Oil Field Chain and Sprockets

Upstream Segment

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Introduction

This specification is under the jurisdiction of the API Subcommittee on Drilling Structures and Equipment.

The purpose of this specification is to provide standards for roller chains suitable for use in oil field drilling and producing operations.

Much of the engineering material pertaining to roller chains and sprockets was base on ASME B29.1 and the book *Chains for Power Transmission and Material Handling*, published by the American Chain Association. Additionally, portions of ASME B29.1 are requirements of this specification as referenced herein.

Some of the performance related characteristics of the chains that are contained in this document are specific to oil field chains and to their application to oil field drives. This information cannot be found in other publications and imposes performance testing that goes beyond the basic requirements found in any other standards or specifications.

A section on drive design has not been included in this edition of the specification due to the great variety of applications and the complexity of the subject drives.

Conversions of U.S. Customary Units (USC) to International System (SI) metric units are provided throughout the text of this specification in parentheses, e.g., 6 in. (152.4 mm). SI equivalents have also been included in all tables. Formulas and certain relationships are intentionally presented only in U.S. Customary Units to preclude any ambiguity between them and tabulated values. Conversion factors are provided below if SI equivalents are desired for the calculated unit values.

U.S. Customary Units are in all cases preferential and shall be standard in this specification. Products are to be marked in the units in which ordered unless there is an agreement to the contrary between the Purchaser and the Manufacturer.

1 in. (in.)	=	25.4 millimeters (mm) exactly
1 foot (ft)	=	0.3048 meters (m) exactly
1 pound force (lbf)	=	4.448222 Newtons (N)
1 foot•pound force (ft•lbf) torque	=	1.355818 Newton•meters (N•m)
1 horsepower (hp) (550 ft•lbf/s)	=	0.7456999 kilowatts (kW)
1 gallon per minute (gpm)	=	0.0630920 cubic decimeters/second (dm^3/s)

The following formula was used to convert degrees Fahrenheit (F) to degrees Celsius (C):

$°C = 5/9\ (°F - 32)$

Oil Field Chain and Sprockets

1 Scope

This specification covers the manufacture of the components for, and the assembly and packaging of, single and multiple strand, number 40 through 240, standard and heavy series roller chains for oil field applications, including chain designation, chain length tolerance, tensile strength specifications, pin and bushing press-out specifications, and dynamic test requirements.

For informational purposes, Annex A provides recommendations for installation, lubrication, and maintenance of oil field chain drives and Annex B includes a basic description of roller chain sprockets.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ASME[1] B29.1, *Precision Power Transmission Roller Chains, Attachments and Sprockets*

ASME B29.26, *Fatigue Testing Power Transmission Roller Chain*

3 Roller Chain

3.1 Chain Designation

Chain covered by this specification is identified by the designation shown in the following example and in more detail in ASME B29.1.

3.2 Heavy Series Chains

Heavy series chains are made in ¾ in. (19.05 mm) and larger pitches and differ from standard series chains in thicknesses of link plates. Their value is only in the acceptance of higher loads during low-speed operation.

3.3 Dimensions

The general dimensions for roller chains shown in Figure 1 and Figure 2 shall be as specified in ASME B29.1.

3.4 Chain Length Tolerance

Measuring load is the load under which a chain is to be when measured for length. It is equal to 1% of the minimum ultimate tensile strength, with a minimum of 18 lb (8.2 kg) and a maximum of 1000 lb (453.6 kg), for both single and multiple strand chains.

Chains shall be measured for chain length tolerance in accordance with Table 1 after all manufacturing processes, except final lubrication, are complete.

Length measurements are to be taken over a length of at least 12 in. (300 mm).

New chains, under standard measuring load, shall not be under-length.

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[1] ASME International, 3 Park Avenue, New York, NY, 10016-5990, www.asme.org.

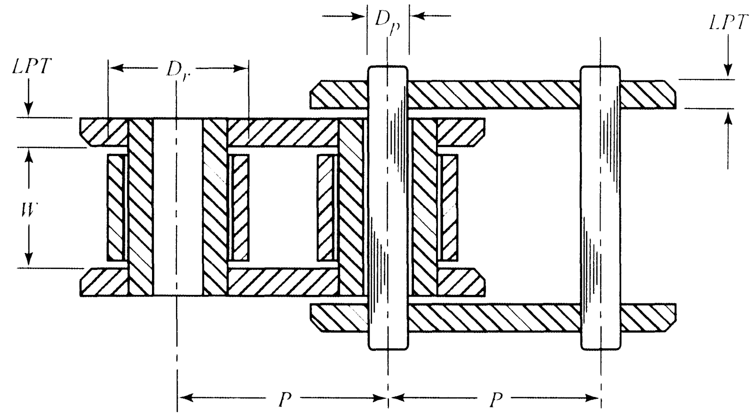


Figure 1—Chain Assembly

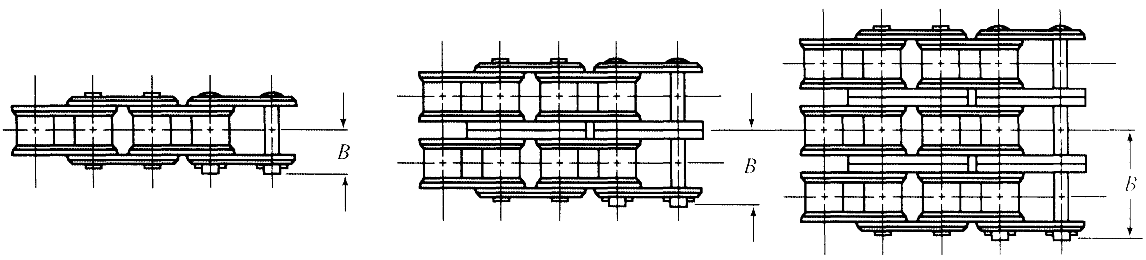


Figure 2—Single and Multiple Chain Assemblies

Table 1—Chain Length Tolerance

Chain Number	Overlength Tolerance	
	in./ft	mm/m
40	0.019	1.58
50	0.018	1.50
60, 60H	0.017	1.42
80, 80H	0.016	1.33
100, 100H	0.016	1.33
120, 120H	0.015	1.25
140, 140H	0.015	1.25
160, 160H	0.015	1.25
180, 180H	0.015	1.25
200, 200H	0.015	1.25
240, 240H	0.015	1.25

3.5 Tensile Strength

3.5.1 Single Strand Chain

Standard and heavy series single strand chain meeting the requirements of this specification will have a minimum ultimate tensile strength equal to or greater than the values listed in Table 2.

3.5.2 Multiple Strand Chain

For multiple strand chain, the minimum ultimate tensile strength equals that of the single strand multiplied by the number of strands.

3.5.3 Minimum Ultimate Tensile Strength

Minimum ultimate tensile strength (MUTS), for chains covered by this specification, is defined in ASME B29.1. Chains covered by this specification shall have a MUTS equal to, or greater than, the values listed in Table 1.

MUTS is not a measure of the load at which a chain may be applied; it is indicative only of the tensile strength quality of the chain.

Any chain tests made to verify the MUTS set by this specification are to be considered destructive. Consequently, all chain specimens subjected to such tests, failed or otherwise, are deemed unfit for application purposes.

3.6 Preloading

Chains covered by this specification shall be preloaded during manufacture to a tensile load of at least 30% of the minimum ultimate tensile strength listed in Table 2.

3.7 Minimum Press-out Force

3.7.1 General

The values in Table 2 represent the minimum force required to start movement of a single pin or bushing in a single link plate. The purpose of these values is to provide for the testing of pin and bushing retention characteristics. This is indicative of the aperture condition in the link plates and the interference fits of the pins and bushings in their respective link plates.

3.7.2 Pin and Pin-link Plates

Chain link assemblies that are assembled with riveted pinheads shall have the rivet removed, exercising care not to remove the link plate metal below the surface of the link plate. One of the link plates shall be removed carefully to avoid destroying the joint integrity between the pins and the link plates. The remaining plate shall be placed in a hydraulically or mechanically operated testing machine with the pin link level and supported to prevent movement when pressure is applied. A single axial load shall be slowly applied to the pin, pressing the pin out of the joint toward the inside of the plate. A force less than the specified press-out load, as applicable for the subject chain, shall constitute failure of the test.

3.7.3 Roller Link Plate

One of the roller link plates shall be removed using the same method as described for the pin link. Remove the two rollers from the bushings and place the plate with the two bushings in the testing machine with the plate supported to prevent movement when pressure is applied. A single axial load shall be slowly applied to the end of the bushing, pressing the bushing out of the plate. A load that is less than the specified press-out load shall constitute failure of the test.

Table 2—Table of Standard Chain Capacities

ANSI Number	Minimum Ultimate Tensile Strength lb (N)	Minimum Press-out Force lb (N)		Minimum Dynamic Strength lb (N)
		Pin	Bush	
40	3125 (13,900)	180 (800)	108 (480)	720 (10,800)
50	4880 (21,710)	300 (1334)	180 (801)	1120 (4980)
60	7030 (31,270)	412 (1833)	247 (1099)	1600 (7120)
80	12,500 (55,600)	728 (3238)	437 (1944)	2810 (12,500)
100	19,500 (86,870)	1060 (4715)	635 (2825)	4300 (19,130)
120	28,100 (125,100)	1430 (6361)	859 (3821)	6060 (26,960)
140	38,300 (170,270)	1880 (8363)	1120 (4982)	8030 (35,720)
160	50,000 (222,400)	2370 (10,542)	1420 (6316)	10,200 (45,370)
180	63,300 (281,470)	3540 (15,747)	2120 (9430)	12,500 (55,600)
200	78,100 (347,500)	4580 (20,373)	2740 (12,188)	15,000 (66,720)
240	112,500 (500,400)	5380 (23,931)	3540 (15,747)	20,100 (89,410)
60H	7030 (31,270)	548 (2438)	329 (1463)	1850 (8230)
80H	12,500 (55,600)	910 (4048)	546 (2429)	3140 (13,970)
100H	19,500 (86,740)	1270 (5649)	762 (3390)	4710 (20,950)
120H	28,100 (125,000)	1670 (7429)	1000 (4448)	6550 (29,140)
140H	38,300 (170,370)	2150 (9564)	1280 (5694)	8580 (38,170)
160H	50,000 (222,410)	2670 (11,877)	1600 (7117)	10,800 (48,040)
180H	63,300 (281,570)	3930 (17,482)	2360 (10,498)	13,200 (58,720)
200H	78,100 (347,410)	5500 (24,465)	3290 (14,635)	16,400 (72,950)
240H	112,500 (500,420)	7170 (31,894)	4720 (20,996)	23,200 (103,200)

3.8 Minimum Dynamic Strength

3.8.1 General

Standard and heavy series single strand chain conforming to this specification shall be capable of surviving a conformance test at the minimum dynamic strength listed in Table 2. Connecting links, offset links, and multiple strand chains are not subject to the conformance test.

3.8.2 Conformance Test

Initially, the Manufacturer shall conduct a conformance test on at least one representative sample from each design family of oil field chain. A design family being defined as different sizes of chain designed to the same parameters, and manufactured by the same processing operations.

Thereafter, the Manufacturer shall conduct a conformance test on a representative sample of each model of oil field chain at least once every five years.

The sample chain shall survive a conformance test conducted at the minimum dynamic strength listed for the subject chain in Table 2.

NOTE 1 The dynamic strength values are not valid characteristics for designing actual applications. Neither the specified dynamic strength values nor the conformance test results are to be interpreted as allowable working loads.

NOTE 2 The conformance test is a destructive test. Even though the chain may survive the test without failure, it will have been damaged and will be unfit for service.

3.8.3 Conformance Test Procedure

Sample chains shall be tested according to the conformance test described in ASME B29.26.

3.9 Marking Requirements

For compliance with API Spec 7F, the chain shall be marked with the ANSI chain number and the Manufacturer's identifying mark at least once in every 1 ft (0.3 m). "API Spec 7F" shall be marked on the chain packaging.

Annex A
(informative)

Recommended Practice for Installation, Lubrication, and Maintenance of Roller Chain Drives

A.1 Installation

A.1.1 Check Condition of Components

Check shafts and bearings and assure they are in good condition. Check bearings mounts and make sure they are correctly positioned and secure. If the chain is not new, be sure that it is clean, well lubricated, and not excessively worn. If sprockets are not new, make sure they are not excessively worn or otherwise damaged.

A.1.2 Align Shafts and Sprockets

Good drive alignment is necessary to prevent uneven loading across the width of the chain and damaging wear between the sprockets teeth and the roller link plates of the chain. Aligning the drive is a straightforward, two-step procedure.

1) The shafts must be parallel within fairly close limits. This is readily done by using a machinist's level and feeler bars (see Figure A.1). First, using the machinist's level, make sure the shafts are level or in the same plane. Then, using the feeler bars, make sure the shafts are parallel in that plane. If the shafts can float axially, lock them in the normal running position before attempting to align them.

   Most single strand drives will perform acceptable if the shafts are parallel and in the same plane within 0.050 in./ft (4.2 mm/m) of shaft length, or ¼ degree. However, high speed, high horsepower, or multiple strand drives should be aligned within the tolerance obtained from the following formula:

In USC units:

$$\text{Tolerance} = \frac{0.00133C}{P_n} \text{ (in./ft)} \tag{A.1}$$

In SI units:

$$\text{Tolerance} = \frac{0.0011C}{P_n} \text{ (mm/m)}$$

where

C is the center distance in inches (mm);

P is the chain pitch in inches (mm);

n is the number of chain strands.

2) The sprockets must be mounted on the shafts as closely in line axially as practicable, normally with a straight edge or a length of piano wire (see Figure A.2). In practice, the maximum amount of axial misalignment is obtained from the following formula:

$$\text{Maximum offset} = 0.045\,P \text{ inches (mm)} \tag{A.2}$$

where

P is the chain pitch in inches (mm).

This formula applies to both single and multiple strand chains.

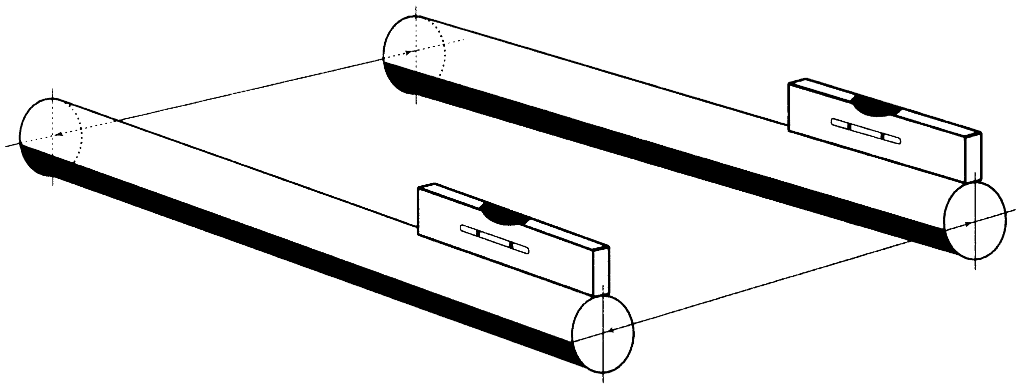


Figure A.1—Align Shafts

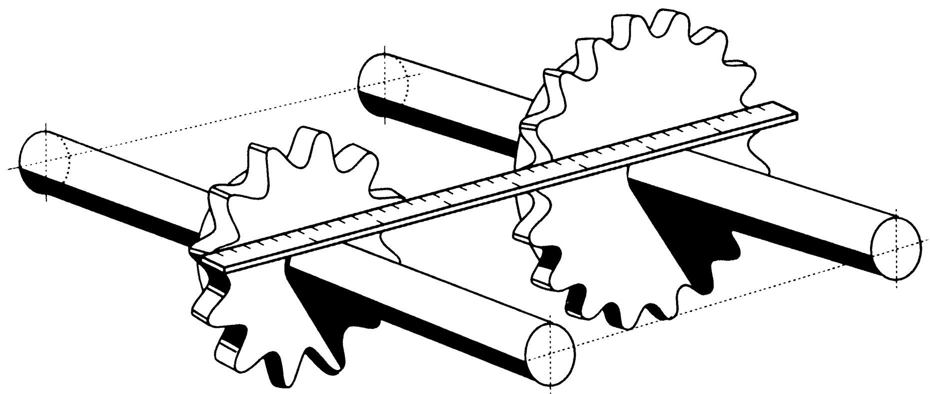


Figure A.2—Align Sprockets

A.1.3 Install Chain

If the chain is not the correct length—in pitches—to properly fit on the drive, a longer stock length may have to be shortened or several sections may have to be connected to make the chain the correct length. ACA *Connect and Disconnect Instructions for ANSI B29.1 Roller Chains*, describes how to do this. It is recommended that all sections of a particular chain be from the same Manufacturer.

When the correct chain length has been obtained, fit the chain around the sprockets and bring the free ends together on one sprocket using the sprocket teeth to hold the chain ends in position. With large heavy chains it may be necessary to block the sprockets to prevent them from turning while the chain ends are brought together. Insert the pins of the connecting link through the bushing holes to couple the chain endless. With long chain spans, it may be necessary to support the chain with a plank or rod while the connection is made. Then install the cover plate and the spring clip or cotters. After the fasteners have been installed, the ends of the pins should be pressed back until the fasteners are snug against the cover plate. This restores the intended clearances across the chain and allows the joint to flex freely as it should. Again, the connection procedure is described in the ACA *Connect and Disconnect Instructions for ANSI B29.1 Roller Chains*.

A.1.4 Connecting Links

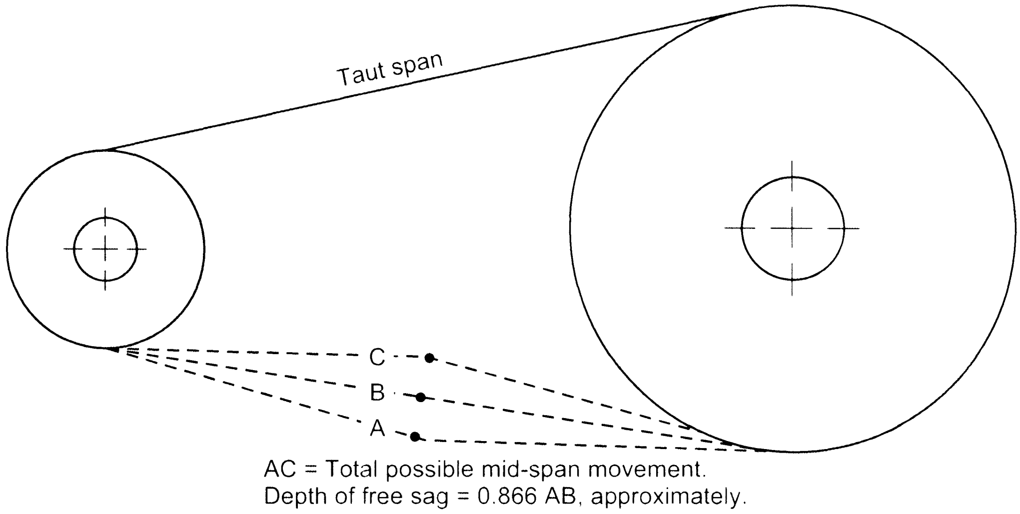
Connecting links should use interference fit cover plates because their capacity is virtually the same as the rest of the chain. The use of slip fit cover plates should be avoided because their capacity can be much less than the rest of the chain.

A.1.5 Offset Links

The use of offset links should be avoided whenever possible because their capacity can be much less than the rest of the chain. If an offset link is necessary, an offset section, assembled with press fit pins, should be used.

A.1.6 Adjust Chain Tension

First, turn one sprocket to tighten one span of the chain. Then use a straight edge and a scale to measure the total mid-span movement in the slack span (Figure A.3). Adjust the drive center distance or the idler to produce 4% to 6% mid-span movement for drives that are on horizontal centers to a 45° incline, and 2% to 3% for drives that are inclined 45° to vertical or subject to high shock loads.



NOTE 1 AC is the total possible mid-span movement.

NOTE 2 Depth of free sag is approximately 0.866 × (AB).

Recommended Possible Mid-span Movement, AC, in. (mm)						
Drive Center-line	Tangent Length Between Sprockets, in. (cm)					
	10 (25)	20 (51)	30 (76)	50 (127)	70 (178)	100 (254)
Horizontal to 45°	0.4–0.5 (10–15)	0.8–1.2 (20–30)	1.2–1.8 (30–45)	2.0–3.0 (51–76)	2.8–4.2 (71–107)	4.0–6.0 (102–152)
45° to vertical	0.2–0.3 (5–8)	0.4–0.6 (10–15)	0.5–0.9 (15–23)	1.0–1.5 (25–38)	1.4–2.1 (36–53)	2.0–3.0 (51–76)

Figure A.3—Mid-span Movement Diagram

A.1.7 Ensure Freedom from Interferences

Check the drive carefully to ensure that there is no contact between the chain or sprockets and any adjacent object. Ample clearance must be provided to allow for chain pulsations, chain wear elongation, and shaft end float.

A.1.8 Provide Adequate Lubrication

Before starting the drive, be sure that the specified lubrication system is working properly (see A.2).

A.1.9 Install Guards

If the roller chain drive does not run in a chain casing, it should be enclosed by guarding that will prevent personnel from being injured by inadvertent contact with the moving components of the drive. More detailed information can be found in ASME B15.1.

Prior to installation, inspect the guard to make sure it is not broken or damaged, especially at or near the mounting points. Then, install the guard making sure that all fasteners are secure and all safeguarding devices (such as presence sensors and interlocks) are functioning.

A.2 Lubrication

A.2.1 Lubrication Flow

Each joint in a roller chain is a journal bearing, so it is essential that the chain receive an adequate amount of the proper lubricant to achieve maximum wear life. In addition to resisting wear between the pins and bushings, an adequate flow of lubricant smooths the engagement of the chain rollers with the sprockets, cushions roller to sprocket impacts, dissipates heat, flushes away wear debris and foreign materials, and retards rust.

The lubricant should be applied to the upper edges to the link plates in the lower span of the chain shortly before the chain engages a sprocket (Figures A.4 and A.5). Then, gravity and centrifugal force both will aid in carrying the lubricant to the critical pin and bushing surfaces. Surplus lubricant spilling over the link plate edges will supply the roller and bushing surfaces.

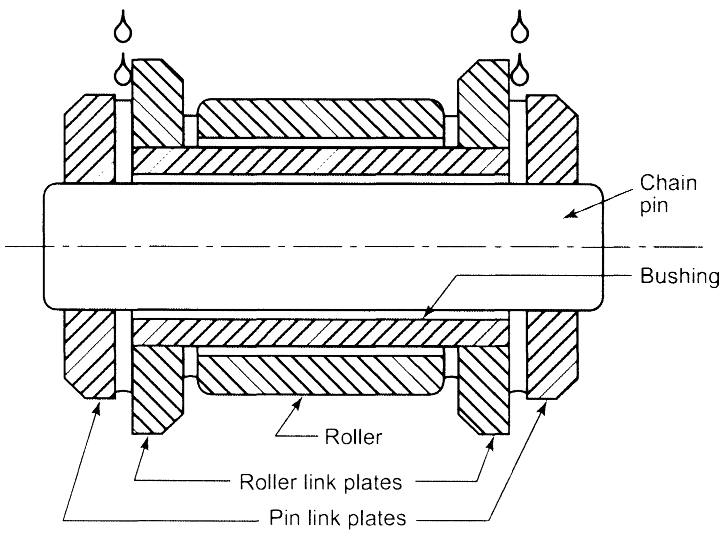


Figure A.4—Lubricant Flow into the Chain Joint

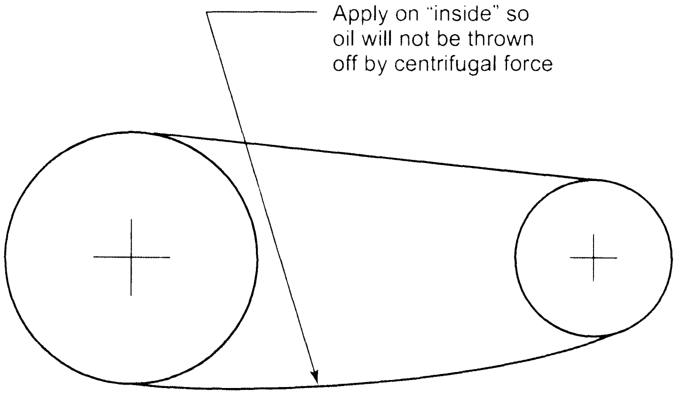


Figure A.5—Application of Lubricant to Chain

A.2.2 Lubricant Characteristics

Lubricants for roller chain drives should have the following characteristics:

a) sufficiently low viscosity to penetrate into the critical internal surfaces;

b) sufficiently high viscosity, or appropriate additives, to maintain the lubricating film under the prevailing bearing pressures;

c) clean and free of corrodents;

d) capability to maintain lubrication qualities under the prevailing operating conditions.

These requirements usually are met by a good grade of nondetergent petroleum-base oil. Detergents normally are not necessary, but antifoam, antirust, and film strength improving additives often are beneficial.

Low-grade or impure oils should be avoided. Low-grade oils cannot provide effective lubrication and acids or abrasive particles in the oil can damage the chain beyond repair. Heavy oils or greases should not be used because they are too thick to penetrate into the internal surfaces of the chain. The recommended oil viscosity for various surrounding temperature ranges is shown in Table A.1.

Table A.1—Recommended Oil Viscosities for Various Temperatures

Recommended Grade	Temperature °F	Temperature °C
SAE 5	–50 to +50	–46 to +10
SAE 10	–20 to +80	–29 to +27
SAE 20	+10 to +110	–12 to +43
SAE 30	+20 to +130	–7 to +54
SAE 40	+30 to +140	–1 to +60
SAE 50	+40 to +150	+4 to +66
NOTE When the temperature range permits a choice, the heavier grade should be used.		

A.2.3 Types of Lubrication

A.2.3.1 General

The ASME standards list three types of lubrication for roller chain drives. The recommended type is mainly influenced by the chain speed and may be selected from Table A.2. The recommended types should be regarded as minimum lubrication requirements and the use of a better type may be beneficial.

Table A.2—Lubrication Type for Chain Size and Speed

Chain Pitch in. (mm)	**Chain Speed** ft/min (m/min)		
	Type 1	**Type 2**	**Type 3**
0.500 (12.70)	up to 290 (88)	up to 2200 (670)	over 2200 (670)
0.625 (15.88)	240 (73)	1930 (588)	1930 (588)
0.750 (19.05)	210 (64)	1740 (530)	1740 (530)
1.000 (25.40)	170 (52)	1480 (451)	1480 (451)
1.250 (31.75)	145 (44)	1300 (396)	1300 (396)
1.500 (38.10)	125 (38)	1170 (357)	1170 (357)
1.750 (44.45)	110 (34)	1080 (329)	1080 (329)
2.000 (50.80)	100 (30)	1000 (305)	1000 (305)
2.250 (57.15)	90 (27)	930 (283)	930 (283)
2.500 (63.50)	85 (26)	880 (268)	880 (268)
3.000 (76.20)	75 (23)	790 (241)	790 (241)

A.2.3.2 Type I—Manual or Drip Lubrication

For manual lubrication, oil is applied periodically with a brush or a spout can, preferably once each eight hours of operation. The time may be longer than eight hours, if it has proven adequate for that particular drive. The volume and frequency of oil application must be sufficient to prevent a red-brown (rust) discoloration of the oil in the joints. The red-brown discoloration indicates that the oil in the joints is inadequate. When the rust discoloration is found, remove, clean, relubricate, and reinstall the chain prior to continuing operation.

NOTE Manual lubrication is to be done only when the drive is stopped and power to the drive is locked out.

For drip lubrication, oil is dripped between the link plate edges from a drip lubricator. Drip rates range from 4 to 20 or more drops per minute, depending on chain speed. Here again, the drip rate must be sufficient to prevent a red-brown (rust) discoloration of the lubricant in the chain joints. Care must be taken to prevent windage from misdirecting the oil drops. The oil level in the reservoir should be checked after each 8 hours of operation, and the reservoir refilled when needed.

For multiple strand chains, a distribution pipe is needed to feed oil to all the rows of link plates, and a wick packing usually is required to distribute oil uniformly to all holes in the pipe (Figure A.6).

A.2.3.3 Type II—Oil Bath or Slinger Disc Lubrication

For oil bath lubrication, a short section of the lower strand of the chain runs through a sump of oil in the chain casing (Figure A.7). The oil level should just reach the pitch-line of the chain at its lowest point in operation. Long sections of chain running through the oil bath, as in a nearly horizontal lower span, should be avoided because they can cause oil foaming and overheating.

In slinger disc lubrication, the chain operates above the oil level. A disc on one shaft picks oil up from the sump and slings it against a collector plate. Then, the oil usually flows into a trough that applies it to the upper edges of the link plates in the lower strand of the chain (Figure A.8). The diameter of the disc should produce rim speeds between 600 ft/min (183 m/min) and 8000 ft/min (2438 m/min). Lower speeds may not pick up the oil effectively, while higher speeds may cause oil foaming or overheating.

In both oil bath and slinger disc lubrication, the temperature of the oil bath and the chain should not exceed 180°F. Also, the volume of oil applied to the chain must be great enough to prevent the red-brown (rust) discoloration of lubricant in the chain joints. The oil level in the sump of both oil bath and slinger disc systems should be checked after each 8 hours of operation, and oil added when needed. At the same time, the system should be checked for leaking, foaming, or overheating.

A.2.3.4 Type III—Oil Stream Lubrication

With oil stream lubrication, a pump delivers oil under pressure to nozzles that direct a stream or spray onto the chain. The oil should be applied evenly across the width of the chain, and be directed onto the lower span from inside the chain loop (Figure A.9). Excess oil collects in the bottom of the casing and is returned to the pump suction reservoir. A pressure-regulating valve may be used to divert excess pump discharge to the reservoir. Oil cooling may occur by radiation from the external surfaces of the reservoir or by a separate heat exchanger.

Oil stream lubrication is always recommended for chains operating at relatively high speeds and loads. It is absolutely essential for roller chains that operate in the indicated galling region for any extended time period. The oil stream not only lubricates the chain, but also cools the chain and carries away wear debris from a drive being run at or near full rated capacity. The minimum oil flow rate for the amount of horsepower being transmitted is shown in Table A.3.

Here again, the oil level in the sump should be checked after each 8 hours of operation, and oil added when needed. At the same time, the system should be checked for leaking or overheating.

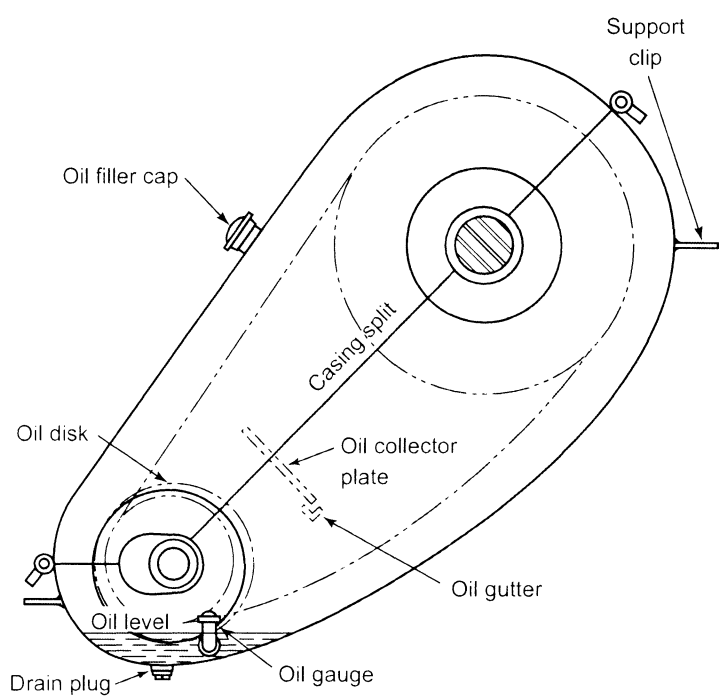


Figure A.8—Slinger Disc Lubrication

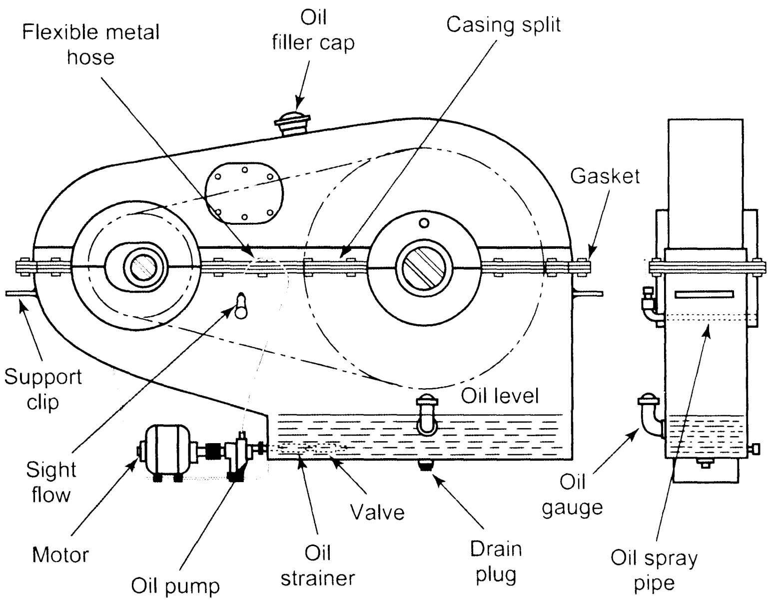


Figure A.9—Oil Stream Lubrication

Table A.3—Required Oil Flow for Chain Drives

Transmitted		Minimum Required	
HP	**kW**	**gal/min**	**L/min**
50	37	0.25	0.95
100	75	0.50	1.89
150	112	0.75	2.84
200	149	1.00	3.78
300	224	1.50	5.68
400	298	2.00	7.57
500	373	2.50	9.46
600	447	3.00	11.40
800	597	3.75	14.20
1000	746	4.75	18.00
1500	1119	7.00	26.50
2000	1491	10.00	37.90

A.2.4 Chain Casings

A.2.4.1 General

Chain casings (Figure A.10) are used to facilitate lubrication and to protect the drive from being damaged by debris or contamination. Chain casings are usually made of sheet metal, stiffened by steel angles or embossed ribs, and have access doors or panels for inspection and maintenance of the drive.

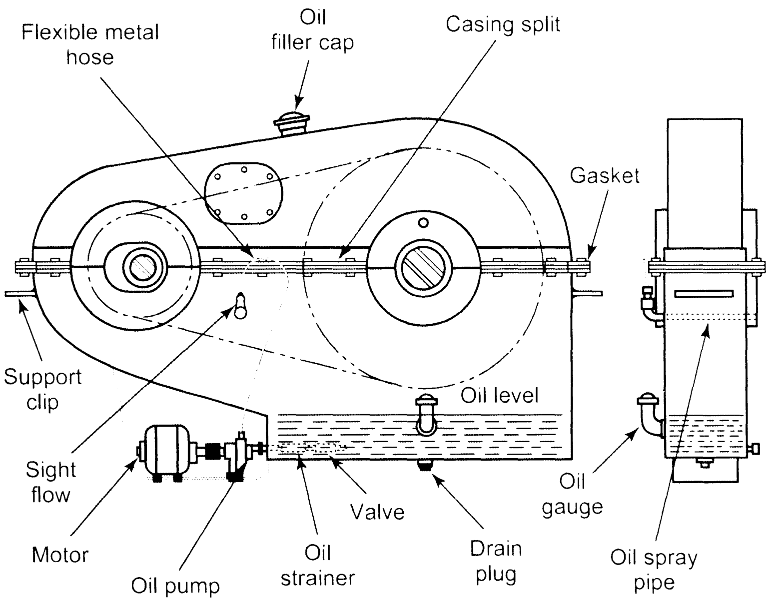


Figure A.9—Oil Stream Lubrication

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600	447	3.00	11.40
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Adequate clearances must be provided inside the chain casing or the useful wear life of the chain may be restricted. As chain wear elongation accumulates in the slack span, chain sag can become great enough to allow the chain to strike the bottom of the chain casing, damaging both the chain and the casing. Casing clearances to allow for maximum wear elongation percentages may be determined from Figure A.11. In addition to the clearance to accommodate chain sag, there should be at least a 3 in. (76 mm) clearance around the periphery of the chain and 0.75 in. (19 mm) on each side of the chain.

When a chain casing is used, it may need to be sized for adequate heat dissipation. The temperature rise of the oil in a chain casing may be estimated by the use of Figure A.12 and Figure A.13 and the procedures that accompany them.

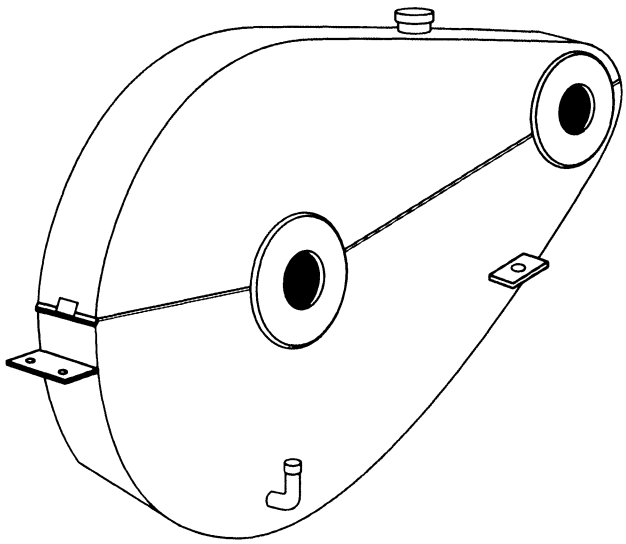


Figure A.10—Typical Oil Retaining Chain Casing

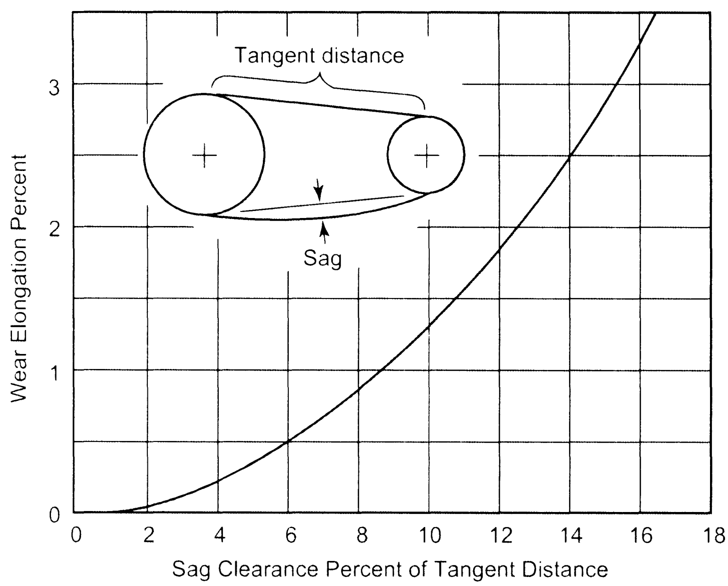


Figure A.11—Casing Clearance Wear Limit

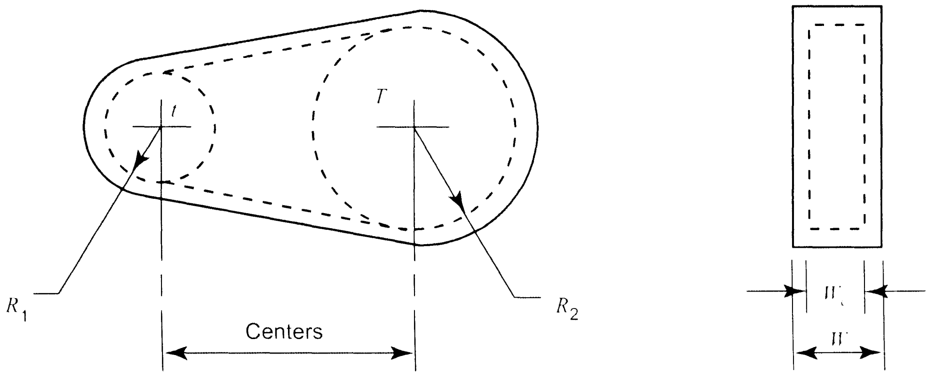


Figure A.12—Chain Casing Schematic

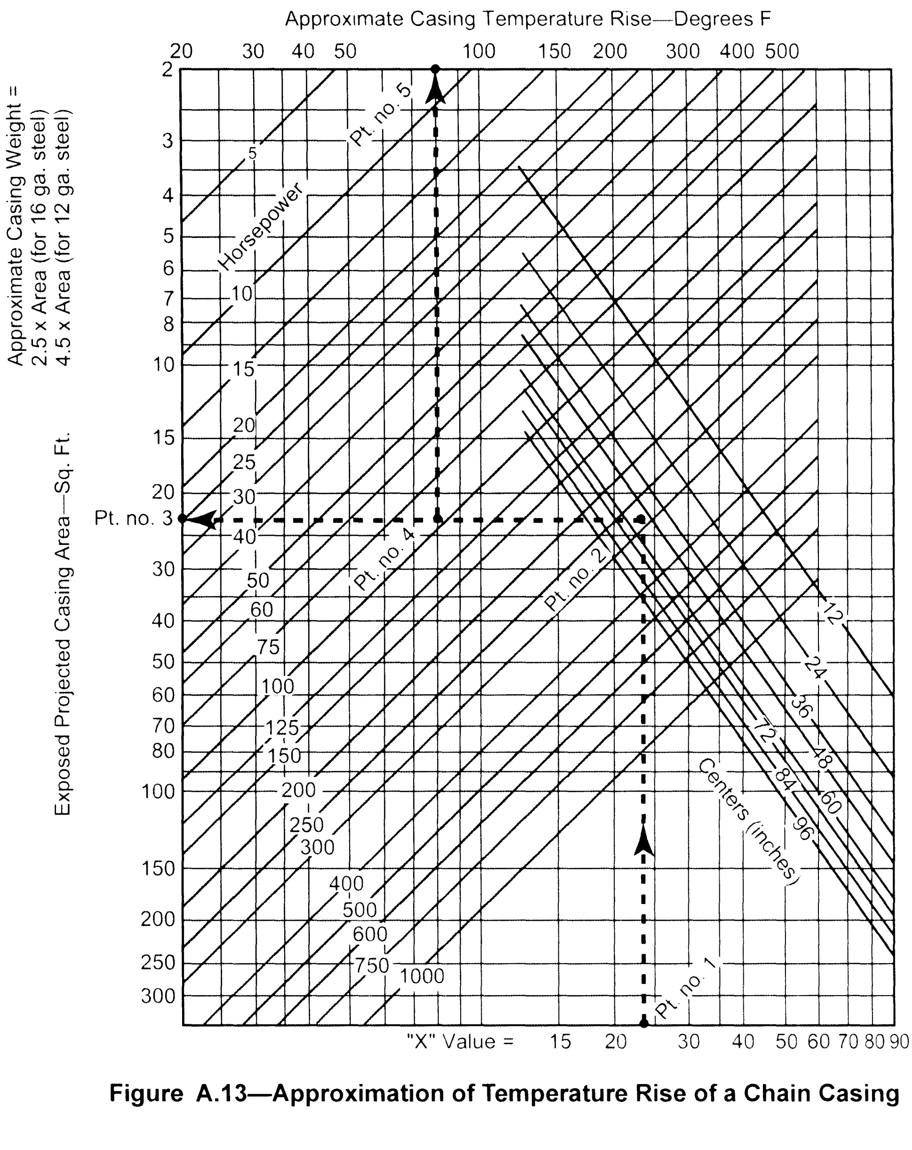


Figure A.13—Approximation of Temperature Rise of a Chain Casing

To estimate the probable temperature rise of a chain case, the following formula may be used:

$$T = \frac{50.9\ \mathrm{HP}}{AK} = °\mathrm{F\ above\ ambient}$$

where

T is the temperature rise in degrees Fahrenheit;

HP is the transmitted horsepower;

A is the casing area exposed to air circulation in square feet;

K is the radiation constant in Btu per square foot per hour per degree Fahrenheit temperature difference.

NOTE K is 2.0 for still air, 2.7 for normal free air circulation, or 4.5 for rapid air circulation.

Good practice limits the allowable operating temperature to approximately 180 °F (temperature rise plus ambient). If the calculated temperature is greater than this value, a larger casing could be used or an oil cooler added to reduce the operating temperature to allowable limits. The accompanying chart may be used for a quick approximation of possible temperature rise (Figure A.13).

A.2.4.2 Explanation

1) Compute value of X and plot point #1.

2) Draw vertical line from X value (point #1) to intersect appropriate centers (point #2).

3) Draw horizontal line from "centers" (point #2) and read exposed projected casing area (point #3).

4) At intersection of appropriate HP and horizontal line (point #4) from step 3, draw a vertical line and read approximate casing temperature rise (point #5).

Values of X:

standard casing, $X = \frac{P}{6}(t + T) + W_c + 9$

oversize casing, $X = R_1 + R_2 + W$

where

P is the chain pitch, in inches;

t is the number of teeth small sprocket;

W_c is the chain width in inches;

R_1 is the casing radius, small end, in inches;

R_2 is the casing radius, large end, in inches;

W is the casing width in inches;

HP is the horsepower;

T is the number of teeth large sprocket;

A is the area in square feet.

A.3 Maintenance

A.3.1 Inspection and Service Schedule

A roller chain drive requires proper and timely maintenance to deliver satisfactory performance and service life. It is assumed that the shafts, bearings, and supports; the chain and sprockets; and the lubrication type have been properly selected and installed. Then, a maintenance program must be established to assure the following:

a) the drive is correctly lubricated;

b) drive interferences are eliminated;

c) damaged chains or sprockets are replaced;

d) worn chains or sprockets are replaced;

e) the sprockets are properly aligned;

f) the chain is correctly tensioned;

g) guarding is in good condition and is properly installed.

A roller chain drive should be inspected after the first 50 hours of operation. After that, drives subject to heavy shock loads or severe operating conditions should be inspected after each 200 hours of operation, while more ordinary drives may be inspected after each 500 hours of operation. Experience may indicate a longer or shorter interval between inspections.

At each inspection, the following items should be checked and corrected when necessary. In addition, maintenance personnel should refer to Table A.4 for more information on troubleshooting roller chain drives.

A.3.2 Inspect Lubrication System

For manual lubrication, be sure that the lubrication schedule is being followed and the correct grade of oil is being used. If the chain is dirty, clean it with kerosene or a nonflammable solvent and relubricate it.

For drip lubrication, check the flow rate and be sure that the oil is being directed onto the chain correctly.

For oil bath, slinger disc, or oil stream lubrication, be sure that all orifices are clear and that the oil is being directed onto the chain correctly. Change the oil after the first 50 hours of operation and after each 500 hours thereafter (200 hours in severe service).

A.3.3 Inspect for Drive Interferences

Inspect for any evidence of interference between the drive components and other parts of the equipment. If any is found, correct it immediately. Rubbing between the chain or sprockets and other parts of the machine can cause abnormal wear and damage. Impact between the chain link plates and a rigid object can cause link plate fatigue and chain failure.

Also inspect for and eliminate any buildup of debris or foreign material between the chain and sprockets. A relatively small amount of debris in the sprocket roller seat can cause tensile loads great enough to break the chain if forced through the drive.

Table A.4—Roler Chain Drive Troubleshooting Guide

Condition/Symptom	Possible Cause	What to Do
Missing parts	Missing at assembly	Replace chain
	Broken and lost	Find and correct cause of damage Replace chain
Rusted chain	Exposed to moisture	Replace chain Protect from moisture
	Water in lubricant	Change lubricant Protect lubrication system from water- Replace chain
	Inadequate lubrication	Provide or re-establish proper lubrication Replace chain if needed
Excessive noise	Chain striking an obstruction	Replace chain. Eliminate interference
	Loose casing or shaft mounts	Tighten fasteners, mounts
	Excess chain slack	Re-tension chain
	Excessive chain wear	Replace and re-tension chain
	Excessive sprocket wear	Replace sprockets and chain
	Sprocket misalignment	Replace chain and sprockets if needed Realign sprockets
	Inadequate lubrication	Replace chain if needed. Re-establish proper lubrication
	Chain pitch too large	Redesign drive for smaller pitch chain
	Too few sprocket teeth	Check to see if larger sprockets can be used. If not, redesign drive
Wear on inside of roller link plates and one side of sprockets	Sprocket misalignment	Replace sprockets and chain if needed Realign drive Re-tension chain
Chain clings to sprocket	Excessive sprocket wear	Replace sprockets and chain
	Sprocket misalignment	Replace sprockets and chain if needed Realign sprockets
Chain climbs sprocket teeth	Excess chain slack	Re-tension chain
	Excessive chain wear	Replace and re-tension chain
	Excessive sprocket wear	Replace sprockets and chain
	Extreme overload	Replace chain Eliminate cause of overload

Table A.4—Roler Chain Drive Troubleshooting Guide (Continued)

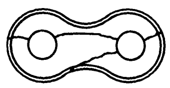
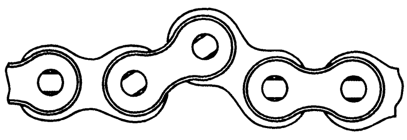
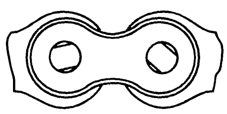
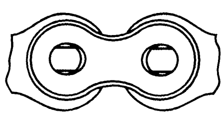
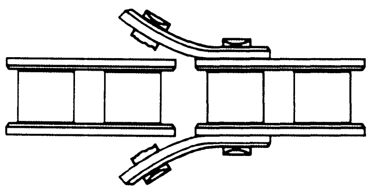
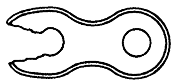
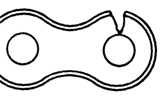
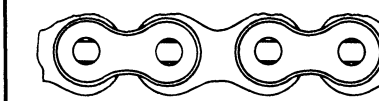
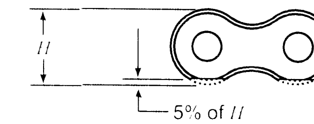
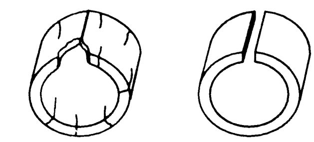
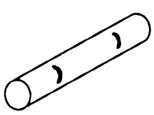
Condition/Symptom	Possible Cause	What to Do
Missing or broken cotters	Cotters installed improperly	Install new cotters per Manufacturer's instructions
	Striking obstruction	Replace chain Eliminate interference
	Vibration	Replace chain Reduce vibration Use larger sprockets
	Excessively high speed.	Replace chain Reduce speed Redesign drive for smaller pitch chain
Exposed chain surfaces corroded or pitted	Exposure to corrosive environment	Replace chain Protect from hostile environment
Cracked link plates (stress corrosion) 	Exposure to corrosive environment combined with stress from press fits.	Replace chain Protect from hostile environment
Tight joints 	Dirt or foreign material in chain joints	Clean and relubricate chain
	Inadequate lubrication	Replace chain Re-establish proper lubrication
	Misalignment	Replace sprockets and chain if needed Realign sprockets.
	Internal corrosion or rust	Replace chain Eliminate cause of corrosion or protect chain
	Overload bends pins or spreads roller link plates	Replace chain Eliminate cause of overload
Turned pins 	Inadequate lubrication	Replace chain Re-establish proper lubrication.
	Overload	Replace chain Eliminate cause of overload
Enlarged holes 	Overload	Replace chain Eliminate cause of overload

Table A.4—Roler Chain Drive Troubleshooting Guide (Continued)

Condition/Symptom	Possible Cause	What to Do
Broken pins  Broken link plates 	Extreme overload	Replace chain Replace sprockets if indicated Eliminate cause of overload or redesign drive for larger pitch chain
Cracked link plates (fatigue) 	Loading greater than chain's dynamic capacity	Replace chain Reduce dynamic loading or redesign drive for larger chain
Battered link plate edges 	Chain striking an obstruction	Replace chain Eliminate interference
Worn link plate contours 	Chain rubbing on casing, guide, or obstruction	Replace chain if 5% or more of height worn away, or if any evidence of heat discoloration Re-tension chain Eliminate interference
Broken, cracked, or deformed rollers 	Speed too high	Replace chain Reduce speed
	Sprockets too small	Replace chain Use larger sprockets, or possibly redesign drive for smaller pitch chain
	Chain riding too high on sprocket teeth	Replace chain Re-tension chain more often
Pin galling 	Speed or load too high	Reduce speed or load Possibly redesign drive for smaller pitch chain
	Inadequate lubrication	Provide or re-establish proper lubrication

A.3.4 Inspect for Damaged Chain or Sprockets

Inspect the chain for cracked, broken, deformed, or corroded parts; and for tight joints or turned pins. If any are found, find and correct the cause of the damage and replace the entire chain. Even though the rest of the chain appears to be in good condition, it very probably has been damaged and more failures are likely to occur in a short time.

Inspect sprockets for chipped, broken, or deformed teeth. If any are found, find and correct the cause of the damage and replace the sprocket. Sprockets normally are stronger and less sensitive to damage than chain, but running a worn chain on new sprockets can ruin the sprockets in a short time. This is because a worn chain rides very high on the sprocket teeth and wears the sprocket teeth in an abnormal pattern.

A.3.5 Inspect for Chain Wear

In most roller chain drives, the chain is considered worn out when it has reached 3% wear elongation. With 3% wear. the chain does not engage the sprocket properly and can cause sprocket damage or chain breakage. On drives with large sprockets (more than 66 teeth), allowable wear is limited to $200/N$ (where N is the number of teeth on the largest sprocket) and may be substantially less than 3%. On fixed-center, nonadjustable drives, allowable wear elongation is limited to approximately one-half of one chain pitch.

Measure a representative section of chain, as shown in Figure A.14, and Table A.5, and if wear elongation exceeds 3% or the functional limit, replace the entire chain. Do not connect a new section of chain to a worn section because it may run rough and damage the drive.

A.3.6 Inspect for Sprocket Wear

A worn out sprocket is not nearly as well defined as a worn out chain. However, there are some sprocket characteristics that indicate when a sprocket should be replaced. Check for roughness or binding when a new chain engages or disengages the sprocket. Inspect for reduced tooth thickness and hooked tooth tips (Figure A.15). If sprocket teeth are hooked visibly, without aid of a template, chain life can be significantly reduced, and the sprocket should be replaced.

Do not run new chain on worn out sprockets because it can cause the chain to wear rapidly. The pitch of the new chain is much shorter than the effective pitch of the worn sprocket, so the total chain load is concentrated on the final sprocket tooth before disengagement. Then, when the chain disengages from the sprocket, the roller is jerked out of the hooked portion of the sprocket tooth and that results in a shock load on the chain as the load is transferred from one tooth to the next.

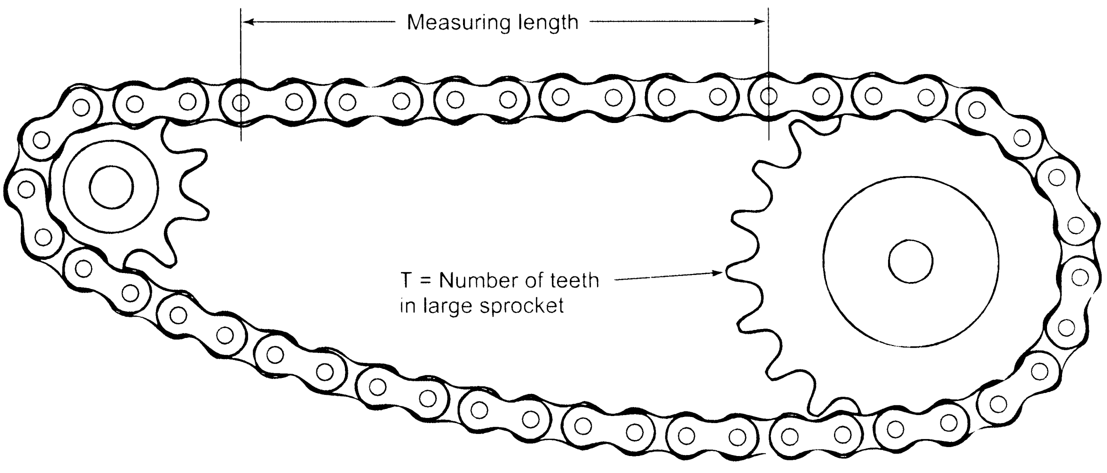


Figure A.14—Measurement of Chain for Wear Elongation

Table A.5—Chain Wear Elongation Limits

ANSI Chain Number	Chain Pitch in. (mm)	Measured Length		
		No. of Pitches	Nominal in. (mm)	At 3% Wear in. (mm)
25	0.250 (6.35)	48	12.00 (305)	12.360 (314)
35	0.375 (9.52)	32	12.00 (305)	12.360 (314)
41	0.500 (12.70)	24	12.00 (305)	12.360 (314)
40	0.500 (12.70)	24	12.00 (305)	12.360 (314)
50	0.625 (15.88)	20	12.50 (318)	12.875 (327)
60, 60H	0.750 (19.05)	16	12.00 (305)	12.360 (314)
80, 80H	1.000 (25.40)	12	12.00 (305)	12.360 (314)
100, 100H	1.250 (31.75)	20	25.00 (635)	25.750 (654)
120, 120H	1.500 (38.10)	16	24.00 (610)	24.719 (628)
140, 140H	1.750 (44.45)	14	24.50 (622)	25.250 (641)
160, 160H	2.000 (50.80)	12	24.00 (610)	24.720 (628)
180, 180H	2.250 (57.15)	12	27.00 (686)	27.812 (706)
200, 200H	2.500 (63.50)	10	25.00 (635)	25.750 (654)
240, 240H	3.000 (76.20)	8	24.00 (610)	24.720 (628)

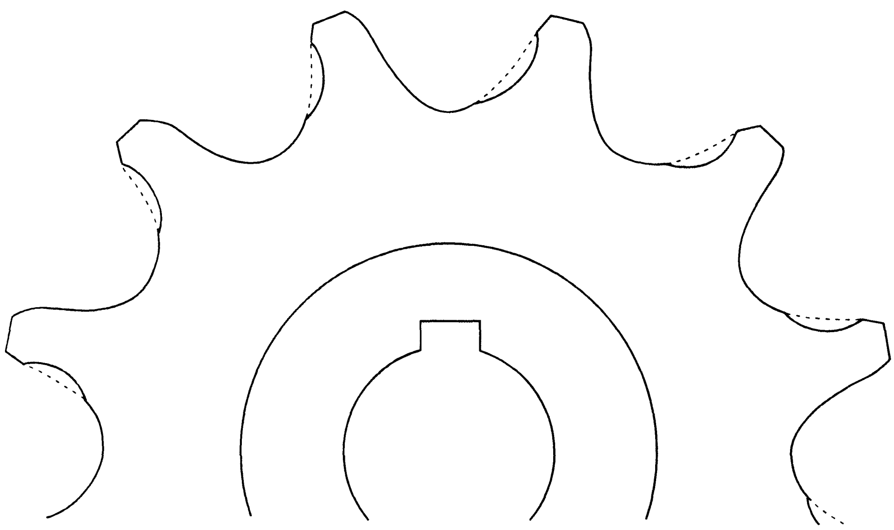


Figure A.15—Worn Sprocket

A.3.7 Inspect for Sprocket Misalignment

Inspect for significant wear on the inside surfaces of the chain roller link plates and on the sprocket flange faces. If this type of wear is present, the sprockets may be misaligned. Realign the sprockets as described in the installation instructions to prevent further abnormal chain and sprocket wear. If 5% or more of the link plate thickness is worn away, or if there are sharp gouges in the link plate surface, the chain should be replaced immediately. If 10% or more of the sprocket tooth flange thickness is worn away, the sprocket should be replaced.

A.3.8 Inspect Chain Tension

Measure the total mid-span movement (Figure A.3). If it exceeds the tabulated limit, adjust the center distance to obtain the desired amount of slack. If elongation exceeds the available adjustment, and wear elongation still has not exceeded 3% or the functional limit, remove two pitches and reinstall the chain. If the minimum adjustment will not permit shortening the chain two pitches, the chain may be shortened one pitch by using an offset link or an offset section.

A.3.9 Inspect Guards

Inspect the guards to ensure they are in serviceable condition. The guards must not be bent or deformed so that intended clearance is reduced. Any designed openings in the guard (mesh) must not be enlarged. The guards must not be broken or damaged, especially at or near the mounting points.

If the guards are in serviceable condition, reinstall them on the drive, making sure that all fasteners are secure and that all safeguarding devices (such as presence sensors and interlocks) are functioning.

Annex B
(informative)

Sprockets for Roller Chain

B.1 Sprocket Types

Four types of sprockets are shown in Figure B.1 and are designated as follows:

a) Type A—plain plate;

b) Type B—hub on one side only;

c) Type C—hub on both sides;

d) Type D—hub detachable.

B.2 Tooth Profile

Figure B.2, Section A and Section B, show the recommended sprocket tooth chamfer for roller chains. Figure B.2, Section C, shows sprocket tooth flange location for multiple-strand roller chains. All sprocket flanges are chamfered to guide the chain onto the sprocket in case of misalignment due to sprocket misalignment or permissible flange weave. Flange chamfer may be either as described in Section A or Section B, or any intermediate profile. The fillet radius r_f maximum equals 0.04 × pitch for maximum hub diameter. Other dimensions indicated in Figure B.2 are as specified in ASME B29.1 for precision sprockets.

B.3 Tooth Form

The tooth form shall conform dimensionally to those described in ASME B29.1.

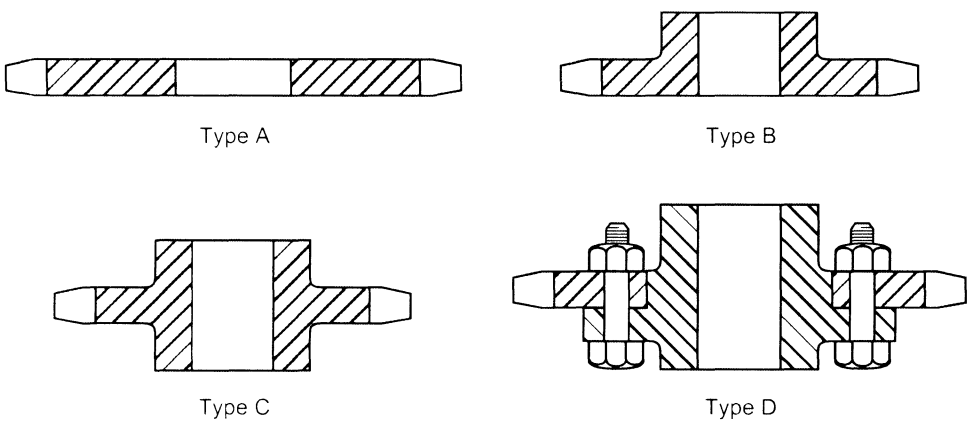


Figure B.1—Sprocket Types

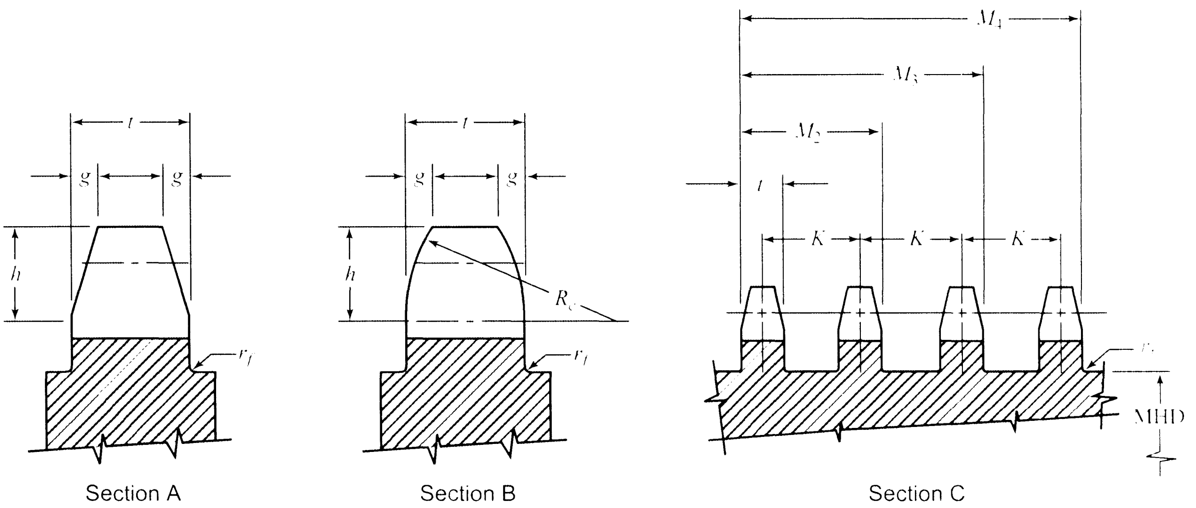


Figure B.2—Sprocket Tooth Profile

Annex C
(informative)

Use of the API Monogram by Licensees

C.1 Scope

The API Monogram Program allows an API Licensee to apply the API Monogram to products. The API Monogram Program delivers significant value to the international oil and gas industry by linking the verification of an organization's quality management system with the demonstrated ability to meet specific product specification requirements. The use of the Monogram on products constitutes a representation and warranty by the Licensee to Purchasers of the products that, on the date indicated, the products were produced in accordance with a verified quality management system and in accordance with an API product specification.

When used in conjunction with the requirements of the API License Agreement, API Q1, in its entirety, defines the requirements for those organizations who wish to voluntarily obtain an API license to provide API monogrammed products in accordance with an API product specification.

API Monogram Program licenses are issued only after an on-site audit has verified that the Licensee conforms to the requirements described in API Q1 in total, and the requirements of an API product specification. Customers/users are requested to report to API all problems with API monogrammed products. The effectiveness of the API Monogram Program can be strengthened by customers/users reporting problems encountered with API monogrammed products. A nonconformance may be reported using the API Nonconformance Reporting System available at https://ncr.api.org. API solicits information on new product that is found to be nonconforming with API specified requirements, as well as field failures (or malfunctions), which are judged to be caused by either specification deficiencies or nonconformities with API specified requirements.

This annex sets forth the API Monogram Program requirements necessary for a supplier to consistently produce products in accordance with API specified requirements. For information on becoming an API Monogram Licensee, please contact API, Certification Programs, 1220 L Street, N. W., Washington, D.C. 20005 or call 202-962-4791, or by email at certification@api.org.

C.2 References

In addition to the referenced standards listed earlier in this document, this annex references the following standard:

API Specification Q1.

For Licensees under the Monogram Program, the latest version of this document shall be used. The requirements identified therein are mandatory.

C.3 API Monogram Program: Licensee Responsibilities

C.3.1 Maintaining a License to Use the API Monogram

For all organizations desiring to acquire and maintain a license to use the API Monogram, conformance with the following shall be required at all times:

a) the quality management system requirements of API Q1;

b) the API Monogram Program requirements of API Q1, Annex A;

c) the requirements contained in the API product specification(s) for which the organization desires to be licensed;

d) the requirements contained in the API Monogram Program License Agreement.

C.3.2 Monogrammed Product Conformance with API Q1

When an API-licensed organization is providing an API monogrammed product, conformance with API specified requirements, described in API Q1, including Annex A, is required.

C.3.3 Application of the API Monogram

Each Licensee shall control the application of the API Monogram in accordance with the following.

a) Each Licensee shall develop and maintain an API Monogram marking procedure that documents the marking/ monogramming requirements specified by the API product specification to be used for application of the API Monogram by the Licensee. The marking procedure shall define the location(s) where the Licensee shall apply the API Monogram and require that the Licensee's license number and date of manufacture be marked on monogrammed products in conjunction with the API Monogram. At a minimum, the date of manufacture shall be two digits representing the month and two digits representing the year (e.g., 05-07 for May 2007) unless otherwise stipulated in the applicable API product specification. Where there are no API product specification marking requirements, the Licensee shall define the location(s) where this information is applied.

b) The API Monogram may be applied at any time appropriate during the production process but shall be removed in accordance with the Licensee's API Monogram marking procedure if the product is subsequently found to be nonconforming with API specified requirements. Products that do not conform to API specified requirements shall not bear the API Monogram.

c) Only an API Licensee may apply the API Monogram and its license number to API monogrammable products. For certain manufacturing processes or types of products, alternative API Monogram marking procedures may be acceptable. The current API requirements for Monogram marking are detailed in the API Policy Document, Monogram Marking Requirements, available on the API Monogram Program website at http://www.api.org/certifications/monogram.

d) The API Monogram shall be applied at the licensed facility.

e) The authority responsible for applying and removing the API Monogram shall be defined in the Licensee's API Monogram marking procedure.

C.3.4 Records

Records required by API product specifications shall be retained for a minimum of five years or for the period of time specified within the product specification if greater than five years. Records specified to demonstrate achievement of the effective operation of the quality system shall be maintained for a minimum of five years.

C.3.5 Quality Program Changes

Any proposed change to the Licensee's quality program to a degree requiring changes to the quality manual shall be submitted to API for acceptance prior to incorporation into the Licensee's quality program.

C.3.6 Use of the API Monogram in Advertising

Licensee shall not use the API Monogram on letterheads or in any advertising (including company-sponsored web sites) without an express statement of fact describing the scope of Licensee's authorization (license number). The Licensee should contact API for guidance on the use of the API Monogram other than on products.

C.4 Marking Requirements for Products

C.4.1 General

These marking requirements apply only to those API Licensees wishing to mark their products with the API Monogram.

C.4.2 Product Specification Identification

Manufacturers shall mark equipment as specified in 3.9, as a minimum.

The API Monogram and the date of manufacture shall be marked on the chain packaging, in addition to the marking requirements in 3.9.

C.4.3 Units

As a minimum, equipment should be marked with U.S. customary (USC) units. Use of dual units [metric (SI) units and USC units] is acceptable.

C.4.4 License Number

The API Monogram license number shall not be used unless it is marked in conjunction with the API Monogram.

C.5 API Monogram Program: API Responsibilities

The API shall maintain records of reported problems encountered with API monogrammed products. Documented cases of nonconformity with API specified requirements may be reason for an audit of the Licensee involved, (also known as audit for "cause").

Documented cases of specification deficiencies shall be reported, without reference to Licensees, customers or users, to API Subcommittee 18 (Quality) and to the applicable API Standards Subcommittee for corrective actions.

Bibliography

[1] ACA [2], Standard Handbook of Chains, *Chains for Power Transmission Material Handling*

[2] ACA, *Connect and Disconnect Instructions for ANSI B29.1 Roller Chains*

[3] ASME B15.1, *Safety Standard for Mechanical Power Transmission Apparatus*

[2] American Chain Association, 6724 Lone Oak Blvd., Naples, Florida 34109, www.americanchainassn.org.

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