm)	G (mm)
Bearing Strap Tapped Hole	SPL 55	106.4	35.1	93.7	53.8	0.8	134.9	0.375 x 24 UNF
	SPL 70	126.2	35.1	113.5	53.8	0.8	152.4	0.375 x 24 UNF
	SPL 90 / 100	126	41	115	59	6	154	0.375 x 24 UNF
	SPL 140	139	49	113	76	8	174	12 x 1.25
	SPL 170	164	55	140	82	8	193	12 x 1.25
	SPL 250	163	60	135	88	10	193	12 x 1.25

BP Cross Holes





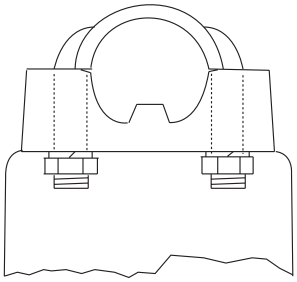


Type	Series	A (mm)	B (mm)	C (mm)	D* (mm)	E (mm)
Bearing Plate Full Round	1610	134.9/5.31	47.8/1.88	58.7/2.31	180.8/7.12	0.312-24
	1710	1.54.7/6.09	49.3/1.94	62.0/2.44	200.2/7.88	0.375-24
	1760	177.8/7.00	49.3/1.94	62.0/2.44	220.5/8.68	0.375-24
	1810	191.8/7.55	49.3/1.94	62.0/2.44	235.0/9.25	0.375-24
	1880	205.5/8.09	55.6/2.19	71.4/2.81	250.9/9.88	0.438-20

*Swing Diameter Clears Yoke by 1.5/0.06 mm/in.

Joint Kit Attaching Hardware and Torque Specifications

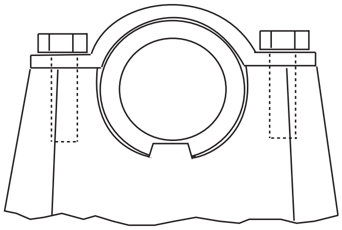
U-bolts



Series	Spicer Kit No	Assemblies	Recommended Nut Torque
1210	5-443X	-	-
1310, SPL22	5-153X, 5-785X, SPL22-1X	2-94-28X	14-17 lbs. ft.
1330, SPL25	5-213X, 5-790X, SPL25-1X	2-94-28X	14-17 lbs. ft.
1350, SPL30	5-178X, 5-799X, SPL30-1X	3-94-18X	20-24 lbs. ft.
1410, SPL36	5-160X, 5-801X, SPL36-1X	3-94-18X	20-24 lbs. ft.
1480, SPL55	5-188X, 5-803X, SPL55X	3-94-28X	32-37 lbs. ft.
1550, SPL70	5-155X, 5-808X, SPL70X	3-94-28X	32-37 lbs. ft.
3R	5-3147X, 5-795X, SPL25-6X	2-94-58X	17-24 lbs. ft.

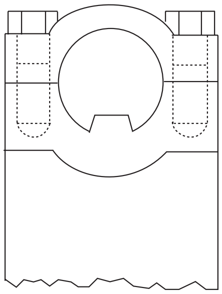
Bearing Strap

WARNING: Bearing strap retaining bolts should not be reused.



Series	Spicer Kit No	Assemblies	Recommended Bolt Torque
SPL90	SPL90X	90-70-28X	45-60 lbs. ft.
SPL100	SPL100-1X	90-70-28X	45-60 lbs. ft.
1210	5-443X	2-70-18X	13-18 lbs. ft.
1310, SPL22	5-153X, 5-785X, SPL22-1X	2-70-18X	13-18 lbs. ft.
1330, SPL25	5-213X, 5-790X, SPL25-1X	2-70-18X	13-18 lbs. ft.
1350, SPL30	5-178X, 5-799X, SPL30-1X	3-70-28X	30-35 lbs. ft.
1410, SPL36	5-160X, 5-801X, SPL36-1X	3-70-28X	30-35 lbs. ft.
1480, SPL55	5-188X, 5-803X, SPL55X	3-70-28X	30-35 lbs. ft.
1550, SPL70	5-155X, 5-808X, SPL70X	3-70-28X	30-35 lbs. ft.
1610	5-674X	5-70-28X	45-60 lbs. ft.
1710	5-675X	6.5-70-18X	115-135 lbs. ft.
1760	5-677X	6.5-70-18X	115-135 lbs. ft.
1810	5-676X	6.5-70-18X	115-135 lbs. ft.
3R	5-3147X, 5-795X, SPL25-6X	2-70-48X	30-35 lbs. ft.
7260	5-1306X, 5-789X, SPL22-8X	2-70-38X	13-18 lbs. ft.

Cap and Bolts



(*) Discontinued

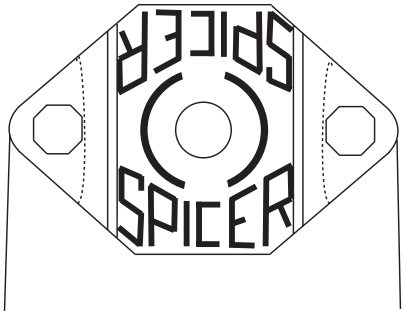
Series	Spicer Kit No	Assemblies	Recommended Bolt Torque
1650	5-165X	5-70-18X	77-103 lbs. ft.
1850	5-185X	8-70-18X (*)	110-147 lbs. ft.
2050	5-340X	9-70-28X (*)	744-844 lbs. ft.

Bearing Plate

WARNING: Self locking bolts should not be reused.

Serrated Bolts with Lock Patch / No Lock Strap (Models after Spring 1994)

Series	Bolt Part No	Thread Size	Recommended Bolt Torque
1610	5-73-709	.312-24	26-35 lbs. ft.
1710	6-73-209	.375-24	38-48 lbs. ft.
1760	6-73-209	.375-24	38-48 lbs. ft.
1810	6-73-209	.375-24	38-48 lbs. ft.
1880	7-73-315	.438-20	60-70 lbs. ft.



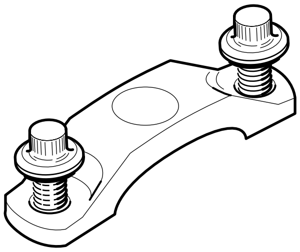
Bolt with Lock Strap (Pre-Spring 1994 Models)

Series	Bolt Part No	Thread Size	Recommended Bolt Torque
1610	5-73-109	.312-24	26-35 lbs. ft.
1710	6-73-109	.375-24	38-48 lbs. ft.
1760	6-73-109	.375-24	38-48 lbs. ft.
1810	6-73-109	.375-24	38-48 lbs. ft.
1880	7-73-115 (*)	.438-20	60-70 lbs. ft.

Quick Disconnect (Half Round)

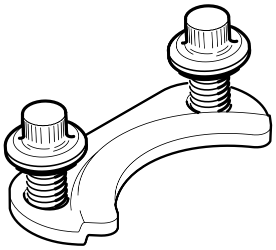
Series	Bolt Part No	Thread Size	Recommended Bolt Torque
SPL90	6-73-412	.375-24	45-60 lbs. ft.
1610	6-73-412	.375-24	45-60 lbs. ft.
1710	8-73-316	.500-20	115-135 lbs. ft.
1760	8-73-316	.500-20	115-135 lbs. ft.
1810	8-73-316	.500-20	115-135 lbs. ft.

Bearing Retainer



Series	Spicer Kit No	Retainer Kit No	Bolt Part No	Recommended Bolt Torque
SPL140	SPL140X	140-70-18X	5007417	115-135 lbs. ft.
SPL170	SPL170X	170-70-18X	5007417	115-135 lbs. ft.
SPL250	SPL250X	250-70-18X	5007417	115-135 lbs. ft.

Spring Tab



Series	Spicer Kit No	Spring Tab Kit No	Bolt Part No	Recommended Bolt Torque
SPL140	SPL140X	211941X	8-73-114M	25-30 lbs. ft.
SPL170	SPL170X	211941X	8-73-114M	25-30 lbs. ft.
SPL250	SPL250X	211941X	8-73-114M	25-30 lbs. ft.

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