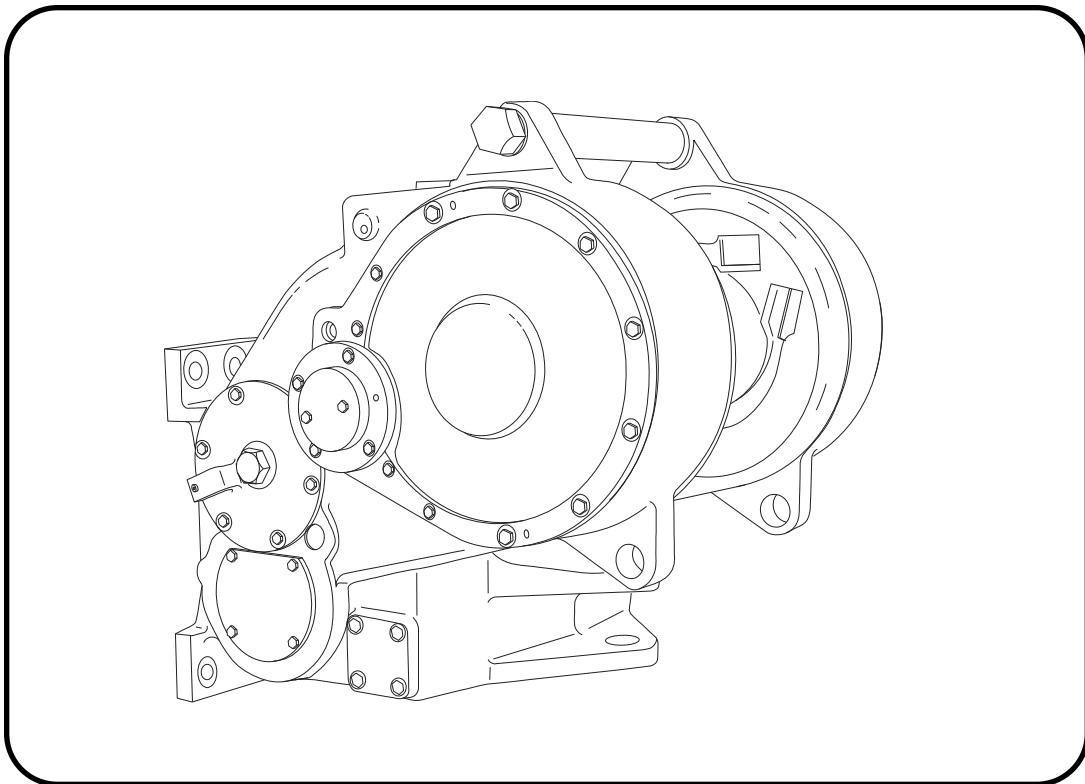


OPERATION & PREVENTIVE MAINTENANCE MANUAL WINCH MODELS PA55 & PA56 WITH ELECTRONIC CONTROLS



FOREWORD

Please read and understand this entire manual BEFORE operating or servicing your PACCAR winch. Retain this manual for future reference.

This manual contains instructions for the operation of PACCAR Models PA55 & PA56 power shift winches. When instructions apply to only one series of winch, the specific model number (PA55 or PA56 only) will appear at the beginning of the pertinent text. If not identified in this manner, the text applies to BOTH series of winches; PA55 & PA56.

Some illustrations in this manual may show details or attachments which may be different from your winch.

Also, some components may have been removed for illustrative purposes.

Continuing product improvement may cause changes in your winch which may not be included in this manual. Whenever a question arises regarding your PACCAR winch or this manual, please contact your nearest Caterpillar dealer or the PACCAR SERVICE DEPARTMENT at 1-918-251-8511, Monday - Friday, 0800 hrs - 1630 hrs CST or by FAX at 1-918-259-1575. Provide the complete winch MODEL NUMBER and SERIAL NUMBER when making inquiries.

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Safety and informational callouts used in this manual include:



WARNING - This emblem is used to warn against hazards and unsafe practice which COULD result in severe personal injury or death if proper procedures are not followed.



CAUTION - This emblem is used to warn against potential or unsafe practices which COULD result in personal injury, and product or property damage if proper procedures are not followed.

GENERAL SAFETY RECOMMENDATIONS

Safety for operators and ground personnel is of prime concern. Always take the necessary precautions to ensure safety to others as well as yourself. To ensure safety, the tractor and winch must be operated with care, concern by the operator for the equipment and a thorough knowledge of the machine's performance capabilities. The following recommendations are offered as a general safety guide. Local rules and regulations will also apply.



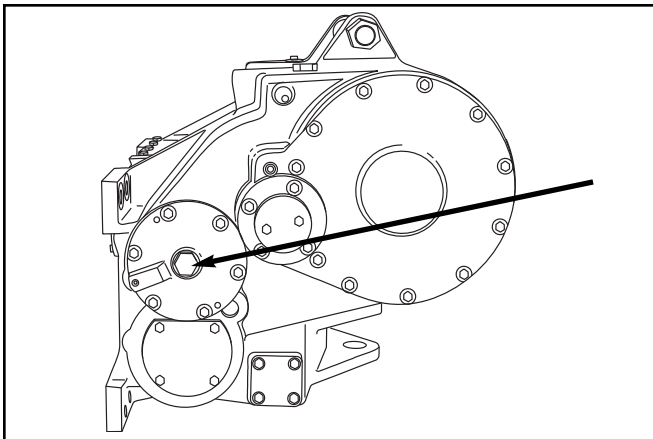
FAILURE TO OBEY THE FOLLOWING SAFETY RECOMMENDATIONS MAY RESULT IN PROPERTY DAMAGE, INJURY OR DEATH.

1. Read all warning tag information and become familiar with all controls BEFORE operating winch.
2. Never attempt to clean, oil or perform any maintenance on a machine with the engine running, unless instructed to do so in the Service Manual.
3. Before starting tractor, be certain all controls move freely and are placed in the "Brake-On" (neutral) position.
4. Never operate winch controls unless you are properly seated at the operators station on the tractor and you are sure personnel are clear of work area.
5. Operate winch line speeds to match job conditions.
6. Assure that personnel who are responsible for hand signals are clearly visible and that the signals to be used are thoroughly understood by everyone.
7. Never attempt to handle winch cable when the hook end is not free.
8. Leather gloves should be used when handling winch cable.
9. Ground personnel should stay in view of tractor operator and clear of winch drum. Do not allow ground personnel near winch line under tension. A safe distance of at least 1½ times the length of the cable in use should be maintained.
10. When winding cable on the winch drum, never attempt to maintain tension by allowing cable to slip through hands. Always use "hand-over-hand" method.
11. Use correct size ferrule for cable and pocket in winch drum. Never use knots to secure or attach cable.
12. Inspect rigging, winch and tractor at the beginning of each work shift. Any cable with broken strands or rigging worn or damaged should be replaced.
13. Position tractor for straightest line of pull. Use fair-lead if side pulls are frequently encountered.
14. The cable anchor or ferrule pocket in the cable drum is designed to provide a self release in the event a back-sliding load must be released from the tractor in an emergency situation. The cable anchor or ferrule alone will **NOT** support rated linepull. Therefore, a minimum of five (5) complete wraps of cable must be maintained on winch drum.
15. Be sure of tractor ground stability before winching in load.
16. Store unused chokers, slings and rigging in a neat and orderly fashion to prevent damage to equipment or injury to personnel.
17. The maximum rated bare drum line pull of the PACCAR PA55 is 69,200 LB (307.8 kN)* and 89,800 lb (399.4 kN)** for the PACCAR PA56. Do not operate the winch under loads that exceed the maximum rated bare drum line pull. If excessive loads are encountered, use a multi-part line and sheave blocks. Any attempt to exceed the capabilities of one winch (such as coupling 2 or more tractors together) is extremely hazardous.
* Breaking strength of 7/8 in. (22 mm) IPS wire rope.
**Breaking strength of 1 in. (25 mm) IPS wire rope.
18. The factory approved adaptations for PACCAR winches are designed and intended for use on specific models of crawler tractors. Changing winches between tractors is not possible in some cases because of differences in tractor models. Some changes cannot be approved by PACCAR because of safety limitations. Call a PACCAR dealer or the Factory prior to attempting winch modifications or before mounting on a different tractor.
19. PACCAR power shift winches are equipped with hydraulic accumulators. Discharge accumulator stored oil supply before removing any hydraulic lines or fittings or servicing winch. Personal injury may result from the sudden release of oil pressure. To discharge the accumulator, stop the engine, slowly cycle the Power Shift control handle into full Haul-In then Pay-Out positions a minimum of five (5) times.
20. On machines having hydraulically, mechanically and/or cable controlled equipment, be certain the equipment is either lowered to the ground or blocked securely before servicing, adjusting and/or repairing the winch. Always apply tractor parking brakes and lower equipment before dismounting the tractor.

MODEL DESCRIPTION

The PACCAR Power Shift Winch is a single drum unit that mounts to the rear of a crawler tractor. It is driven by engine power through the tractor PTO (Power Take-Off). The winch may be operated independently or with the tractor transmission engaged. When operated properly, it is capable of utilizing maximum engine horsepower. The standard winch is equipped with equal speed gearing, power-in and power-out multi-disc oil actuated friction clutches and a spring applied, hydraulically released multi-disc oil brake.

The winch may be manufactured as a Standard (or High) PTO or Low PTO configuration, depending on the tractor application. In the Standard PTO configuration, the bevel gear group, clutches and brake assembly are located in the upper bores of the winch case.



Standard PTO Shown

The Low PTO configuration has the bevel gear group, clutches and brake assembly located in the lower bores of the winch case.

The PA55 winch may have either a 3-shaft or 4-shaft gear train configuration depending on the tractor horsepower, PTO speed and winch line speed requirements of the winch application. The PA56 winch is manufactured in a 4-shaft configuration, except when used in a very limited number of special applications.

Standard and Low PTO winch configurations are available with either standard or slow speed gear ratios. The standard speed winch is primarily used in logging, land clearing and general utility applications. The standard speed models have gear ratios which closely match the cable drum rotation speed in Reel-In (forward) to the tractor reverse track speeds for optimum advantage in tractor recovery applications.

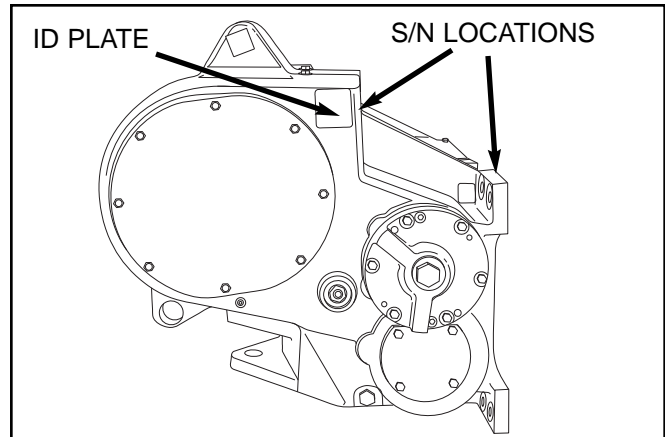
The slow speed winch configuration is similar to the standard speed unit, but uses slow speed gearing for greater load control. A slow speed winch is well suited for oil and gas field, mining and pipeline applications.

Optional features increase the ability of the winch to

meet specific application requirements. Options available for the PA55 & PA56 series winches include:

- Free Spool
- Gear Ratios
- Three or Four Roller Fairlead

The winch model number is an important reference as to the optional components included when the winch was manufactured. The identification plate located on the RH side of the winch contains this code, as well as the winch serial number.



The winch model number contains the following configuration data:

MODEL						
C 0 0 0 0 0 E						
PA55/PA56						
Bevel Gear Ratio						
A-1:1						
B-1.27:1						
C-1.64:1						
D-2.11:1						
E-2.79:1						
0-Overwind 1-Underwind						
0-Standard Brake						
0-Without Freespool 1-With Freespool						
0-Four Shaft Winch 1-Three Shaft Winch						
0-No Fairlead 3-Three Roller Fairlead 4-Four Roller Fairlead						
0-Electronic Controls						

Important: Always refer to the serial number and model number when requesting information or service parts.

WINCH OPERATION

HYDRAULIC SYSTEM

The winch contains an independent, internal hydraulic system. The winch case serves as a reservoir and stores filtered oil for the internally mounted hydraulic pump. The pump is driven by a gear pressed onto the bevel pinion gear, and supplies oil as long as the tractor PTO shaft is turning. Oil from the pump is then routed through a pressure filter then directed to the control valve in the winch case where a stand-by system pressure is maintained at 320-410 PSI (2210-2830 kPa).

Movement of the control lever initiates electrical signals which are routed to solenoids on the control valve in the winch. Oil is then routed to the appropriate Reel-In or Reel-Out clutch, Brake pack or Freespool cylinder to perform the selected winch function.

The winch hydraulic system is equipped with a piston-type accumulator. The accumulator stores a small amount of oil at system pressure to assist the application of clutches and release the brake under all operating conditions.

The stored oil supply may also be used to release the spring-applied brake whenever the tractor engine or torque converter is stalled. The accumulator-stored oil is continuously refilled by the winch pump and valve whenever the tractor PTO is turning.

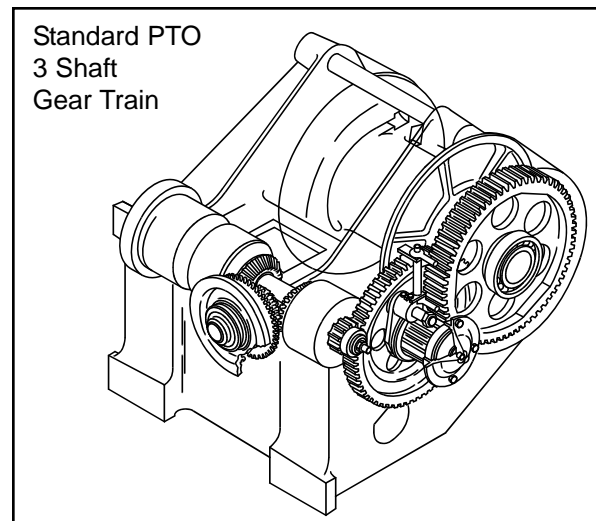
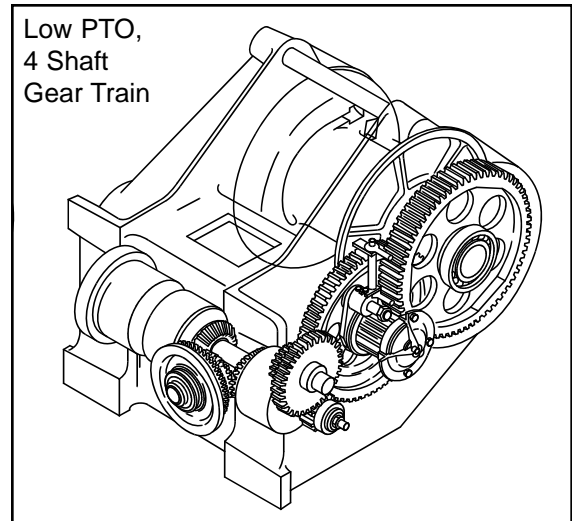
i **NOTE:** On tractors which supply PTO power through the torque converter, it is possible to cause the torque converter to stall if the tractor engine speed is too low. It is important that engine idle be set to factory specifications.

⚠ CAUTION ⚠

Discharge the accumulator oil supply **BEFORE** removing any hydraulic lines or servicing the winch. Personal injury may result from the sudden release of oil under pressure. To discharge the accumulator, shut the engine off, then slowly cycle the Power Shift control lever into full Reel-In and Reel-Out positions a minimum of five (5) times. The tractor master switch and ignition must be ON.

GEAR TRAIN

The winch bevel pinion, bevel gears, hydraulic pump and clutch friction discs are rotating whenever the tractor PTO shaft is rotating. Application of a clutch, Reel-In or Reel-Out, and the simultaneous release of the brake will cause rotation of the remaining gear train and cable drum. See illustrations below.



The clutch shaft assembly (with bevel gears) must turn 40.4 times for one (1) rotation of the cable drum on a 4 shaft gear train winch and 22.3 times on a 3 shaft gear train winch.

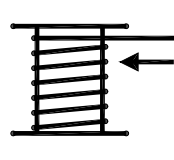
The direction of the tractor PTO shaft rotation and the right and left hand clutch location is determined by facing the rear of the tractor.

The cable drum rotation may be easily changed from overwind (standard) to underwind by reversing clutch pressure lines at ports C₁ and C₂ on the control valve in the winch, and installing the wire rope in the opposite cable drum ferrule pocket.

CONTROL OPERATION

Two actions are required to initiate any winch operation. First, the button on top of the control lever **MUST** be depressed. Next, move the lever into one of four directions to select a winch function. Movement of the lever without first depressing the button will **NOT** result in winch function and is intentional to prevent inadvertent winch function.

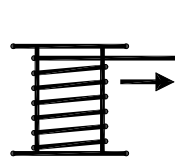
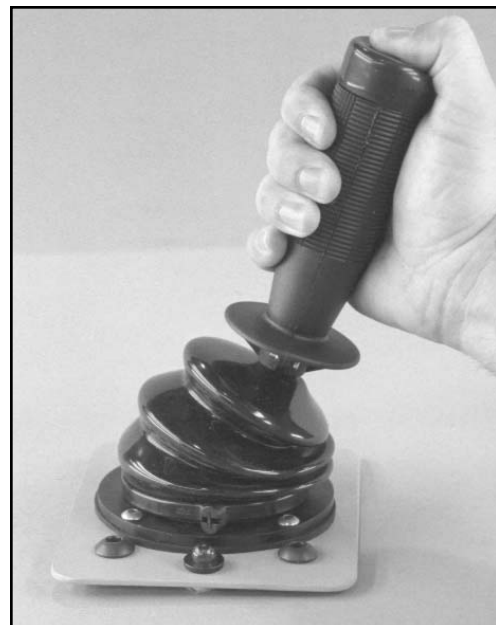
The winch functions available with this control lever are Reel-In (forward), Reel-Out (reverse), Brake-Off and Freespool. The spring-centered, neutral position of the lever is Brake-On. Note that it is **NOT** possible to control winch cable drum speed in the Reel-In and Reel-Out functions with the control lever. The speed of cable drum rotation must be controlled by varying the tractor engine RPM. Sufficient hydraulic pressure will be available to fully apply the clutches at engine (PTO) speeds above low idle. If the winch is installed on a direct drive tractor, the tractor master clutch **MUST** be engaged **BEFORE** moving the winch control lever. The internal winch pump is only driven when the PTO shaft is turning. A continuous supply of oil is needed to provide reliable clutch and brake operation.



Reel-In (forward). Depress the button and move the lever forward into the fully engaged position. The winch brake is hydraulically released and the Reel-In clutch is hydraulically applied.



Brake-On. The control lever is spring-centered to Brake-On. The brake is applied by spring force. The cable drum and load is held secure by the spring-applied brake.



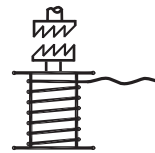
Reel-Out (reverse). Depress the button and move the lever toward the rear of the tractor into the fully engaged position. The winch brake is hydraulically released and the Reel-Out clutch is hydraulically applied.

FREESPOOL CONTROL OPERATION



Brake-Off. Depress the button and move the lever toward the operator, hydraulically releasing the winch brake. Partial brake release may be achieved by slowly moving the control lever in the Brake-Off direction.

The amount of brake release is proportional to the distance the lever is moved.



Freespool. Depress the button and move the lever fully away from the operator. When Freespool is selected, the cable drum drive gears are disengaged, allowing

wire rope to be easily pulled off the cable drum by hand. The brake is automatically released in Freespool.



NOTE: *Freespool is to be used for handling wire rope by hand ONLY. Do NOT attempt to release a load with Freespool, or to engage the gear train while the cable drum is rotating or while the tractor is in motion.*



Full brake release is achieved by moving the lever fully toward the operator into the lock position. With the brake released, the tractor can drive away from the load. Always return the lever to the Brake-On position when the operation is complete.

⚠ WARNING ⚠

Freespool is ONLY to be used when the tractor is stopped for pulling wire rope off the cable drum by hand. DO NOT use Freespool when the tractor is in motion, to release a load or to move away from a load that is attached to the wire rope. Damage to the gear train and loss of load control may result. Loss of load control may result in property damage, injury or death.

To release a load, or to move away from a load, the Reel-Out function or the Brake-Off function MUST be used. Remove any load from the winch cable BEFORE selecting Freespool.

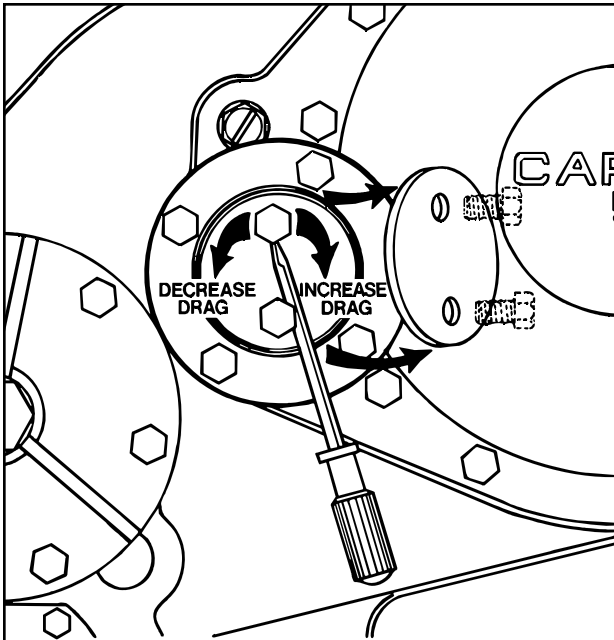
The tractor and the winch cable drum MUST be stopped BEFORE engaging the gear train. Gear train damage will result from attempting to engage the gear train when the cable drum is rotating.

adjuster clockwise until tight. Tap the adjuster with a hammer to seat the bearing and continue turning until the adjuster can no longer be tightened. Back the adjuster out no more than 1/16 turn maximum and secure with lock plate and capscrews. Tighten the capscrews to 75 lb•ft (102 N•m) torque.



NOTE: *Tightening the threaded adjuster pushes the tapered bearing cup (outer race) into closer contact with the bearing cone and increases the bearing drag; much like tightening a wheel bearing nut on an automobile or truck. The snug fitting bearing cup will NOT move outward with the threaded adjuster when the adjuster is loosened. The winch must be operated under load for a brief period to allow the gear train load to push the outer bearing cup out against the threaded adjuster before a reduction in bearing drag can be noticed.*

FREESPOOL ADJUSTMENT



⚠ CAUTION ⚠

Do not back off adjuster more than 1/16 turn as this allows excessive shaft end play and may cause gear train misalignment, accelerated wear and noise.

Using a long screw driver or pry bar, turn the threaded

PREVENTIVE MAINTENANCE & SPECIFICATIONS

A regular program of preventive maintenance for your PACCAR winch will minimize the need for emergency servicing and promote long product life and trouble-free service.

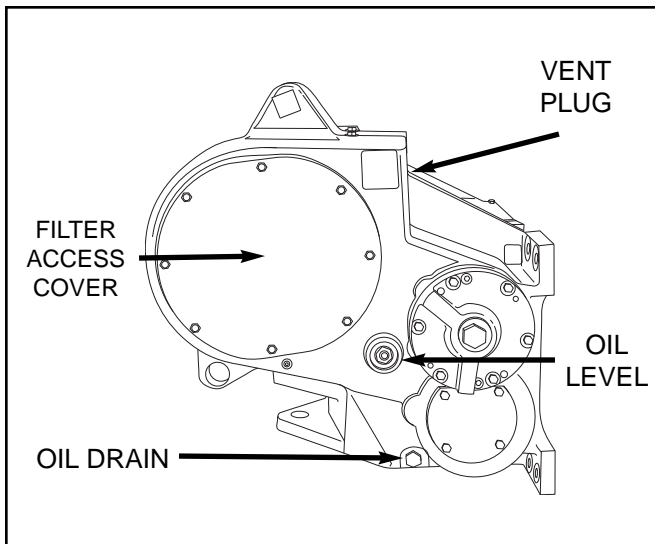
The service intervals suggested in this manual will optimize component service life. The intervals may be gradually increased or decreased with experience of a particular lubricant and evaluation of your application.

⚠ CAUTION ⚠

Discharge the accumulator oil supply BEFORE removing any hydraulic lines or servicing the winch. Personal injury may result from the sudden release of oil under pressure. To discharge the accumulator, shut the engine off, then slowly cycle the control lever into full Reel-In and Reel-Out positions a minimum of five (5) times. The tractor master switch and ignition must be ON.

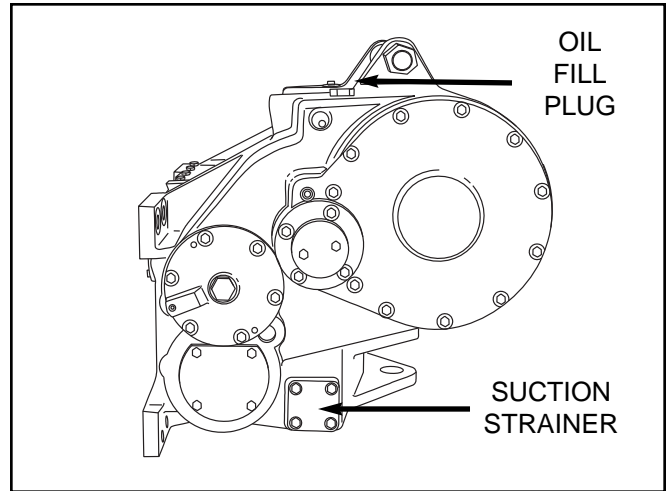
⚠ WARNING ⚠

Hot oil may cause severe injury. Make certain the oil has cooled to safe temperature (less than 110°F or 43°C) before servicing.



1. OIL LEVEL

Check the oil level at the beginning of each work shift, with the tractor and winch in a level position. The oil must be visible in the upper half of the sight gauge located on the RH side of the winch. If an oil level plug is used in place of the sight gauge, the oil level should be at the bottom of oil level port. Add oil as required through the fill port on the top LH side of the winch case.



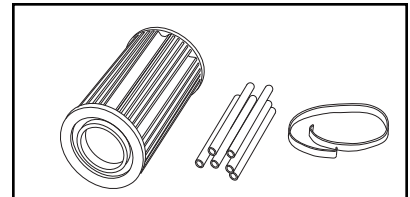
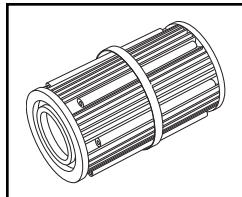
2. OIL CHANGE, FILTER AND STRAINER SERVICE

Under normal operating conditions, the oil and pressure circuit filter should be changed, and the suction strainer cleaned after the first 100-250 hours of operation. Follow-up oil and filter changes should occur after every 1000 hours or 6 months of operation, whichever occurs first, or when the filter bypass light remains on after initial warm-up.

⚠ WARNING ⚠

Hot oil may cause severe injury. Make certain the oil has cooled to safe temperature (less than 110°F or 43°C) before servicing.

To drain the oil, place the tractor and winch in a level position and remove the drain plug located on the lower RH side of the winch case. Drain the oil into a suitable container and recycle or dispose of used oil in an environmentally responsible manner. Install the drain plug securely after all oil has been drained. Next, remove the suction strainer cover, compression spring and seal rings. Remove the suction strainer from the winch case, then remove the metal band and magnetic rods from the strainer. Thoroughly wash the strainer in clean solvent and blow dry with compressed air or clean shop air. Inspect the wire mesh for damage or clogging with debris. Do NOT reuse a damaged suction strainer.



Install the magnetic rods onto the strainer and secure with the metal band. Lubricate the O-ring and install the strainer, seal rings, spring and cover back into the winch.

Refill the winch to the proper level with the recommended oil. Refer to page 10 for oil recommendations.

OIL CAPACITY:

PA55 & PA56 Std. PTO - 78 qt. (74 L)

PA55 & PA56 Low PTO - 66 qt. (63 L)

 **CAUTION** 

To prevent serious damage to the winch gear train, do NOT operate the tractor engine while the oil is drained from the winch.

The pressure filter is located inside the large RH access cover. Remove the cover, locate the spin-on filter and remove the filter element with a filter wrench.

Lubricate the filter seal and adapter threads with hydraulic oil and install the new filter onto the filter head. Tighten the filter ½ - ¾ turn by hand after the seal contacts the filter head.

Start the tractor and operate the engine at low idle. BE SURE the winch has been filled with oil BEFORE starting the engine. Correct any leaks.

The indicator lamp may come on for a short time during the initial cold start-up, but should go out as the oil warms up. If the light remains on, possible conditions are a restricted filter element, the filter sending unit

stuck in the bypass position, or an accidentally grounded sending unit wire.

3. VENT PLUG

The vent is located on the RH side of the winch next to the electrical connector. It is very important to keep this vent clean and unobstructed to limit leakage and winch seal damage. When changing the winch oil, remove the vent and thoroughly clean in safety solvent and reinstall. Do NOT replace with a solid plug.

4. WINCH CABLE (WIRE ROPE)

Inspect the entire length of wire rope, and the chokers and hooks according to the wire rope and rigging manufacturer's recommendations.

5. MOUNTING FASTENERS

Check/tighten all winch mounting fasteners to recommended torque after the first 100-250 hours of operation, then every 1000 hours or six months, whichever occurs first.

6. WARM-UP PROCEDURE

 **WARNING** 

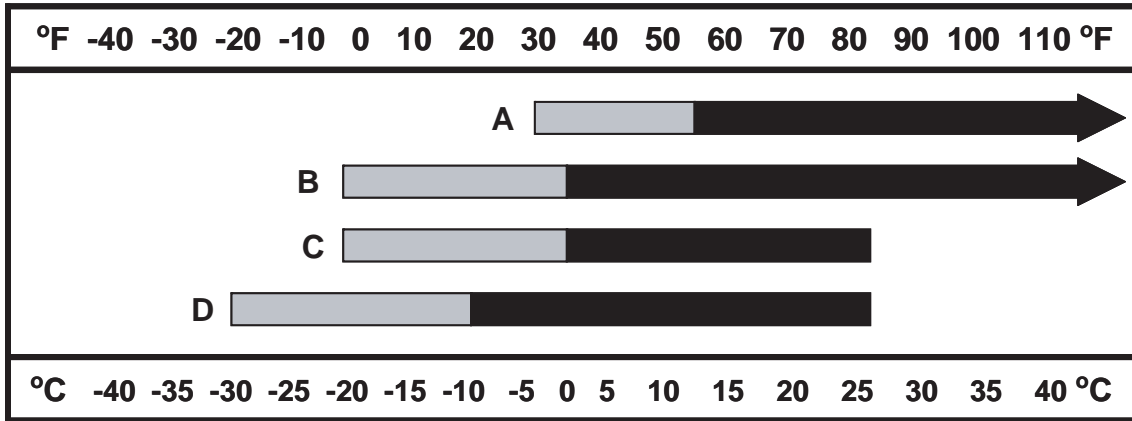
A warm-up procedure is recommended at each start-up, and is essential at ambient temperatures below +40°F (+4°C). Failure to warm the oil and the winch hydraulic system may result in erratic clutch/brake operation may result in property damage, personal injury or death.

Start the tractor engine and operate at low idle for five minutes.

RECOMMENDED OIL

We have published the following specification to help you determine which lubricant is best suited to your application. Your lubricant supplier should assure you that his product meets this specification. If there is still any doubt as to the suitability of a lubricant, contact the PACCAR Winch Service Department, providing a detailed copy of the product specifications.

Prevailing Ambient Temperature



! WARNING !

 ***Cold start-up in this ambient temperature range requires extended equipment warm-up to prevent erratic clutch and brake operation which may result in property damage, injury or death.***

- A - HTF Type C3/C4 SAE 30, CAT TO4 SAE30
- B - CAT TO4 SAE 10W30
- C - HTF Type C4/C4 SAE 10, CAT TO4 SAE 10W
- D - CAT TO4 SAE 5W20 spc.

Basic Oil Requirements

15,000 SUS maximum allowed viscosity at cold start-up; requires extended equipment warm-up.
 3,000 SUS maximum allowed viscosity at cold start-up; requires normal equipment warm-up.
 60 SUS minimum allowed viscosity at maximum winch operating temperature assuming ambient plus 80 °F (27 °C).

Oil must possess high temperature oxidation stability, rust and corrosion protection, good dispersant and detergent characteristics, anti-wear additives and remain compatible with nitrile base seals.

SPECIFICATIONS:

Unit Weight w/o oil, cable or specific tractor adapters Approximately 1960 lb. (885 kg)

Gear Ratios

3 - Shaft Gear Train

Bevel Gear Ratio1.00:11.27:11.64:12.11:12.78:1

Overall Ratio22.3:128.3:136.6:147.0:162.2:1

4 - Shaft Gear Train

Bevel Gear Ratio1.00:11.27:11.64:12.11:12.78:1

Overall Ratio40:4:151.4:166.3:185.3:1112.8:1

Cable Drum Dimensions

Barrel Diameter10 in. (254 mm)

Flange Diameter19 7/8 in. (504 mm)

Barrel Length12 3/8 in. (314 mm)

Throat Clearanceapprox. 9 in. (229 mm)

Cable Storage Capacity

3/4 in. (19 mm)319 ft. (97 m)

7/8 in. (22 mm)226 ft. (69 m)

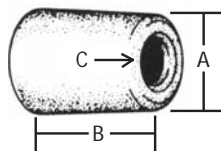
1 in. (25 mm)154 ft. (47m)

Cable Ferrule Part Number - L Series

3/4 in. (19 mm)118-6273

7/8 in. (22 mm)118-6275

1 in. (25 mm)118-6276



A - 2.12 in. (45 mm)

B - 2.56 in. (65 mm)

C - To match cable dia.

Hydraulic System

Oil Capacity

Standard PTO78 qt. (84 l)

Low PTO66 qt. (64 l)

Operating Pressure390-410 PSI (2689-2827 kPa)

Stand-by Pressure315-370 PSI (2172-2551 kPa)

Typical Operating TemperatureUp To Ambient Plus 80°F (26.7°C)

RECOMMENDED FASTENER TORQUE

Higher or lower torques for special applications will be specified such as the use of spanner nuts, nuts on shaft ends, jam nuts and where distortion of parts or gaskets is critical.

Lubricated Torque values based on use of SAE 30wt engine oil applied to threads and face of bolt or nut.

Avoid using thread lubricants as the applied torque may vary by 10-40% depending upon product used.

Bolt Dia. Inches	Thds Per Inch	Torque (LB-FT)			
		Grade 5		Grade 8	
		Dry	Lubed	Dry	Lubed
1/4	20	8	6	12	9
	28				
5/16	18	17	13	24	18
	24				
3/8	16	31	23	45	35
	24				
7/16	14	50	35	70	50
	20				
1/2	13	75	55	110	80
	20				
9/16	12	110	80	150	110
	18				
5/8	11	150	115	210	160
	18				

Bolt Dia. Inches	Thds Per Inch	Torque (LB-FT)			
		Grade 5		Grade 8	
		Dry	Lubed	Dry	Lubed
3/4	10	265	200	380	280
	16				
7/8	9	420	325	600	450
	14				
1	8	640	485	910	680
	14				
1 1/8	7	790	590	1290	970
	12				
1 1/4	7	1120	835	1820	1360
	12				
1 3/8	6	1460	1095	2385	1790
	12				
1 1/2	6	1940	1460	3160	2370
	12				

To convert lb ft to kg•m, multiply lb ft value by 0.1383.

METRIC CONVERSION TABLE

English to Metric			Metric to English		
LINEAR					
inches (in.)	X 25.4	= millimeters (mm)	millimeters (mm)	X 0.3937	= inches (in.)
feet (ft.)	X 0.3048	= meters (m)	meters (m)	X 3.281	= feet (ft.)
miles (mi.)	X 1.6093	= kilometers (km)	kilometers (km)	X 0.6214	= miles (mi.)
AREA					
inches ² (sq.in.)	X 645.15	= millimeters ² (mm ²)	millimeters ² (mm ²)	X 0.000155	= inches ² (sq.in.)
feet ² (sq.ft.)	X 0.0929	= meters ² (m ²)	meters ² (m ²)	X 10.764	= feet ² (sq.ft.)
VOLUME					
inches ³ (cu.in.)	X 0.01639	= liters (l)	liters (l)	X 61.024	= inches ³ (cu.in.)
quarts (qts.)	X 0.94635	= liters (l)	liters (l)	X 1.0567	= quarts (qts.)
gallons (gal.)	X 3.7854	= liters (l)	liters (l)	X 0.2642	= gallon (gal.)
inches ³ (cu.in.)	X 16.39	= centimeters ³ (cc)	centimeters ³ (cc)	X 0.06102	= inches ³ (cu.in.)
feet ³ (cu.ft.)	X 28.317	= liters (l)	liters (l)	X 0.03531	= feet ³ (cu.ft.)
feet ³ (cu.ft.)	X 0.02832	= meters ³ (m ³)	meters ³ (m ³)	X 35.315	= feet ³ (cu.ft.)
fluid ounce (fl.oz.)	X 29.57	= milliliters (ml)	milliliters (ml)	X 0.03381	= fluid ounce (fl.oz.)
MASS					
ounces (oz.)	X 28.35	= grams (g)	grams (g)	X 0.03527	= ounces (oz.)
pounds (lbs.)	X 0.4536	= kilograms (kg)	kilograms (kg)	X 2.2046	= pounds (lbs.)
tons (2000 lbs.)	X 907.18	= kilograms (kg)	kilograms (kg)	X 0.001102	= tons (2000 lbs.)
tons (2000 lbs.)	X 0.90718	= metric tons (t)	metric tons (t)	X 1.1023	= tons (2000 lbs.)
tons (long) (2240 lbs.)	X 1013.05	= kilograms (kg)	kilograms (kg)	X 0.000984	= tons (long) (2240 lbs.)
PRESSURE					
inches Hg (60°F)	X 3600	= kilopascals (kPa)	kilopascals (kPa)	X 0.2961	= inches Hg (60°F)
pounds/sq.in. (PSI)	X 6.895	= kilopascals (kPa)	kilopascals (kPa)	X 0.145	= pounds/sq.in. (PSI)
pounds/sq.in. (PSI)	X 0.0703	= kilograms/sq.cm. (kg/cm ²)	kilograms/sq.cm. (kg/cm ²)	X 14.22	= pounds/sq.in. (PSI)
pounds/sq.in. (PSI)	X 0.069	= bars	bars	X 14.5	= pounds/sq.in. (PSI)
inches H ₂ O (60°F)	X 0.2488	= kilopascals (kPa)	kilopascals (kPa)	X 4.0193	= inches H ₂ O (60°F)
bars	X 100	= kilopascals (kPa)	kilopascals (kPa)	X 0.01	= bars
POWER					
horsepower (hp)	X 0.746	= kilowatts (kW)	kilowatts (kW)	X 1.34	= horsepower (hp)
ft.-lbs./min.	X 0.0226	= watts (W)	watts (W)	X 44.25	= ft.-lbs./min.
TORQUE					
pound-inches (in.-lbs.)	X 0.11298	= newton-meters (N-m)	newton-meters (N-m)	X 8.851	= pound-inches (in.-lbs.)
pound-feet (ft.-lbs.)	X 1.3558	= newton-meters (N-m)	newton-meters (N-m)	X 0.7376	= pound-feet (ft.-lbs.)
pound-feet (ft.-lbs.)	X .1383	= kilograms/meter (kg-m)	kilogram/meter (kg-m)	X 7.233	= pound-feet (ft.-lbs.)
VELOCITY					
miles/hour (m/h)	X 0.11298	= kilometers/hour (km/hr)	kilometers/hour (km/hr)	X 0.6214	= miles/hour (m/h)
feet/second (ft./sec.)	X 0.3048	= meter/second (m/s)	meters/second (m/s)	X 3.281	= feet/second (ft./sec.)
feet/minute (ft./min.)	X 0.3048	= meter/minute (m/min)	meters/minute (m/min)	X 3.281	= feet/minute (ft./min.)
TEMPERATURE					
°Celsius = 0.556 (°F - 32)			°Fahrenheit = (1.8 X °C) + 32		
COMMON METRIC PREFIXES					
mega	(M)	= 1,000,000 or 10 ⁶	deci	(d)	= 0.1 or 10 ⁻¹
kilo	(k)	= 1,000 or 10 ³	centi	(c)	= 0.01 or 10 ⁻²
hecto	(h)	= 100 or 10 ²	milli	(m)	= 0.001 or 10 ⁻³
deka	(da)	= 10 or 10 ¹	micro	(µ)	= 0.000.001 or 10 ⁻⁶