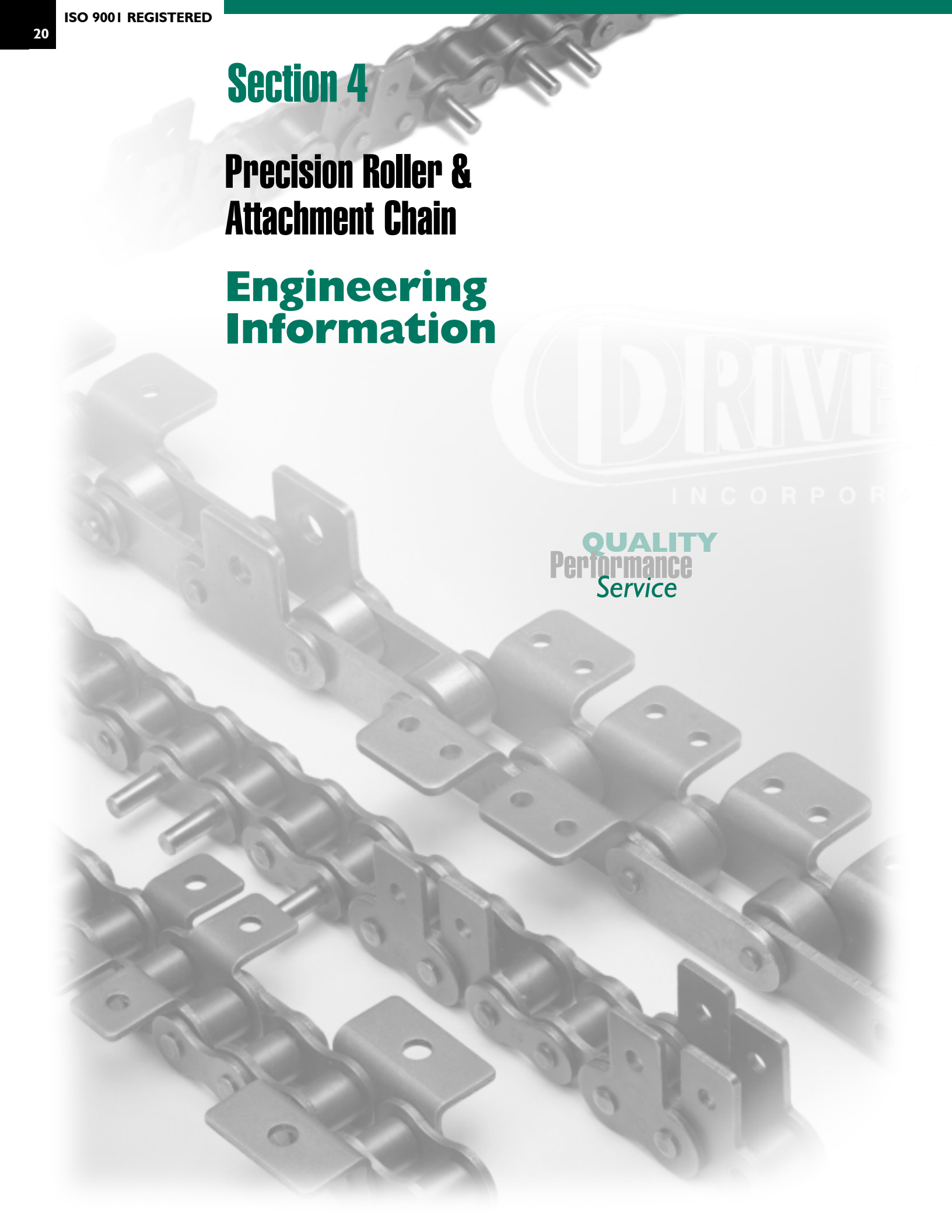
Section 4

Precision Roller & Attachment Chain

Engineering Information



Precision Attachment Roller Chain Products

Selection Guide

Drives, Incorporated ANSI single and double pitch roller chain is widely used for conveyor service. The following procedure is useful for economical and quick chain selection.

Step 1: Confirm the operating conditions of the conveyor

Step 2: Tentatively select the chain size

Step 3: Calculate the design chain tension (actual chain tension)

Step 4: Verify the chain selection

Step 5: Verify the allowable roller load

Step 1: Confirm the operating conditions of the conveyor

The following information is needed to design a chain conveyor.

1. Type of conveyor (slat conveyor, bucket elevator, etc.)
2. Method of chain travel (horizontal, inclined, or vertical conveyor)
3. Type, weight, and size of materials to be conveyed
4. Weight of materials to be transported per foot of conveyor length
5. Conveyor speed
6. Conveyor length
7. Lubrication
8. Considerations for special environments

Step 2: Tentatively select the chain size

To tentatively select the chain size, estimate the chain tension (P) by the following formula. A chain with an allowable load equal to or over the below calculated chain tension may be tentatively selected.

$P\ (lbs.) = M_T \times f \times k_I$

M_T	Total weight of material conveyed (lbs.)
f	Coefficient of friction, sliding and/or rolling (f_r f_s Table I, II or III)
k_I	Chain speed coefficient (Table V)

Precision Attachment Roller Chain Products

Selection Guide

Step 3: Calculate chain tension

Next, the chain tension should be calculated using the actual weight of the conveyor chain and material conveyed.

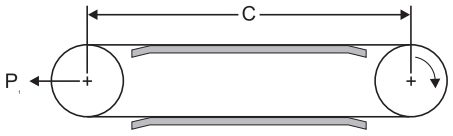
CONVEYOR CHAIN PULL FORMULAS

Horizontal

Material Carried: $P = (2.1W + M) f_r C$
(Slat)

Material Sliding:
$P = (2.1 Wf_s + Mf_s) C + J$
(Drag or Scraper Conv.)

HORIZONTAL - RETURN SIDE SUPPORTED



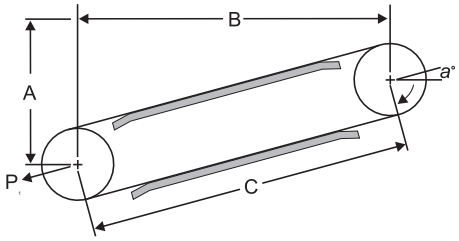
Inclined

Material Carried:
$P = [(M + W) f_r COSa + (M + W)SINa] C + (Wf_r COSa - WSINa) C$
(Slat)

Material Sliding:
$P = [(Mf_s + Wf_s) COSa + (M + W) SINa] + J$
(Scraper Conv.)

Note: When $(Wf_r COSa - WSINa) C$ is positive, multiply quantity by 1.1 to account for tail shaft friction.

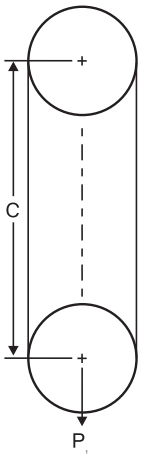
INCLINED



Vertical

Material Carried:
$P = (M + W) C + P_l / 2$

VERTICAL



GLOSSARY

P = Total conveyor pull (lbs.)

P_l = Take-up force (lbs.)

W = Weight of chains, attachments, slats, etc. and other moving elements of the conveyor per ft. (lbs./ft.)

M = Weight of material per ft. on the conveyor (lbs./ft.)

f_r = Friction coefficient of chain rolling on support rail (Table I)

f_s = Sliding friction coefficient of material or chain sliding (Tables II and III)

C = Center distance (ft.)

J = Pull (lbs.) caused by sideboard sliding friction (Table IV)

Precision Attachment Roller Chain Products

Selection Guide

Step 3: Continued

Table I - Coefficient of Rolling Friction (f_r)

Type of Roller	Dry	Lubricated
Oversize Roller	0.12	0.08
Standard Roller	0.21	0.14

Table II - Coefficient of Sliding Friction (f_s)

Material	Coefficient	
	Dry	Lubricated
Steel on steel	.33	.20
Cast iron or cast steel on same surface	.50	.40
Steel on bronze	-	.15
Steel on hardwood	.35	.25
Cast iron or cast steel on hardwood	.44	-

Table III - Coefficient of Sliding Friction of Conveyed Material (f_s)

Material	Coefficient	
	Dry	Lubricated
Coal on steel	.55	-
Crushed Stone or Sand on Steel	.70	-
Cement on Steel	.80	-
Wood on Wood	.55	-
Corn on Steel	.30	-
Soybeans on Steel	.41	-
Oats on Steel	.35	-
Wheat on Steel	.43	-
Salt on Steel	.70	-

Table IV - Additional Pull on Conveyor (J) Material Sliding Against Sideboards

$J = Ch^2/R$

Where:

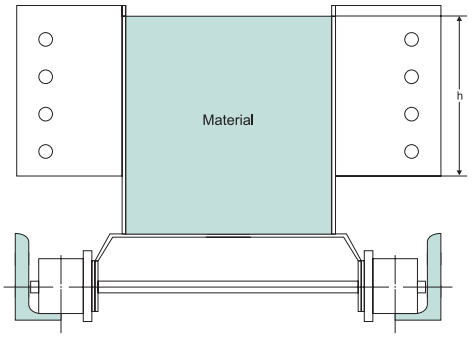
h = Height of material in inches

R = Variable factor for different materials (see Table IV)

C = Length of conveyor in feet

Table IV

Material	R
Coal	14.0
Coke	35.0
Limestone	7.5
Gravel	7.0
Sand	5.5
Ashes	35.0



Precision Attachment Roller Chain Products

Selection Guide

Step 4: Calculate the required power

Calculate the required power to drive the conveyor from the following formula.

Horizontal and/or Inclined Conveyor

$$HP = \frac{P \times S}{33{,}000}$$

Vertical Conveyor

$$HP = \frac{M \times C \times S}{33{,}000}$$

Where: $S = \frac{P_c \times N \times n}{12}$ (ft./min.)

HP = Horse Power

S = Chain speed (ft. / min.)

M = Material weight (lbs./ft.)

C = Sprocket center distance

n = Small sprocket speed (RPM)

N = Number of teeth small sprocket

P_c = Chain Pitch (in.)

P = Chain Tension (lbs.)

Step 5: Verify the chain selection

Multiply the chain tension (P) by the chain speed coefficient (k_1) listed in Table V and verify the following formula.

$P \times k_1 \leq$ Max. allowable load of the chain

When the design chain tension ($P \times k_1$) is over the allowable load or much less than it, try the same steps again for the next bigger or smaller chain size to select a more suitable chain.

Table V - Chain Speed Coefficient (k_1)

Chain Speed ft./min.	Speed Factor (k_1)
0 ~ 50	1.0
50 ~ 100	1.2
100 ~ 160	1.4
160 ~ 230	1.6
230 ~ 300	2.2
300 ~ 360	2.8
360 ~ 400	3.2

Step 6: Verify the allowable roller load

When the load is carried on the rollers, the total weight of the chain and load per roller should not exceed the allowable roller load shown in Table VI.

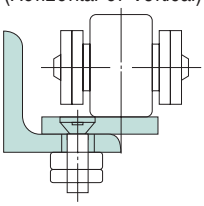
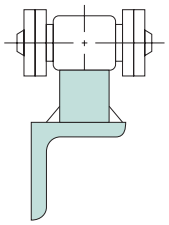
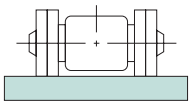
Note: Large rollers are available only for double pitch roller chains.

Table VI - Allowable Roller Load (Lbs./Roller, Carbon Steel Only)

Chain	Size	Large Roller	Std. Roller
C2040	40	143	33
C2050	50	220	44
C2060H	60	350	66
C2080H	80	590	120

Precision Attachment Roller Chain Products

General Engineering Information

Method of Chain Travel	Type of Roller	Features
Chain Rolling (Horizontal or Vertical) 	**Oversize "R" Roller Type** • Heavy in chain weight • Greater allowable roller load • Less roller wear	• Smooth operation • Less vibration • Lower friction and less power required • Generally used for conveyor lengths over 35 ft. - conveyor speeds over 70 ft./min.
Chain Rolling 	**Standard "S" Roller Type** • Light weight • Lower allowable roller load	• Generally used for conveyor lengths less than 35 ft. - conveyor speeds less than 70 ft./min.
Chain Sliding (Double Pitch Chain) 		• Suitable for impact and dirty conditions • Economical • Impact resistant • Greater power required

Points to Consider:

1. For long conveyors, use take-up devices to eliminate chain slack.
Take-up stroke = (center distance between sprockets x 0.02) + catenary sag allowance.

2. Chain must always be engaged with at least 3 sprocket teeth.

3. When two or more strands of conveyor chain operate together, all sprocket teeth on the head shaft should be aligned. The chain may be matched at the factory for uniform length and attachment alignment for accurate multiple strand operation.

Drives, Incorporated Corrosion Resistant Chain Products

Stainless Steel Material Selection

304 Stainless Steel Series

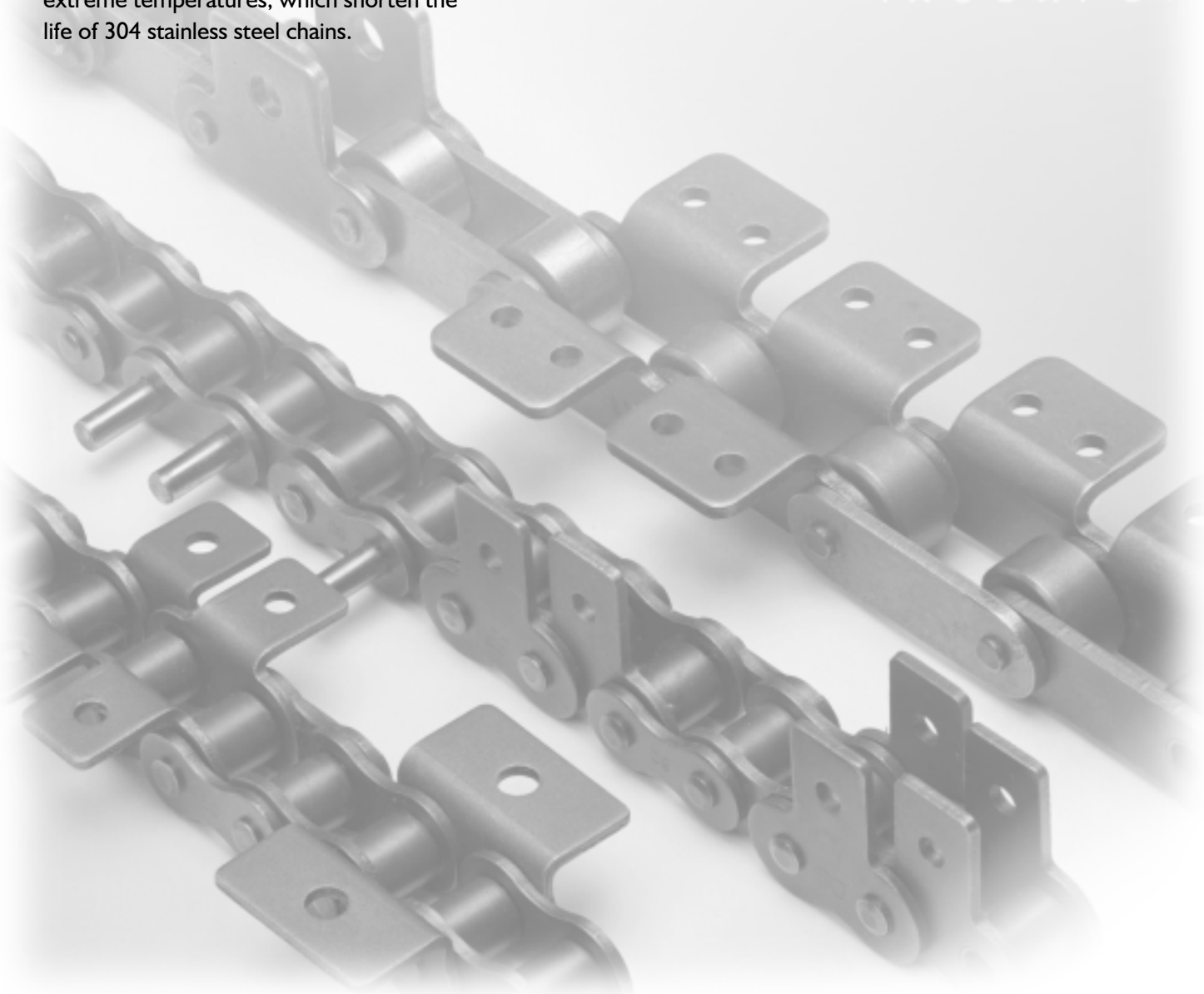
The primary use of 304 stainless steel chain is in corrosive and/or high temperature environments, which shorten life of standard carbon steel roller chains. The 304 stainless steel chains give excellent resistance to corrosion and high temperatures. 304 stainless steel is generally considered non-magnetic.

316 Stainless Steel Series

The primary use of 316 and 317 stainless steel chain is in highly corrosive and/or extreme temperatures, which shorten the life of 304 stainless steel chains.

400 and 600 Stainless Steel Series

The primary use of 400 and 600 stainless steel chain is in corrosive and/or high temperature environments, which shortens the life of standard carbon steel chain. The 400 and 600 stainless steel chains have less corrosion resistance than 304 stainless steel, but the hardened round parts provide for better wear life than 304 stainless steel chains. These chains are designed for drive applications, which normally have a high number of articulations.



Corrosion Resistant Chain Products

Stainless Steel

Materials of Component Parts

	Link Plate	Pin	Bushing	Roller
304 Series	AISI 304	AISI 304	AISI 304	AISI 304
316 Series	AISI 316	AISI 316	AISI 316	AISI 316
400 Series	AISI 304	AISI 431	AISI 403	AISI 403
600 Series	AISI 304	600 APH	600 APH	600 APH

*PH: Precipitation Hardened

Performance of Anti-corrosive Chains

	Corrosion Resistance	Temperature Resistance	Magnetism	Wear Resistance
NP Chain	Acceptable for outdoor and decorative applications.	14°F - 140°F (Never use below -4°F or above 300°F)	Magnetic	Excellent
400 & 600 Series	Good for general acid, alkali and water.	-40°F ~ 750°F (Never use over 930°F)	Magnetic	Very Good
304 Series	Good for general acid, alkali and water.	-40°F ~ 750°F (Never use below -270°F or over 1300°F)	Non-magnetic	Fair
316 Series	Superior to the other stainless material.	-40°F ~ 750°F (Never use below -270°F or over 1500°F)	Non-magnetic	Fair

Chain Selection

General selection is based on bearing pressure between the pin and bushing. Anti-corrosive roller chains are normally intended to be used at slow speed without lubrication. Chain selection should be made based on the bearing pressure as shown below.

	Max. Allowable Bearing Pressure Between Pin & Bushing	Maximum Operating Speed
304 & 316 Series	1,420 psi	230 Ft./Min.
400 & 600 Series	2,130 psi	230 Ft./Min.

Chain selection can be made using the following formula.

Maximum Chain Tension x Service Factor x Speed Coefficient x Temperature Factor ≤ Maximum Allowable Load

Maximum allowable load or maximum bearing pressure as shown above can be doubled only when chain is used in group "A" of the "Corrosion Resistance Guide" on pages 28-29 and properly lubricated.

Maximum Allowable Load

The chain's maximum allowable load can be obtained by the formula: (Maximum allowable bearing pressure) X (Bearing area between pin and bushing)

	304 & 316 Series	400 & 600 Series
40	100 Lbs.	155 Lbs.
50	165 Lbs.	230 Lbs.
60	231 Lbs.	350 Lbs.
80	396 Lbs.	600 Lbs.
2040	100 Lbs.	155 Lbs.
2050	165 Lbs.	230 Lbs.
2060H	250 Lbs.	375 Lbs.
2080H	415 Lbs.	625 Lbs.

Service Factor

Type of Impact	Service Factor
Smooth transmission	1.0
Transmission with some impact	1.3
Transmission with large impact	1.5

Speed Coefficient

Speed	Speed Coefficient
0~50 Ft./Min.	1.0
50~100 Ft./Min.	1.2
100~160 Ft./Min.	1.4
160~230 Ft./Min.	1.6

Temperature Factor

Temperature	304 Series	316 Series	400 & 600 Series
~ -270°F	X	X	X
-270°F~ -40°F	1.0	1.0	X
-40°F~ 750°F	1.0	1.0	1.0
750°F~ 930°F	1.2	1.0	1.8
930°F~ 1,100°F	1.5	1.2	X
1,100°F~ 1,300°F	1.8	1.5	X
1,300°F~ 1,500°F	X	2.0	X
1,500°F~	X	X	X

X = Not suggested.

Drives, Inc. Corrosion Resistant Chain Products

Stainless Steel

Substance	Concentration	Temp. F	600 SS	400 SS	304 SS	316 SS
Acetone		68	A	C	A	A
Oil (Plant, Mineral)		68	A	A	A	A
Linseed Oil	100%	68	B	A	A	A
Sulfur Dioxide		68	C	C	A	A
Alcohol		68	A	A	A	A
Ammonia Water		68	A	A	A	A
Whiskey		68	A	A	A	A
Ethyl Ether		68	A	A	A	A
Zinc Chloride	50%	68	D	D	B	B
Sal Ammoniac	50%	Boiling	C	D	B	A
Potassium Chloride	Saturation	68	B	A	A	A
Calcium Chloride	Saturation	68	D	D	B	A
Ferric Chloride	5%	68	D	D	B	B
Sodium Chloride	5%	68	B	B	A	A
Chlorine Gas		68	D	D	D	B
Chlorinated Water			D	D	D	A
Oleic Acid		68	A	A	A	A
Sea-water		68	C	C	B	A
Sodium Perchlorate	10%	Boiling	D	D	A	A
Hydrogen Peroxide	30%	68	B	B	A	A

Substance	Concentration	Temp. F	600 SS	400 SS	304 SS	316 SS
Gasoline		68	A	A	A	A
Potassium Permanganate	Saturation	68	A	A	A	A
Ferric Acid	50%	68	A	A	A	A
Milk		68	A	A	A	A
Citric Acid	50%	68	A	A	A	A
Glycerol		68	A	A	A	A
Creosote		68	A	A	A	A
Chromic Acid	5%	68	B	B	A	A
Ketchup		68	A	A	A	A
Developing Solution		68	B	B	A	A
Synthetic Detergent			A	A	A	A
Coffee		Boiling	A	A	A	A
Syrup			A	A	A	A
Acetic Acid	10%	68	A	A	A	A
Sugar Solution		68	A	A	A	A
Calcium Hypochlorite	11-14%	68	C	C	A	A
Sodium Hypochlorite	10%	68	D	D	D	A
Sodium Cyanide		68	--	--	A	A
Carbon Tetrachlorite		68	A	A	A	A
Potassium Bichromate	10%	68	A	A	A	A
Oxalic Acid	10%	68	B	B	A	A
Tartaric Acid	6%	68	A	A	A	A

A = Total Resistance

B = Partial Resistance

C = Satisfactory Resistance

D = Not Recommended

Drives, Inc. Corrosion Resistant Chain Products

Stainless Steel

Substance	Concentration	Temp. F	600 SS	400 SS	304 SS	316 SS
Nitric Acid	Saturation	Boiling	B	B	A	A
Ammonium Nitrate		68	A	A	A	A
Potassium Nitrate	25%	68	A	A	A	A
Potassium Nitrate	25%	Boiling	D	D	A	A
Vinegar		68	C	C	B	A
Potassium Hydroxide	20%	68	A	A	A	A
Calcium Hydroxide	20%	Boiling	A	A	A	A
Sodium Hydroxide	25%	68	A	A	A	A
Formic Acid	100%	Boiling	C	C	C	A
Soft Drink		68	A	A	A	A
Hydroxbensene		68	A	A	A	A
Petroleum		68	A	A	A	A
Soap & Water Solution		68	A	A	A	A
Phosphate			A	A	A	A
Sodium Hydrocarbonate		68	A	A	A	A
Sodium Carbonate	Saturation	Boiling	A	A	A	A
Sodium Thiosulfate	25%	Boiling	A	A	A	A
Turpentine		95	A	A	A	A
Kerosene		68	A	A	A	A
Varnish			A	A	A	A
Heavy Nitric Acid	85%	68	D	D	A	A
Heavy Nitric Acid	65%	68	D	D	B	B
Lactic Acid	10%	68	B	B	A	A
Honey			A	A	A	A
Paraffin		68	A	A	A	A
Beer		68	A	A	A	A
Picric Acid	Saturation	68	A	A	A	A

Substance	Concentration	Temp. F	600 SS	400 SS	304 SS	316 SS
Fruit Juice		68	B	B	A	A
Benzene		68	A	A	A	A
Boric Acid	50%	Boiling	A	A	A	A
Formalin	40%	68	A	A	A	A
Mayonnaise		68	B	B	A	A
Water			A	A	A	A
Vegetable Juice		68	A	A	A	A
Lard			A	A	A	A
Butyric Acid		68	A	A	A	A
Hydrogen Sulfide (dry)			A	A	A	A
Hydrogen Sulfide (wet)			D	D	D	D
Sulfuric Acid	5%	68	D	D	D	A
Zinc Sulfate	25%	68	A	A	A	A
Aluminum Sulfate	Saturation	68	D	D	A	A
Ammonium Sulfate	Saturation	Boiling	B	B	A	A
Sodium Sulfate	Saturation	68	A	A	A	A
Malic Acid	50%	Boiling	A	A	A	A
Phosphoric Acid	5%	68	B	B	A	A
Phosphoric Acid	10%	68	B	B	B	B
Wine		68	A	A	A	A

A = Total Resistance

B = Partial Resistance

C = Satisfactory Resistance

D = Not Recommended