Spicer® Off-Highway Driveshaft Standard Product Catalog

Introduction

In 1904, Clarence Spicer revolutionized the vehicular chain-driven systems of his day with the first practical application of a cardan universal joint. Ever since then, Spicer engineers have been creating and refining driveshaft technologies to provide more power, greater efficiency and better overall performance. Today, the Spicer Off-Highway Driveshaft Group serves the global off-highway and industrial marketplace as part of the Dana Corporation. With the acquisition of Spicer GWB™ and Spicer Italcardano™, Spicer Driveshaft has numerous operations in 10 countries, manufacturing and assembling the most extensive line of driveshaft products for the off-highway and industrial markets.

This driveshaft catalog illustrates many of the standard universal joint couplings that are manufactured by Dana Corporation. These driveshafts are installed in many applications ranging from off-highway equipment to industrial machines. The items listed are considered standard and are sold most commonly for approved applications. If a part is not listed, or you have a unique application please contact a Spicer Off-Highway Driveshaft engineer at 419-887-3000, and they can make individual recommendations to fit your needs.

It is important to note that the data listed here is correct to the best of our knowledge and belief, having been compiled from reliable and official sources of information. However, WE CANNOT ASSUME ANY RESPONSIBILITY for possible errors.

How to Read this Catalog

Before you get Started

W A R N I N G

Contact with a rotating driveshaft can result in serious injury or even death. Safety guards should be used at all times to protect individuals from contact with a rotating shaft, and/or to contain the shaft in the event of a failure.

C A U T I O N

Under no circumstance should individuals attempt to perform driveshaft service and/or maintenance procedures for which they have not been trained or do not have the proper tools and equipment. This catalog is not a service manual - please refer to Spicer Service Manual 3264-SPL or OHD-3264-04 for proper maintenance information.

N o t e

This is an off-highway and industrial catalog only. For on-highway applications please refer to DSAG-0200

N o t e

This catalog is intended for driveshaft application engineers. For further engineering information refer to SAE AE-7.

Application Policy

Capability ratings, features and specifications vary depending upon the model type of application and the type of service. Application approval must be obtained from Spicer Off-Highway Driveshaft Engineering. We reserve the right to change or modify our product specifications, configurations or dimensions at any time without notice.

Part Number Determination

Included in this catalog are standard Spicer Off-Highway assembly part numbers for tube type driveshafts. Each assembly has its own individual simple formula for calculating the proper tube length of the collapsed assembly.

*10-Series

The four digits to the right of the dash on all Spicer driveshaft parts are used to identify the length of the tube used in the shaft. The first two digits indicate the length in whole numbers of inches while the last two digits indicate the fractions of inches in 32 nds. That is to say a tube length of 9 1/2 inches would be expressed as "-0916" (nine and 16/32 inches).

whole inches fraction of inches

909250-0916

length

*SPL-Series

The four digits to the right of the dash on Spicer Life Series driveshaft parts are used to identify the length of the tube used in the shaft. The four digits indicate the length in millimeters followed by the letter "M". That is to say a tube length of 923mm would be expressed as "-0923M".

*Note: Shaft length is always expressed fully collapsed.

whole millimeters

170DS55022-0923M

length

Torsional Rating Definitions

T_{lnd} **Industrial Rating**	The driveshaft torque that will achieve 5000 hours of life (B10) at 100 RPM and 3 degrees of angularity.
T_{MOH} **MOH Rating**	The maximum driveshaft torque that will allow infinite fatigue life of all driveshaft components. Usually equated to a driveshaft stall torque in equipment that produces low speed, high unidirectional loading.
Maximum Net Driveshaft Power	The power that can transmitted by the driveshaft and achieve 5000 hours of B10 life with 3 degrees of universal joint angularity. Can be used to size on/off-highway vehicle driveshaft, but with caution. Extreme low gear ratios can result in torques that will exceed the driveshaft yield strength.
T_d **Bearing Capacity**	The ISO rating for the universal joint bearing. Equates to the load that can be applied to the bearing that will result in a B10 life of 1 million revolutions. The bearing capacity is used in the bearing life equation.
Mass Moment of Inertia	The component mass moment of inertia value represents an approximation of the standard driveshaft componemt for a given series. This value **does not** contain tubing mass moment of inertia. Exact values may vary.
Tubing Mass Moment of Inertia	Tubing mass moment of inertia value is a calculated value based on the standard tubing size for the series.

Guidlines for Selection of Driveshaft Series for Stationary Industrial Applications

Selection of the correct driveshaft series is dependent on the power being transmitted, the alignment or angularity of the driveshaft and the life requirements.

Step 1

The selection process is to determine the ***Equivalent Torque,*** T_e from the expression given by:

$$T_e = k_p k_a k_l T_n$$

Where:

T_e = Equivalent Torque

k_p = Power Factor - from Table 1 (below)

k_a = Angularity Factor - from Chart 1

k_l = Life Requirement Factor - from Chart 1A

T_n = Nominal Transmitted Torque

Power Factor - k_p	
Electric Motor	1.00
Gasoline Engine	1.20
Diesel Engine	1.25

Table 1

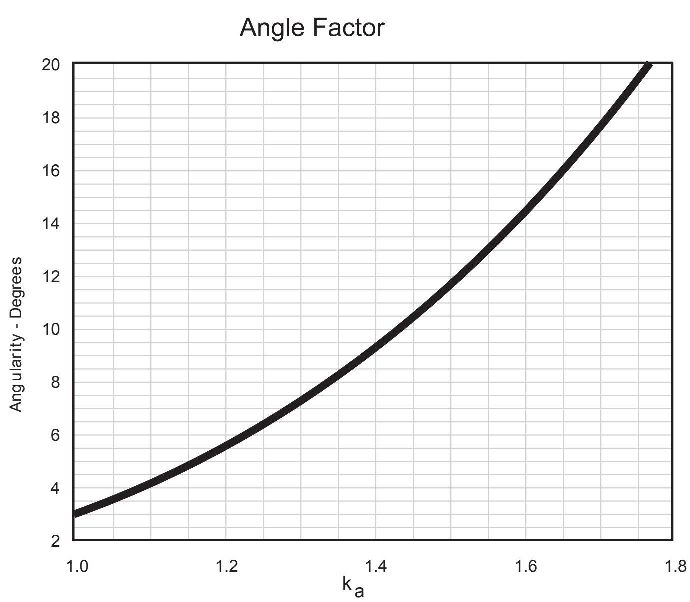


Chart 1

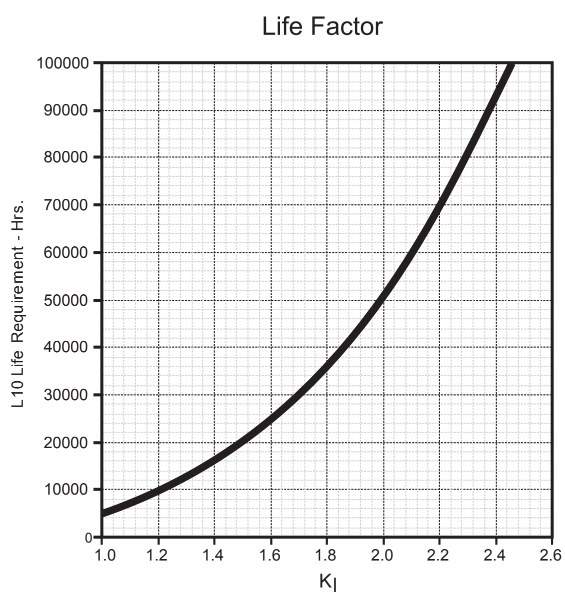


Chart 1 A

Step 2

The *Nominal Transmitted Torque* is determined from the transmitted power using the expression:

$$T_n = 9549 \frac{P}{n}$$

Where:

T_n = Nominal Transmitted Torque - Nm

P = Nominal Power - kW

n = Driveshaft Speed - RPM

If English units are preferred, the following expression can be used to determine the *Nominal Transmitted Torque*:

$$T_n = 5252 \frac{P}{n}$$

Where:

T_n = Nominal Transmitted Torque - Lb Ft

P = Nominal Power - HP

n = Driveshaft Speed - RPM

Step 3

Using the performance chart for the desired driveshaft type, select the appropriate driveshaft size (see Charts 2 through 4 on pages 5,6,& 7).

Step 4

A check must be made to verify that the maximum torsional rating for the selected driveshaft is not exceeded. Compare the maximum expected shock load with the series *Industrial Rating,* T_{Ind}, from the appropriate *Torsional Rating* Specifications (Tables 2 through 4).

$$T_{Ind} > T_n k_{sf}$$

Service factor k_{sf} is dependent on the application. For easy reference, service factors for typical applications can be found in Table 5 on page 8.

Note

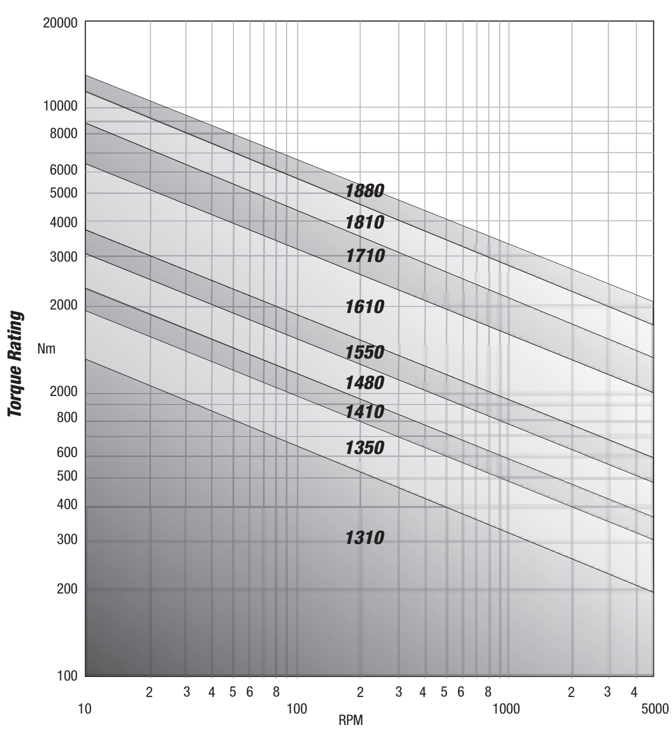
If the expected shock load exceeds the maximum torsional rating, increase driveshaft series until sufficient torsional capacity is assured.

Driveshaft Torsional Ratings* - 10 Series™

Driveshaft Series	Industrial Rating T_{Ind}		MOH Rating T_{MOH}		Maximum Net Driveshaft Power		Bearing Capacity T_d		Component Mass Moment of Inertia		Tubing Mass Moment of Inertia	
	Nm	LbFt	Nm	LbFt	KW	HP	Nm	LbFt	kg cm^2	$LbFt^2$	kg cm^2/100 mm	$LbFt^2$/in
1310	1490	1100	1490	1100	46	62	631	466	26	.061	2.99	.0018
1350	2400	1790	2100	1580	70	94	958	707	51	.120	5.32	.0032
1410	2900	2160	2100	1580	85	110	1154	851	79	.186	8.48	.0051
1480	3900	2890	2400	1800	100	130	1517	1119	145	.344	8.48	.0051
1550	5050	3720	3100	2280	125	170	1900	1401	256	.606	9.64	.0058
1610	7780	5740	4670	3450	180	240	3200	2360	585	1.385	13.13	.0079
1710	10,300	7610	6200	4570	245	330	4306	3176	862	862	19.95	.0120
1710HD	11,500	8475	8400	6210	245	330	4306	3176	862	2.042	27.57	0.166
1760	13.750	10,150	6200	4570	270	360	4782	3527	793	1.880	19.95	.0120
1760HD	13,870	10,230	8400	6210	270	360	4782	3527	778	1.848	27.57	0.166
1810	15,000	11,060	7900	5850	320	430	5620	4144	1542	3.652	28.60	0.172
1810HD	15,000	11,060	10,760	7940	320	430	5620	4144	1542	3.652	50.87	0.306
1880	21,980	16,210	14,050	10,380	375	500	6565	4842	2401	5.686	50.87	0.306

Table 2

*Note See page 2 for definitions.



Driveline Speed

Chart 2

Equivalent Torque - 10 Series

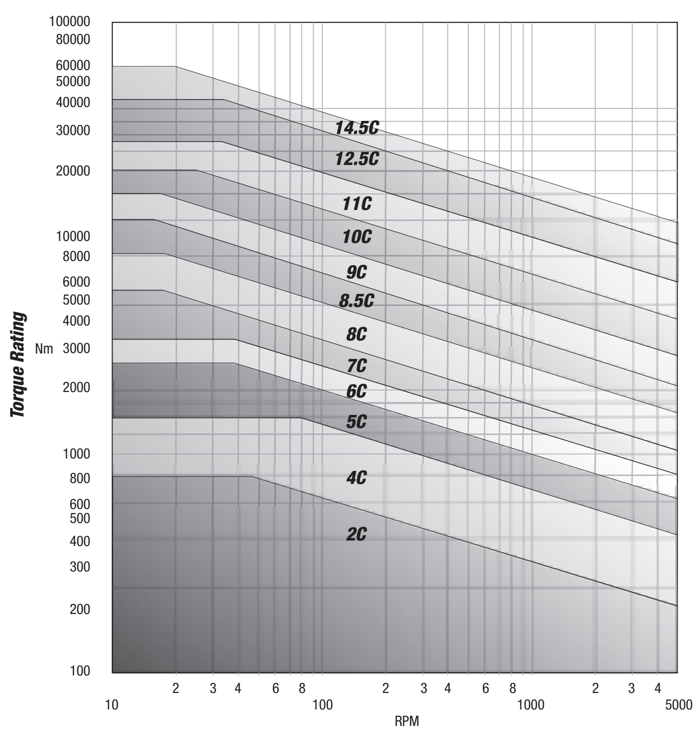
Performance Charts for Industrial Driveshaft Selection

Driveshaft Torsional Ratings* - Wing Bearing Series™

Driveshaft Series	Industrial Rating T_{Ind}		MOH Rating T_{MOH}		Maximum Net Driveshaft Power		Bearing Capacity T_d		Component Mass Moment of Inertia		Tubing Mass Moment of Inertia	
	Nm	LbFT	Nm	LbFT	KW	HP	Nm	LbFt	$kg\ cm^2$	$LbFt^2$	$kg\ cm^2/100\ mm$	$LbFt^2/in$
2C	800	590	800	590	48	64	650	479	25	.059	1.9	.00115
4C	1500	1110	1200	900	106	140	1400	1033	63.5	.151	1.9	.00115
5C	2650	1950	2130	1570	145	190	2000	1475	98	.233	3.9	.00235
6C	3400	2510	3200	2370	170	230	2600	1918	185	.439	7.1	.00428
7C	5700	4200	5260	3880	220	290	3400	2508	360	.859	14.5	.00874
8C	8500	6270	8500	6270	290	390	5100	3762	872	2.069	30.70	.01850
8.5C	14,000	10,330	9750,9	7190	390	520	6800	5015	1583	3.757	30.70	.01850
9C	18,600	13,720	15,850	11,700	530	710	9300	6859	2610	6.194	57.46	.03463
10C	26,000	19,180	17,140	12,640	740	990	13,000	9588	TBD	TBD	79.95	.04819
11C	27,000	19,910	17,140	12,640	785	1050	13,800	10,178	TBD	TBD	79.95	.04819
11.5C	28,000	20,650	19,000	14,040	1140	1530	20,000	14,751	3634	8.624	74.56	.04494
12.5C	43,600	32160	30,750	22,680	1765	2370	31,000	22,865	6806	16.151	138.1	.08324
14.5C	62,500	46100	49,200	36,280	216	2900	38,000	28,028	12,906	30.626	250.6	.15105

Table 3

*Note See page 2 for definitions.



Driveline Speed

Chart 3

Equivalent Torque - Wing Bearing Series

Performance Charts for Industrial Driveshaft Selection

Driveshaft Torsional Ratings - Spicer Life Series ®*

Driveshaft Series	Industrial Rating T_{Ind}		MOH Rating T_{MOH}		Maximum Net Driveshaft Power		Bearing Capacity T_d		Component Mass Moment of Inertia		Tubing Mass Moment of Inertia	
	Nm	LbFt	Nm	LbFt	KW	HP	Nm	LbFt	kg cm^2	$LbFt^2$	kg cm^2/100 mm	$LbFt^2$/in
SPL 22	1490	1100	1150	860	45	60	631	466	26	.061	2.99	.0018
SPL 25	1700	1280	1300	980	55	74	735	542	TBD	TBD	TBD	TBD
SPL 30	2400	1800	1600	1170	70	94	958	707	51	.120	5.32	.0032
SPL 36	2900	2150	1900	1400	85	110	1154	851	145	.344	8.48	.0051
SPL 55	3900	2890	2900	2150	100	130	1517	1119	145	.344	8.48	.0051
SPL 70	5050	3720	3700	2740	125	170	1900	1401	155	.369	12.77	.0077
SPL 100	6550	4830	5300	3900	170	230	2981	2199	445	1.06	TBD	TBD
SPL 140	9850	7270	7400	5470	235	310	4165	3072	475	1.127	35.17	.0212
SPL 170	13 700	10 120	9000	6650	340	460	6010	4433	842	1.998	33.34	.0201
SPL170HD	13 700	10 120	12 370	9125	340	460	6010	4433	844	2.003	50.59	.0305
SPL250	15 950	11 760	12 370	9125	390	520	6897	5087	1016	2.412	50.14	.0302
SPL250HD	15 950	11 760	14 650	10 800	390	520	6897	5087	1022	2.426	60.09	.0361

Table 4

*Note See page 2 for definitions.

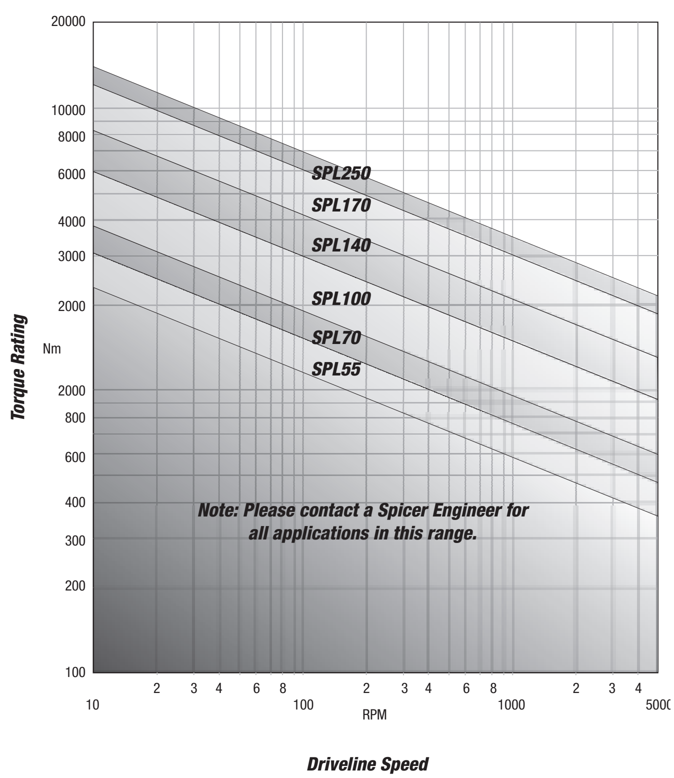


Chart 4

Equivalent Torque - Spicer Life Series

Performance Charts for Industrial Driveshaft Selection

Application Service Factors		
Load Condition	**Driven Equipment**	**Service Factor *ksf***
Continuous Load	Centrifugal Pumps	1.2 - 1.5
	Generators	
	Conveyors	
	Ventilators	
Light Shock Load	Centrifugal Pumps	1.5 - 2.0
(Frequent Starts and Stops)	Generators	
	Conveyors	
	Ventilators	
	Machine Tools	
	Printing Machines	
	Wood Handling Machines	
	Paper and Textile Machines	
Medium Shock Loads	Multi Cylinder Pumps	2.5
	Multi Cylinder Compressors	
	Large Ventilators	
	Marine Transmissions	
	Calendars	
	Transport Rolling Tables	
	Rod and Bar Mills	
	Small Pitch Rolls	
	Small Tube Mills	
	Locomotive Primary Drives	
	Heavy Paper and Textile Mills	
	Irrigation Pumps	
	Blowers	
Heavy Shock Loads	One Cylinder Compressors	3.0
	One Cylinder Pumps	
	Mixers	
	Crane Travel Drives	
	Bucket Wheel Reclaimers	
	Pressers	
	Rotary Drill Rigs	
	Locomotive Secondary Drives	
	Continuous Working Roller Tables	
	Medium Section Mills	
	Continuous Slabbing and Blooming Mills	
	Continuous Heavy Tube Mills	
	Blowers - Heavy Duty	
Extreme Shock Loads	Breast Roller Drives	4.0 - 6.0
	Wrapper Roller Drives	
	Reversing Working Roller Tables	
	Reversing Slabbing and Blooming Mills	
	Scale Breakers	
	Vibration Conveyors	

Table 5

Universal Joint Service Life

Approximate universal joint service life can be determined from the expression:

$$B_{10} = \frac{1.5 \times 10^6}{n\theta} \left(\frac{T_d}{T}\right)^{\frac{10}{3}}$$

Where:

B_{10} = Service Life - *Hrs*

T_d = Universal Joint Bearing Capacity - *See Note*

T = Driveshaft Torque - *See Note*

n = Driveshaft Speed - *RPM*

θ = Universal Joint Angularity - *Deg*

NOTE: Bearing Capacity and Driveshaft Torque must have consistant units

B_{10} life is the hours of life that 90% of the universal joint bearings will achieve successfully. Bearing capacities for each series can be found in the *Driveshaft Torsional Ratings* for the driveshaft type in question (Tables 2 through 4). The universal joint angularity in degrees is defined as the angle, θ, in the above expression. Angularity between 0.5˚ and 3.0˚ should be entered as 3.0˚. In practice, angularity of less than 0.5˚ should be avoided.

Guidelines for Selection of Driveshaft Series for Mobile Applications

Mobile Industrial applications are specialized vehicles or machines that are used primary for transport of payloads from one location to another location in the industrial or off-highway setting. Loads, speeds and angularity of the driveshaft will vary with time, and considerations for service life will depend on the fatigue of not only the universal joint bearings, but also the structural components of the driveshaft.

When a time history of load, speed, and angularity are known, bearing life can be approximated using the following expression for Miner's rule of cumulative fatigue damage.

$$B_{10} = \frac{1}{\sum \frac{t_i}{B_{10_i}}}$$

Where:

B_{10} = Service Life - *Hrs*

B_{10i} = Calculated bearing life at a given condition of speed, torque and angle - see the expression given in the section titled *Universal Joint Service Life*, above.

t_i = Decimal percent of the total time the driveshaft will operate at that condition.

If the variation in load, speed, and angularity, with time are not known, selection can be based on the driveshaft net power. Maximum allowable power for each driveshaft size can be found in the *Driveshaft Torsional Ratings* tables. Maximum driveshaft torque cannot exceed the *Industrial Rating*, T_{Ind}, for the selected size.

Driveshaft applications for off-highway equipment that experience high cyclic loading, such as front loaders, require the selection of a driveshaft size that will provide adequate service life not only of the universal joint bearings, but other components of the driveshaft as well. Stress levels of all structural components that make up the driveshaft must fall below the endurance limits of the materials that make up these components. In applications of this type, the maximum driveshaft torque cannot exceed the MOH Rating, T_{MOH}, found in the appropriate *Driveshaft Torsional Ratings* table.

Guidelines for Selection of Driveshaft Series for Agricultural Applications

Driveshaft selection for agricultural tractors and other agricultural machinery can be accomplished using the method outlined for Industrial applications.

Assuming the machine will be used at or near full available power, the power at the driveshaft can be determined by subtracting drivetrain losses from the gross engine power.

$$P = P_{gross\,-\,eng} - P_{losses}$$

Driveshaft speed is then determined from the average working velocity of the machine. The expression for rotational speed at the driveshaft is:

$$n = 2.65\frac{V \times R_a}{r}$$

Where:

n = Driveshaft rotational speed - *RPM*

V = Tractor velocity - *km/hr*

R_a = Total speed reduction between driveshaft and wheel

r = Tire radius - *meters*

If English units are preferred, the following expression can be used to determine rotational speed:

$$n = 168\frac{V \times R_a}{r}$$

Where:

n = Driveshaft rotational speed - *RPM*

V = Tractor velocity - *MPH*

R_a = Total speed reduction between driveshaft and wheel

r = Tire radius - *inches*

The Equivalent Torque is determined from:

$$T_e = k_a k_l T_n$$

Where:

T_e = Equivalent Torque

k_a = Angularity Factor - *from Chart 1*

k_l = Life Requirement Factor - *from Chart 2*

T_n = Nominal Transmitted Torque (*from page 1*)

Using the *Performance Chart* for the desired driveshaft type, (Charts 2 through 4 on pages 5-7). Select the appropriate driveshaft size.

Angle-Speed Combination

Since the Cardan universal joint is a kinematic mechanism that results in nonuniform output motion, care must be taken to insure the dynamic torsional moments resulting from this motion do not exceed limits that will impose damage to the drivetrain components. The dynamic torsional moments are a function of the angularity, the speed of rotation, and the mass moment of inertia of the driveshaft. Referring to Chart 5 below, the maximum Speed x Angle (driveshaft speed multiplied by the true angularity of the driveshaft) combination can be determined for the rotational inertia of the selected driveshaft size. Values for rotational inertia are included in Tables 2-4 on pages 5-7.

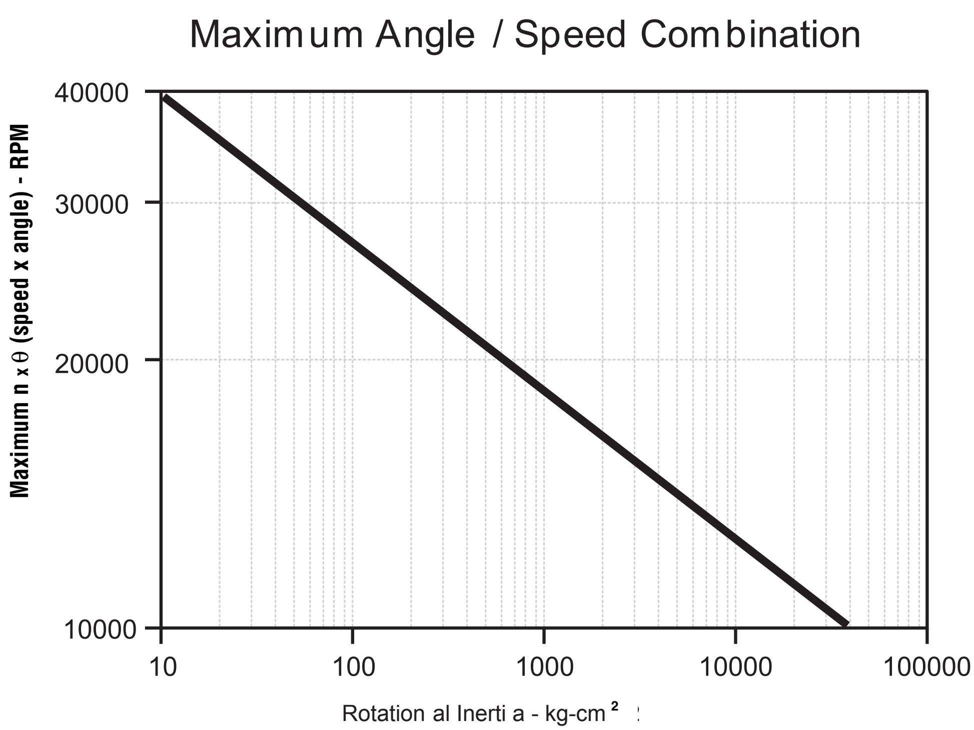


Chart 5

Rotational inertia ($Kg\text{-}cm^2$) = component mass moment of inertia ($Kg\text{-}cm^2$)+Tubing length (mm)/100 x tubing mass($Kg\text{-}cm^2$) / 100mm

Driveshaft Length Limitations

Step 1 Critical Speed Calculations

In extremely long and/or high speed drivelines, driveshaft length can be restricted by critical speed of the driveshaft assembly. The maximum safe rotational speed, for a steel shaft, can be determined from the following relationship between tube size and driveshaft length.

$$n_{\max} = \frac{6.814 \times 10^7 \sqrt{D^2 + d^2}}{l^2}$$

Where:

n_{max} = Maximum safe rotational speed - r*pm*

D = Outer diameter of the driveshaft tube - *mm*

d = Inner diameter of the driveshaft tube - *mm*

l = Length, center to center of U-Joints in the operating position - *mm*

When English units are prefered, the following expression can be used to determine the maximum safe rotational speed of the driveshaft.

$$n_{\max} = \frac{2.682 \times 10^6 \sqrt{D^2 + d^2}}{l^2}$$

Where:

n_{max} = Maximum safe rotational speed - *RPM*

D = Outer diameter of the driveshaft tube - *inch*

d = Inner diameter of the driveshaft tube - *inch*

l = Length, center to center of U-Joints in the operating position - *inch*

When multiple section driveshaft are used, the coupling shaft(s) will be supported on one end by a rotational bearing fixed to the supporting structure. The length, l, is measured from this supporting bearing to the center of the universal joint on the opposite end of the coupling shaft.

Step 2 Determine Series Maximun Rotation Speed

Series	*Maximum Safe Operating Speed (RPM)*
1310, SPL 22	6000
1330, 1350, 1410, 1480, 1550, SPL 25, 30, 36, 55, 70, 90, 100	5000
1610, 1710, 1760, 1810	4500
SPL 140, 170, 250	4000
1880	3000

Table 6

Step 3 Determine the Maximun Operating Length of the Driveshaft Assembly

Tube O.D.		Maximun Length	
Millimeters	Inches	Millimeters	Inches
76	3.0	1524	60
89	3.5	1651	65
101	4.0	1778	70
114	4.5	1905	75
127	5.0	2032	80

Chart 3

Step 4

Safe operation speed is determined by the smallest value in steps 1-3. If your application does not meet the above criteria call Spicer Off-Highway Driveshaft Engineering.

Shaft Alignment Limitations

During the installation of the driveshaft, it is not required to precision align the driving shaft with the driven shaft, as would be required with other type of couplings. However, cancellation of the nonuniform motion characteristics of the cardan joints will occur when the angularity of each universal joint is equal and in the same plane. Deviations from this ideal cancellation should be limited to the motion that produces an angular acceleration of less than 300 rad/sec^2. This deviation, in terms of angular acceleration, can be determined from the following relationship.

One piece driveshaft $$\alpha = ((3.34 \times 10^{-6})\ x\ n^2\ (\theta_i^2 - \theta_o^2)) < 300\ rad / sec^2$$

Two piece driveshaft $$\alpha = ((3.34 \times 10^{-6})\ x\ n^2\ (\theta_i^2 - \theta_c^2 + \theta_o^2)) < 300\ rad / sec^2$$

Where:

α = Resultant output angular acceleration - *rad/sec2*

θ_i = Input universal joint angularity - *degrees*

θ_c = Center universal joint angularity - *degrees*

θ_o = Output universal joint angularity - *degrees*

n = Driveshaft Speed - *RPM*

The relationship above assumes the angularity at each end of the driveshaft lies in the same plane and the driveshaft is of standard factory construction. If they are not, contact the *Spicer Off-Highway Engineering Group.*

When an offset between the driving component and the driven component of the drivetrain occurs in both the side and plan views, the true angularity of the driveshaft can be closely approximated from the expression:

$$\theta = \sqrt{\theta_p^2 + \theta_s^2}$$

Where:

θ = True angularity of the driveshaft - *deg*

θ_p = Plan view angularity - *deg*

θ_s = Side view angularity - *deg*

Joint Life

For maximum durability of the universal joint bearings, the true angularity at each end of the driveshaft should be between 0.5° and 3.0°.

Lubrication

For optimal service life, it is recommended that universal joint bearings and slip members be lubricated with a lubricant meeting the following requirements.

- Good quality grease with E.P. (extreme pressure) capability
- Timken Test Load of 23 Kg minimum
- Meets N.L.G.I. (National Lubricating Grease Institute) Grade 2 Specifications
- Grease operating temperature range of +325˚F to -10˚F (+163˚C to -23˚C)

Lubrication intervals depend on the usage. Driveshafts used in normal industrial applications should be serviced every 500 hours. If the application or environment is severe, servicing interval should be reduced to 200 hours or less. In off-highway applications service the driveshaft every 8,000 to 12,000 Km (5,000 to 8,000 miles) or 3 months, whichever comes first. Driveshaft are also available that have longer intervals or no servicing requirements. Contact Spicer Off-Highway Engineering for recommendations on these types of driveshaft. For further information on methods of proper servicing, refer to Spicer 10 Series Service Manual Section 3, Form number 3283, and Spicer Life Series Service Manual Section 2, 3264-SPL.

Examples of Driveshaft Selection Procedure

Example 1

A 22 kW DC motor drives a centrifugal water pump at 1000 RPM. The universal joint angularity at each end of the driveshaft is 6 degrees. Determine the joint size required to achieve a minimum of 50,000 hours service life.

Use the expression $T_e = k_p k_a k_l T_n$ to determine the *Equivalent Torque*.

The nominal torque, $T_n = 9549 \frac{P}{n} = 9549 \frac{22}{1000} = 210\ Nm$

From Table 1 and Charts 1 and 2,

k_p	= Power Factor 1.0	Page 3 Table 1
k_a	= Angle Factor 1.24	Page 4 Chart 1
k_l	= Life factor 2.0	Page 4 Chart 1a

Therefore, the equivalent torque is $T_e = 1.0 \times 1.24 \times 2.0 \times 210 = 520\ Nm$

Referring to the Performance Charts, the minimum required driveshaft size for this application is 1410 series (Chart 2), 4C (Chart 3), or SPL 36 (Chart 4).

A check of the expected shock load on the driveshaft for a continuously loaded centrifugal water pump application would indicate a service factor of 1.2 (Table 5 Page 8).

$$k_{sf} T_n = 1.2 \times 210 = 252\ Nm$$

From the Driveshaft Torsional Ratings we note that the 1410 series is rated at 2900 Nm, the 4C is rated at 1500 Nm, and the SPL 36 is rated at 2900 Nm. All three driveshafts have torsional capacities that exceed the expected shock load of 252 Nm. The actual expected service life of the SPL 36 series universal joint bearings can be determined from the following expression.

$$B_{10} = \frac{1.5 \times 10^6}{n\theta} \left(\frac{T_d}{T}\right)^{\frac{10}{3}}$$

Where:

n = Driveshaft Speed

θ = Angularity = 6°

T_d = Bearing Capacity = 1154 Nm *(from the Torsional Capacity Chart for the SPL 36)*

$$B_{10} = \frac{1.5 \times 10^6}{1000 \times 6} \left(\frac{1154}{210}\right)^{\frac{10}{3}} = 73,200\ Hrs$$

Example 2

A 10 horsepower DC electric motor running at 450 RPM drives a presser roll on a paper machine through a 14 to 1 reduction gear box. The driveshaft transfers the power from the reduction box to the presser roll. Driveshaft angularity, with offset in the plan view only, is 5 degrees. Select the proper driveshaft size which will achieve a minimum service life of 40,000 hours.

Use the expression $T_e = k_p k_a k_l T_n$ to determine the *Equivalent Torque.*

The nominal torque is given by the expression $T_n = 5252 \frac{P}{n}$

Where the power is given as 10 HP and the driveshaft speed is $n = \frac{450}{14} = 32\ RPM$

Nominal Torque is $T_n = 5252 \frac{10}{32} = 1641\ LbFt$

k_p	= Power Factor = 1.0	Page 3 Table 1
k_a	= Angle Factor = 1.16	Page 4 Chart 1
k_l	= Life Factor = 1.88	Page 4 Chart 1A

The equivalent torque is then $T_e = 1.0 \times 1.16 \times 1.88 \times 1641 = 3580\ LbFt$

The minimum required driveshaft size for this application is 1710 (Chart 2), 8C (Chart 3), or SPL 140 (Chart 4).

The Industrial rating of the selected driveshaft must be greater than the expected shock load on the driveshaft. From Table 2, for a light duty paper roll application, a service factor of 2.0 is required. Therefore, the maximum expected shock load would be

$$T_{ind} > k_{sf} T_n = 2.0 \times 1641 = 3282 LbFt$$

The SPL 140 has an industrial rating of 7270 LbFt, while the 1710 and 8C driveshafts have ratings of 7610 LbFt and 6270 LbFt, respectively. All three driveshafts have adequate capacity for this application.

Guidelines for Selection of Driveshaft Series

Typical driveshaft applications consider two torque levels that a powertrain can deliver to the shaft system and that the tires can deliver to the ground as effective propulsion: net engine/transmission output torque and wheelslip torque. The selected driveshaft series is based on the lowest value of these two conditions and the low gear ratio, unless mitigating circumstances, such as special duty cycles or know modes of operation, dictate otherwise. In its most elementary condition the following equations would be used, along with the charts on pages 18 & 19.

Net engine/transmission output: (ft lb)

$E/T = NET \times TLG \times Rc \times T_{eff}$

NET – Net Torque of the Engine (ft lb)

TLG – Transmission Low Gear Ratio

Rc – Torque Converter Stall Ratio

T_{eff} – Transmission Efficiency

Wheel Slip: (ft lb)

$WS = (W \times F \times RR)/(12 \times AR \times A_{eff})$

W – GVW (drive axle) or GAWR (lbs)

F – Static Coefficient of Friction

RR – Rolling Radius

AR – Axle Ratio

A_{eff} – Axle Efficiency

The above information should be used to complete the application sheets located in the Application Forms tab of this catalog pages 1-4.

10 Series™

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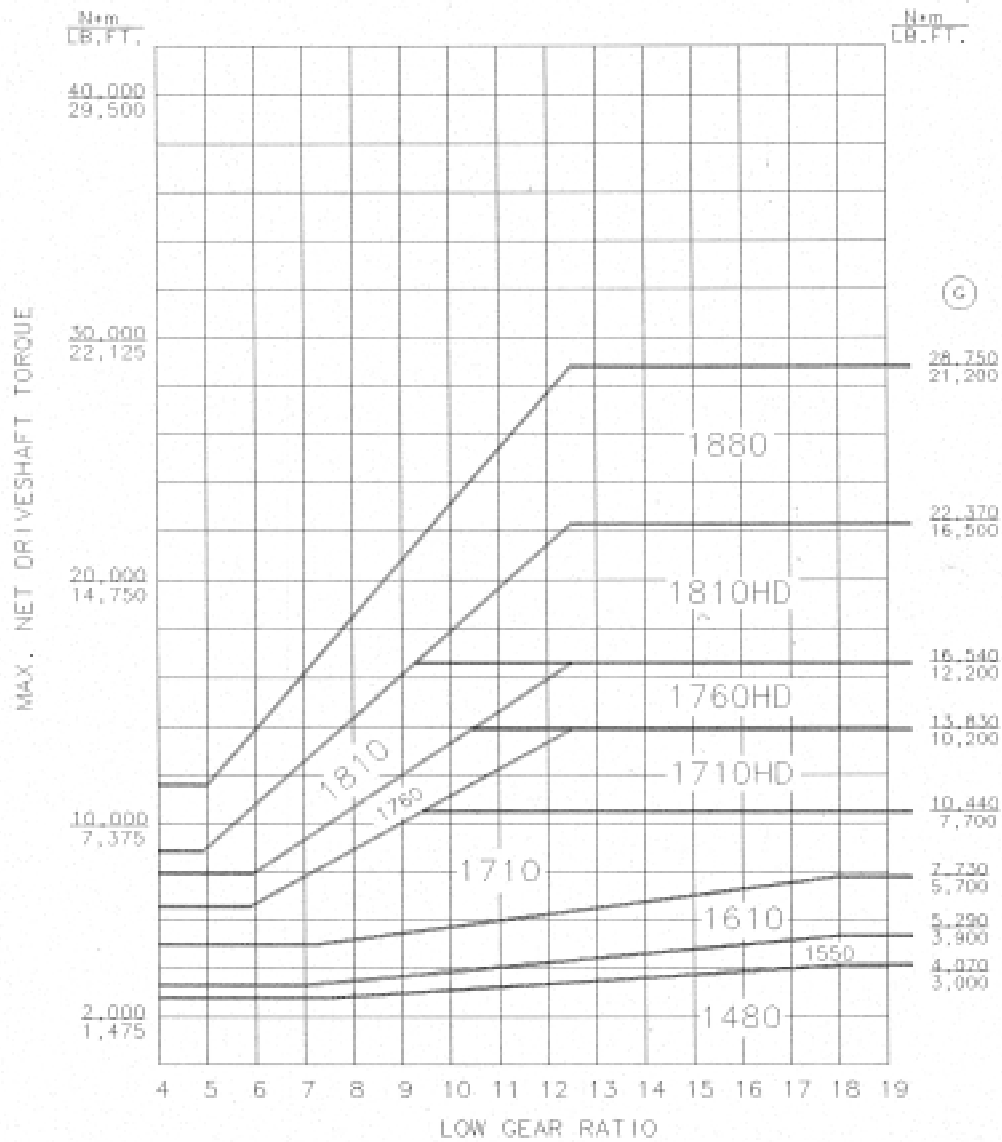

NOTE: To be used in conjunction with Dana Corporation,
Spicer driveshaft division engineering.

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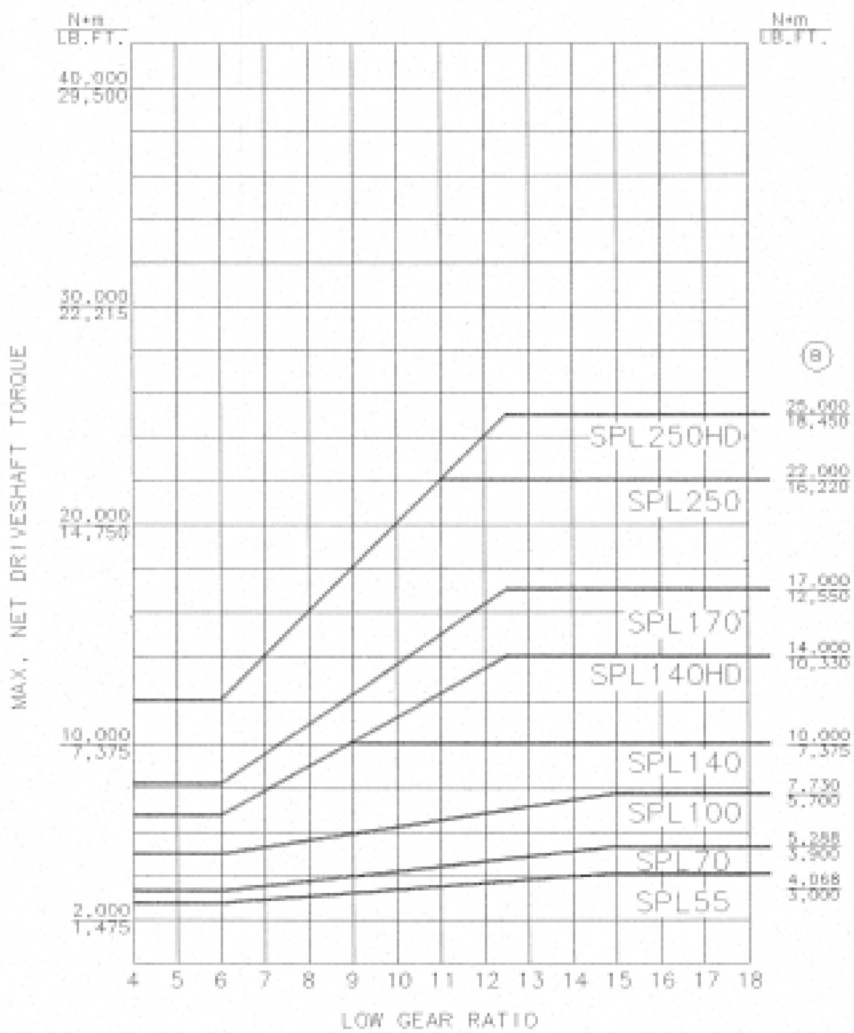

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