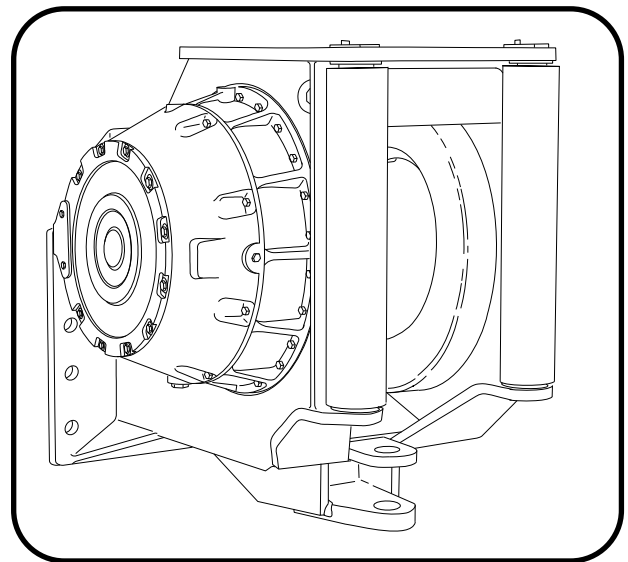
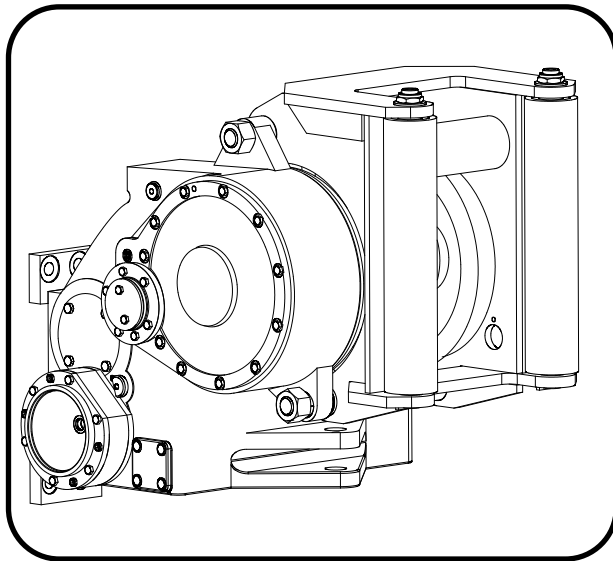


CARCO®

H-SERIES WINCHES

OPERATION AND PREVENTIVE MAINTENANCE MANUAL



FOREWORD

Please read and understand this entire manual **BEFORE** operating or performing service on your CARCO winch. Retain this publication for future reference.

Some illustrations in this manual may show details or attachments that may be different from your winch. Also, some components may have been removed for clarity.

Continuing product improvements may cause changes in your winch, which are not included in this manual. Whenever a question arises regarding your CARCO winch or this publication, please contact the PACCAR Winch Technical Support Department:

Phone: (918)-251-8511, Monday - Friday, 0800 hrs - 1630 hrs CST
Fax: (918)-259-1575
E-mail: winch.service@paccar.com.

Parts and Service

CARCO provides parts and service through a network of authorized construction equipment dealers. Parts and service are not available directly from CARCO. Please contact your local construction equipment dealer for parts and service, or contact CARCO for help defining a dealer near you.

Model and Serial Number

The winch model number and serial number are important references as to which optional components were used at the time your winch was manufactured. The serial and model numbers are stamped into the ID tag located on the RH side of the winch case. The serial number is also stamped into the upper RH mounting pad of the winch case or the sloped surface near the RH mounting pad. Always refer to the serial and model numbers when requesting information or service parts.

TABLE OF CONTENTS

| | |
|--------------------------------------|----|
| General Safety Recommendations | 2 |
| Winch Operation | 4 |
| Preventive Maintenance | 8 |
| Recommended Oil | 10 |
| Fastener Torque Chart | 10 |
| Metric Conversion Chart | 11 |

Safety Information

Safety and informational callouts used in this manual include:



This emblem is used to warn against hazards and unsafe practices that **COULD** result in severe personal injury or death if proper procedures are not followed.



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



This emblem is used to indicate an informational note or service tip.

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 and concern by the operator for the equipment, and a thorough knowledge of the machine's handling and performance capabilities. The following recommendations are offered only as a guide for the operator. Local rules and regulations will also apply.



1. Read all warning tag information and become familiar with all controls **BEFORE** operating the winch.
2. **NEVER** attempt to clean, oil or perform any maintenance on the winch with the tractor engine running, unless specifically instructed to do so in this manual.
3. Before starting the tractor engine, be certain all controls move freely and are placed in the "Brake On" (neutral) position.
4. **NEVER** operate the winch controls unless you are properly seated at the operator's station on the tractor and you are sure all personnel are clear of the work area.
5. **NEVER** attempt to handle winch cable when the hook end is not free. Keep all parts of body and clothing clear of winch drum, cable rollers and entry area of fairleads and arches.
6. Ground personnel should stay in clear view of the tractor operator and clear of the winch drum. **DO NOT** allow ground personnel near a winch line under tension. A safe distance of 1½ times the working length of the cable should be maintained. **NEVER** allow anyone to stand under a suspended load.
7. Avoid sudden "shock" loads or attempting to "jerk" a load free. This type of operation may cause heavy loads in excess of the rated winch capacity, which may result in the failure of the cable and/or winch.
8. Use only GENUINE CARCO parts. Do not use parts from other winch manufacturers on your CARCO winch. Do not use CARCO parts on winches from other manufacturers.
9. Use the correct size ferrule for the cable and pocket in the winch drum. Never use knots to secure or attach

cable to the winch drum, or the hook to the cable. 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 the rated capacity of the winch. Therefore, a minimum of five (5) complete wraps must be maintained on the winch drum.

i **NOTE:** *We suggest painting the last five wraps of cable bright red to serve as a visual warning.*

RECOMMENDED OPERATING PRACTICES

1. Leather gloves should be used when handling winch cable.
2. Operate the winch to match line speeds to job conditions.
3. Assure that personnel who are responsible for hand signals are clearly visible and that the signals to be used are thoroughly understood by everyone.
4. Inspect winch cable, rigging, winch and tractor at the beginning of each work shift. Defects should be corrected immediately.
5. Position the tractor for the straightest line of pull to reduce the wear on the winch cable and ensure even spooling.
6. When winding winch cable on the winch drum, never attempt to maintain tension by allowing the winch cable to slip through the hands. Always use the "hand-over-hand" technique, being careful to keep hands and clothing away from winch drum and fairlead rollers.
7. Be sure of tractor ground stability before winching in a load.
8. Store unused chokers, slings and rigging in a neat and orderly fashion to prevent damage to equipment or injury to personnel.

9. 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 capacity of one winch (such as coupling two or more tractors together) is extremely hazardous.
10. The factory approved adaptations for CARCO 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 CARCO because of safety limitations. Call a CARCO dealer or the CARCO factory prior to attempting winch modifications or before mounting on a different tractor.
11. CARCO H-Series winches are powered by the tractor hydraulic system. Discharge all retained hydraulic system pressure before removing any hydraulic lines or fittings. Personal injury may result from sudden release of oil pressure.

To discharge the winch control system, stop the engine and cycle the winch control lever(s) into all positions five (5) times. Refer to the tractor manufacturer's operators and service manuals for additional information.
12. 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 the tractor parking brakes and lower any equipment to the ground before dismounting the tractor.
13. The winches described in this manual are neither designed nor intended for use or application in the lifting or moving of persons.
14. Install guarding to prevent personnel from getting any part of their body or clothing caught at a point where the cable is wrapped onto the drum or drawn through the fairlead rollers.
15. Keep equipment in good operating condition. Perform the scheduled servicing and adjustments defined in the "Preventive Maintenance" section of this manual. Use of proper lubricants is crucial.
16. An equipment warm-up procedure is recommended for all tractor start-ups, and is essential at ambient temperatures below +40°F (+5°C). Refer to the "Warm-Up Procedure" listed in the "Preventive Maintenance" section of this manual.
17. Do not weld on any part of the winch without the approval of PACCAR Winch Division.

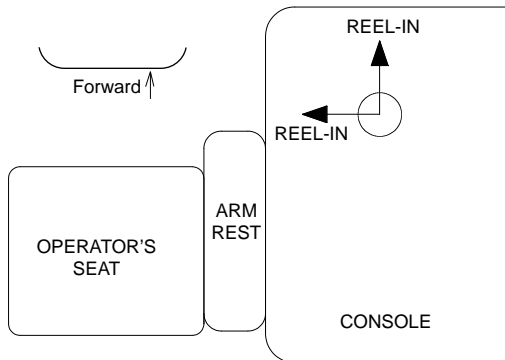
WINCH OPERATION

HYDRAULIC SYSTEM DESCRIPTION

Differential steer or hydrostatically controlled tractors are typically designed with a load sense, pressure compensating hydraulic system. These systems are usually equipped with variable displacement piston pumps, which supply oil to the implement valve only when a work function demands flow. Normally the pumps remain at approximately 300-400 PSI (2070 - 2760 kPa) in the low pressure, standby, condition. Moving the winch control lever will cause the pump displacement control system to upstroke to match the demand of the load. If the pressure starts to exceed the pump compensator setting (cylinder reaches full stroke or motor reaches maximum), the pump will destroke to decrease the flow and maintain the pressure at the compensator setting. The significance of this system is that there is no excess flow metered across a relief or partially shifted control valve spool to generate heat. Returning the control lever to BRAKE-ON (neutral) destrokes the pump to low flow, typically 0.2-0.5 GPM (.75-1.9 LPM), and returns the pump to the low standby pressure. Load sense hydraulic systems provide very precise load control while minimizing hydraulic loss efficiencies in the system.

The H-Series winch may be operated with a ripper controller on some tractors or a CARCO supplied hydraulic joystick. The operation of the lever is dependent upon the lever used and the tractor hydraulic system. Tractor manufacturer supplied levers may be either single-axis or dual-axis joysticks. The CARCO supplied joystick is a dual-axis unit.

The mounting orientation of the control lever will determine the direction of lever actuation. However, in order to conform to current standards, the REEL-IN direction of lever movement **MUST** be either forward, toward the front end of the tractor, or left, toward the operator. The REEL-OUT direction **MUST** be directly opposite of the REEL-IN direction.



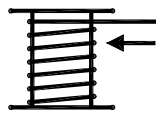
Use of the single-axis joystick requires the use of console-mounted toggle switches to activate BRAKE-OFF/Drum Clutch and FREESPOOL functions. Use of the dual-axis joystick allows these functions to be activated using the joystick, in the direction utilizing the opposite axis from REEL-IN / REEL-OUT.

CONTROL OPERATION

The following paragraphs define winch operation for each function. The joystick provides infinitely variable winch speed control. Slight movement of the joystick lever in either REEL-IN or REEL-OUT direction results in very slow and controlled drum speeds. As the lever is moved further from the center neutral position, the drum speed will increase proportionally. When the lever is released, it will spring return to the neutral BRAKE-ON position. Because there are no directional clutches the lever may be moved in very small increments, or feathered, to achieve precise load control without winch wear or damage. The drum clutch function is not variable when operated by toggle switches.

BRAKE-ON (Neutral)

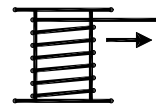
The control lever is spring-returned to center, or BRAKE-ON. The multi-disc, static parking brake is applied by spring force. Loads may be skidded with the lever in this position.



REEL-IN

With the control lever in this position, the winch drum will pull in the cable and load. Cable speed is proportional to the amount of lever movement. When released, the lever will return to BRAKE-ON and the winch drum will stop and hold the load firm.

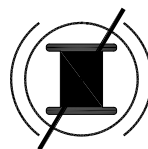
IMPORTANT: The control lever **MUST** be installed so that the direction of movement for REEL-IN is either forward, toward the front of the tractor, or to the left, toward the operator.



REEL-OUT

With the control lever in this position, the winch drum will rotate to power out the cable. Cable speed is proportional to the amount of lever movement. When released, the lever will return to BRAKE-ON and the winch drum will stop and hold the load firm.

IMPORTANT: When using tractor supplied dual-axis control levers, ensure the direction of movement is directly opposite of the REEL-IN direction.



BRAKE-OFF/Drum Clutch Release

When this function is activated, the internal drum clutch will be released with hydraulic pressure, allowing the operator to drive away from a load. The resistance of the gear train will keep a tight wrap of cable on the drum to prevent cable over-run. It should be noted that cable can **NOT** be pulled off the drum by hand while in Drum Clutch Release/Brake-Off mode.

Drum Clutch Release/Brake-Off is typically activated by pressing a toggle switch on the RH tractor console, or by moving the control lever in the proper direction when using a dual-axis control lever. When using a dual-axis lever, the lever should be "detented", or held in position mechanically, to allow the operator to use both hands for tractor operation.

⚠ WARNING ⚠

DO NOT use BRAKE-OFF/Drum Clutch Release for a controlled reeling out of suspended loads. Sudden release of a load may result in property damage, injury or death. Use **ONLY** REEL-OUT to lower any load.



LOW LOCK

LOW LOCK is activated by pressing a toggle switch on the RH tractor console, or by moving the control lever in the proper direction when using a dual-axis control lever, forcing the variable displacement motor to shift into the maximum displacement setting, for maximum line pull and minimum line speed to enhance load control. Deactivating LOW-LOCK, by pressing the toggle switch back to the normal position, will return the winch motor to full auto-speed operation, allowing the motor to self adjust between the maximum and factory-set minimum displacements to achieve the best match of line speed and line pull for the application.

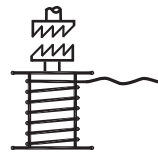
⚠ CAUTION ⚠

The H-Series hydraulic motor and gear ratio is configured to match the specific tractor hydraulic system. It may not be possible to install the winch to a different tractor model. Installation onto a tractor with a higher flow hydraulic system could result in overspeed damage to the motor and winch gear train.

DRIVE AWAY (H40 AND H50 Only)

Drive-Away mode is controlled by the winch motor and drive-away valve. It allows the operator to drive the tractor away from the load while back driving the motor with the winch gear train. When the control lever is moved in to the Drive-Away position, the winch motor and drive-away valve assembly limit the flow of hydraulic oil through the motor to allow for smooth, controlled reeling-off of the winch cable as the tractor drives away from the load. The maximum back driven speed of the winch motor is limited by the Drive-Away valve which is set to achieve tractor ground speed (2.5 mph or 4.0 km/hr) with the winch at bare drum condition.

H-SERIES WINCHES WITH FREESPOOL



FREESPOOL

When activated, the winch cable drum will be disconnected from the hydraulic motor and primary gear train so that cable may be pulled off the drum by hand.

FREESPOOL is typically activated by pressing a toggle switch on the RH tractor console, or by moving the control lever in the proper direction when using a dual-axis control lever. When using a dual-axis lever, the lever should be "detented", or held in position mechanically.



NOTE: *FREESPOOL is to be used **ONLY** for handling wire rope by hand. **DO NOT** attempt to release a load using FREESPOOL or to engage or disengage the gear train while the cable drum is rotating or when the tractor is in motion.*

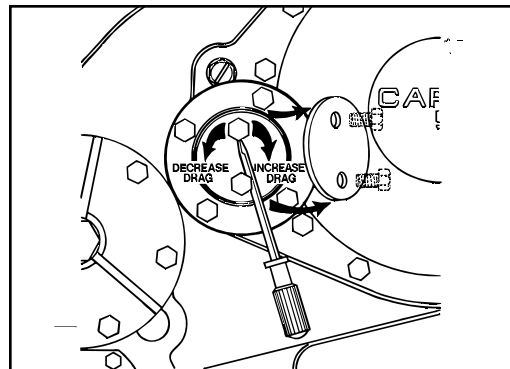
⚠ WARNING ⚠

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 cable. Damage to the gear train and a 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 the FREESPOOL function.

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

FREESPOOL ADJUSTMENT on H60



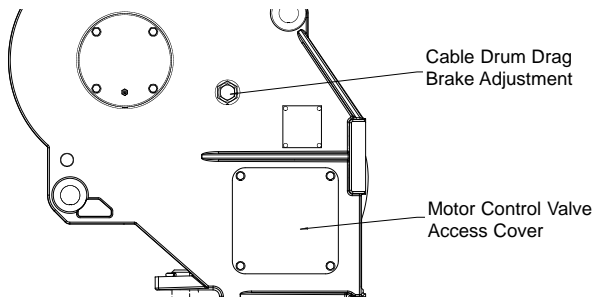
Using a long screw driver or pry bar, turn the threaded adjuster clockwise until tight. Tap the adjuster with a hammer to seat the bearing and continue turning until the adjuster can no longer be tightened. Back the adjuster out no more than 1/16 turn maximum and secure with lock plate and capscrews.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

i **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 outward against the threaded adjuster before a reduction in bearing drag can be noticed.

⚠ 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.

Drum Drag Adjustment on H40 and H50



Cable drum drag may be adjusted to eliminate “birdnesting” caused by drum overrun. Adjustment is made by loosening the locknut and then turning the adjustment screw clockwise to increase drag; counterclockwise to decrease drag. Tighten the locknut after adjustment.

DUAL BRAKE SYSTEM – DESCRIPTION (Not Applicable to H40 and H50)

The dual brake system consists of a dynamic brake system and a static brake system. The dynamic brake system has two operating components:

1. Hydraulic Brake valve assembly
2. Hydraulic motor

The brake valve is similar to a counter-balance valve. It contains a check valve to allow free flow of oil to the motor in the Reel-In direction and a pilot-operated, spring-loaded spool valve which blocks the flow of oil out of the motor when the control valve is placed in neutral. When the control valve is moved into the Reel-Out position, the spool in the brake valve remains closed until sufficient pilot pressure is applied to the end of the spool to shift it against the spring pressure and open a passage. After the spool valve cracks open, the pilot pressure becomes flow dependent and modulates the spool valve opening which controls the Reel-Out speed. See figures 2, 3 & 4.

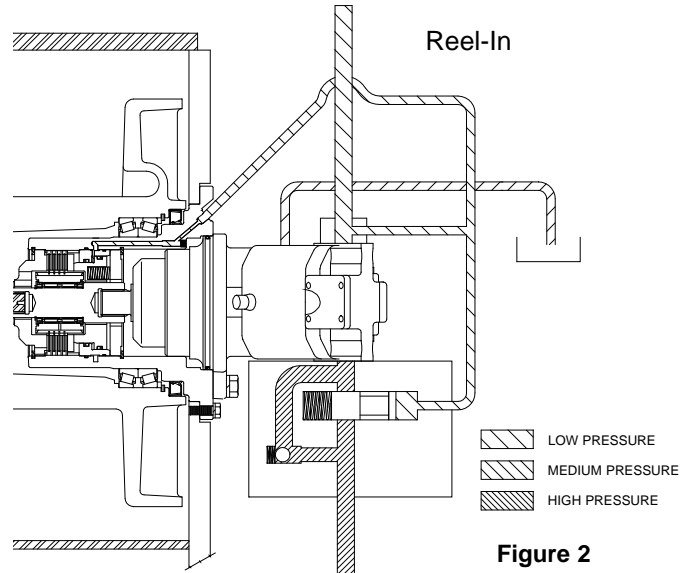


Figure 2

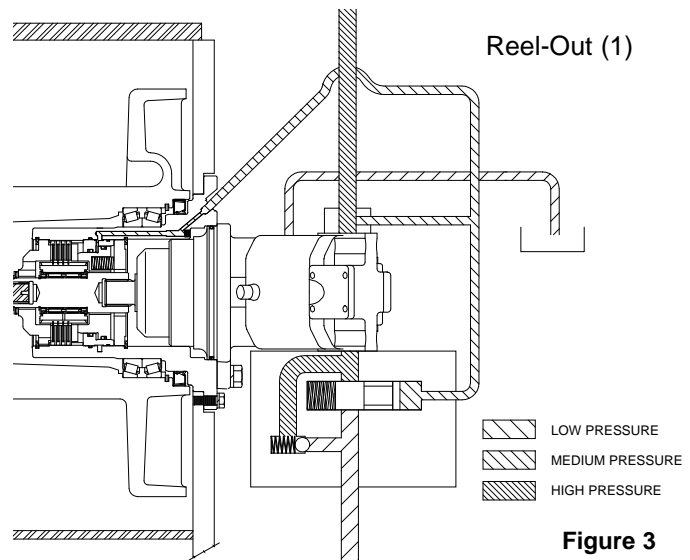


Figure 3

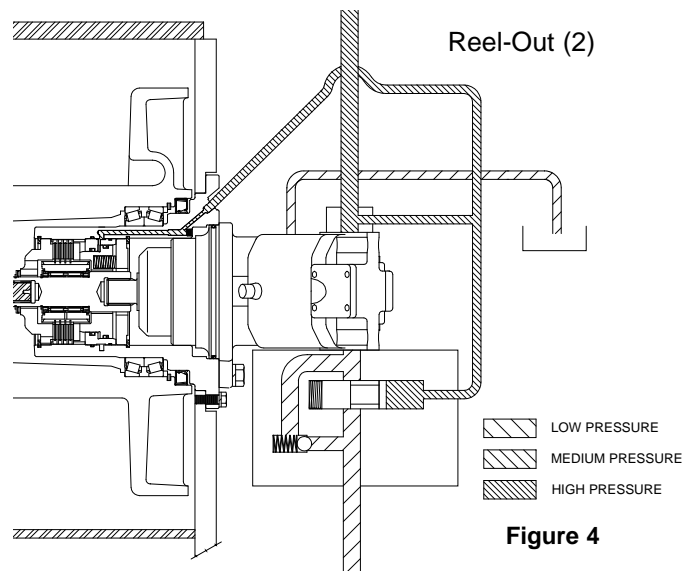


Figure 4

The static brake system has three operating components:

- Spring applied, multiple friction disc static brake
- Sprag-type overrunning brake clutch assembly
- Hydraulic piston and cylinder

The static brake is released by the brake valve pilot pressure at a pressure lower than that required to open the pilot operated spool valve in the brake valve assembly. This sequence assures that dynamic braking takes place in the brake valve and that little, if any, heat is absorbed by the friction discs.

The static friction brake is a load holding brake only and has nothing to do with dynamic braking or the rate of release of a heavy or suspended load.

The overrunning brake clutch is splined to the primary sun gear shaft between the motor and the primary sun gear. It will allow this shaft to turn freely in the direction of Reel-In, and lock up to force the brake discs to turn with the shaft in the direction of Reel-Out. (Fig. 5 and 6)

The hydraulic cylinder, when pressurized, will release the spring pressure on the brake discs, allowing the brake discs to turn freely.

DUAL BRAKE SYSTEM – OPERATION

When pulling in a load (Reel-In), the overrunning brake clutch, which connects the motor shaft to the primary sun gear, allows free rotation through the gear train to the cable drum. The sprag cams lay over and permit the inner race to turn free of the outer race. (Fig. 5). The static friction brake remains fully applied. The winch, while reeling in a load, is not affected by any braking action.

When the Reel-In operation is stopped, the load attempts to turn the primary sun gear in the opposite direction. This reversed input causes the sprag cams to instantly roll upward and firmly lock the shaft to the fully applied friction brake. (Fig. 6)

When the winch is powered in reverse, to Reel-Out the load, the motor can not rotate until sufficient pilot pressure is present to open the brake valve. The friction brake within the winch will completely release at a pressure lower than that required to open the brake valve, typically 350 PSI (2,413 kPa) and 600 PSI (4,137 kPa), respectively. The extent to which the brake valve opens will determine the amount of oil that can flow through it and the speed at which the load will Reel-Out. Increasing the flow of oil to the winch motor will cause the pressure to rise and the opening in the brake valve to enlarge, speeding up the release of the load. Decreasing this flow causes the pressure to lower and the opening in the brake valve to decrease, thus slowing the release of the load.

With the control valve shifted to neutral, the pressure will drop and the brake valve will close, stopping the load. The friction brake will reapply and hold the load after the brake has closed.

The friction brake receives very little wear during the Reel-Out operation. Most of the heat generated by the releasing and stopping of the load is absorbed into the hydraulic oil where it can be readily dissipated.

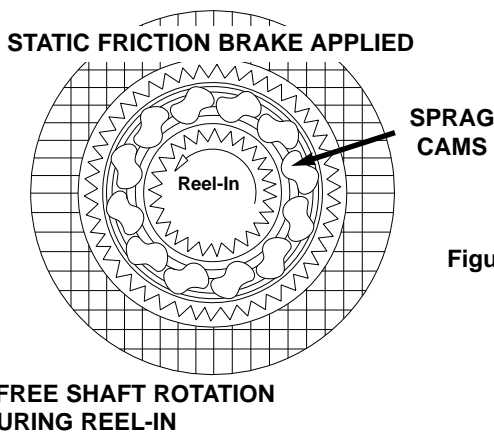


Figure 5

PERMITS FREE SHAFT ROTATION DURING REEL-IN

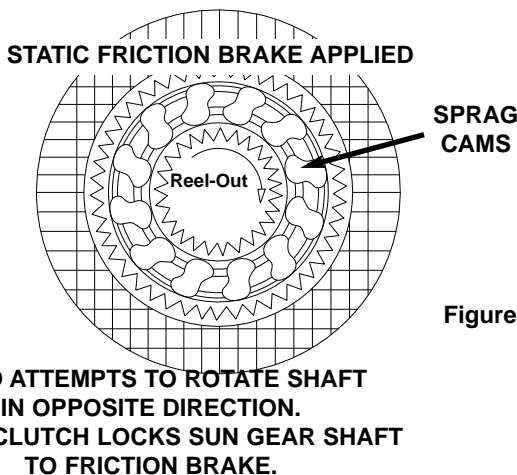


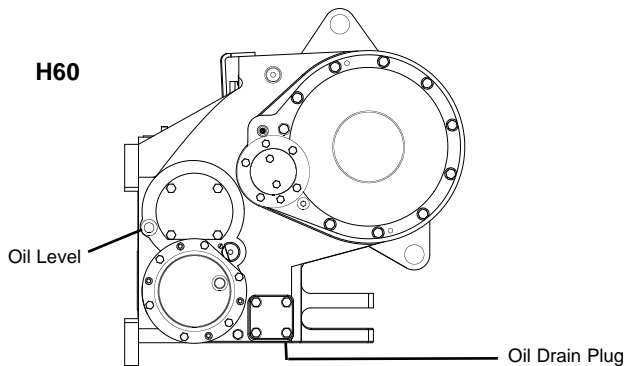
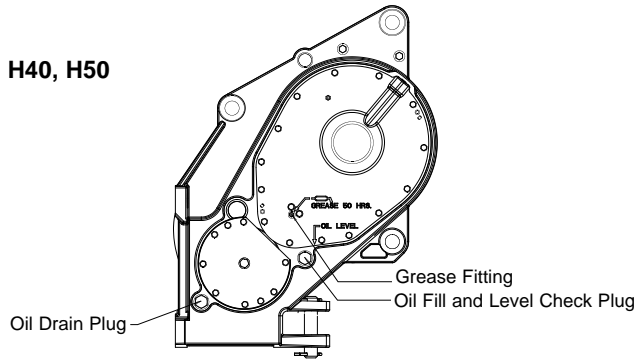
Figure 6

LOAD ATTEMPTS TO ROTATE SHAFT IN OPPOSITE DIRECTION. BRAKE CLUTCH LOCKS SUN GEAR SHAFT TO FRICTION BRAKE.

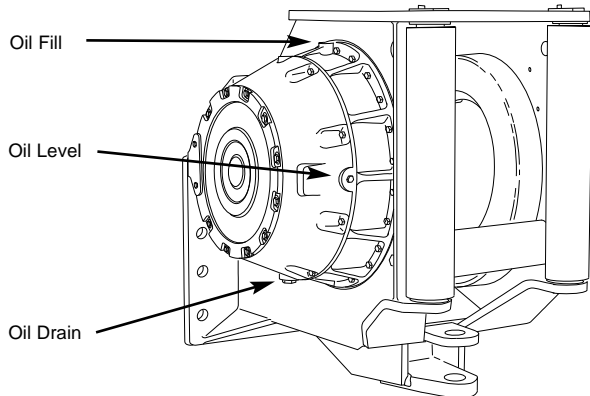
PREVENTIVE MAINTENANCE

A regular program of preventive maintenance for your CARCO 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.



H90, H110, H140 and H200



GEAR CASE OIL LEVEL

Check the oil level weekly with the tractor and winch in a level position. Reference drawings above for oil fill, level and drain locations.

For H60, remove the access cover located above the clutch assembly on the LH side of the unit. The oil level

should be just below the bottom of the opening. Add oil as required through the fill port on the top LH side of the winch case.

Refer to the page 10 for oil recommendations for your application.

GEAR CASE OIL CHANGE

Change the winch gear case oil after the first 100-250 hours of operation, then very 1000 hours or six (6) months, whichever occurs first.

⚠ 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 LH side of the winch case, or remove the square cover from the lower rear LH side of the winch. 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.

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

OIL CAPACITY FOR ALL H-SERIES WINCHES:

| <u>Winch Model</u> | <u>Pints</u> | <u>Liters</u> |
|--------------------|--------------|---------------|
| H40 | 9 | 4.3 |
| H50 | 9 | 4.3 |
| H60VS | 40 | 18.9 |
| H90 | 25 | 11.8 |
| H110 | 32 | 15.1 |
| H140 | 25 | 11.8 |
| H200 | 35 | 16.6 |

⚠ CAUTION ⚠

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

**GREASE
H40/H50)**

Every 50 hours of winch operation grease the drum bearing on the right side of the tractor (viewed from behind the tractor) and the second reduction gear on left side at the installed grease fittings. Use NLGI#2 lithium complex based EP (extreme pressure) grease that meets or exceeds the NLGI GC or GC-LB specifications. Pump

grease into the upper right drum gearing grease fitting until grease comes out the small vent hole in the cover. Pump about 1/2 ounce in the grease fitting for the second reduction shaft on the left side of the winch. This will be about 10 strokes with a standard volume (1.5 grams/stroke) lever operated grease gun.

TRACTOR HYDRAULIC RESERVOIR LEVEL

The tractor hydraulic reservoir oil level should be checked daily, or in accordance with the tractor manufacturer's recommendations. Use the type of hydraulic oil recommended by the tractor manufacturer.

Change the tractor hydraulic oil and filter every 1000 hours, or in accordance with the tractor manufacturer's recommendations.

If a hydraulic oil filter was installed when the winch was installed on the tractor, replace it on the same interval as the other tractor hydraulic oil filters.

VENT PLUG

The vent is located on the LH side of the winch near the top of the winch case. 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.

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.

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.

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 which may result in property damage, personal injury or death.

Start the tractor engine and operate at the lowest RPM setting with the winch control in BRAKE-ON (neutral), allowing sufficient time to warm the hydraulic fluid.

After initial warm-up, operate the winch under a no-load condition, in both REEL-IN and REEL-OUT directions, several times to prime the lines with warm hydraulic fluid and circulate the winch gear oil. This action will minimize the temporary increase in brake-off drag caused by cold oil.

FAIRLEAD ROLLERS

For units with the optional fairlead assembly installed, grease the rollers at the beginning of each work day. The vertical rollers have grease fittings at the top and the bottom of the shaft. The horizontal rollers have only one grease fitting located on the LH end of the shaft. Apply grease until a small amount pushes out around the shaft.

Use a high quality type 12-hydroxy stearate lithium based product, which contains an EP additive, such as Moly, and meets or exceeds an NLGI Grade 2 specification.

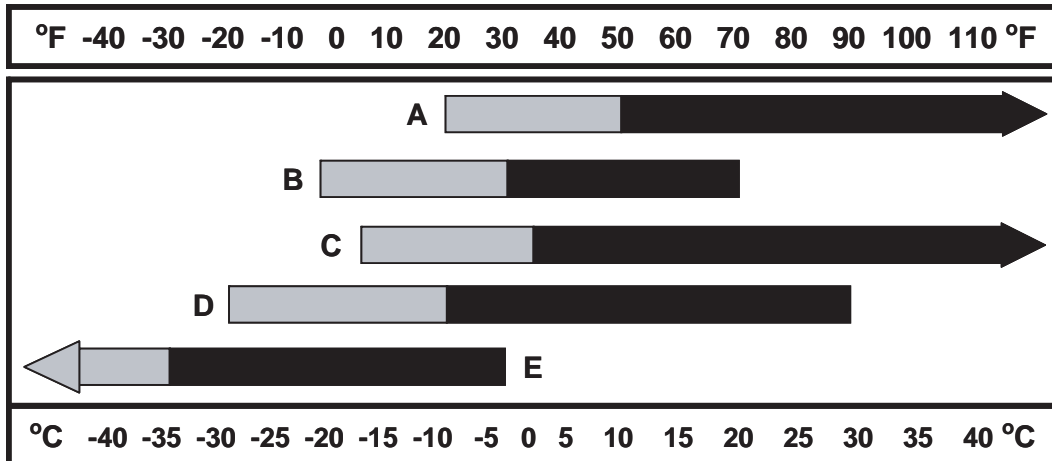
RECOMMENDED OIL

We have published the following specification to help you determine which lubricant is best suited to your application.

The 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.

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 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. Minimum cold startup temp. = Pour Point + 15 to 20°F.

- A - SAE 30 – Transmission Drive Train Oil John Deere JD20C, CAT TO4, C4
- B - SAE 10W – Transmission Drive Train Oil John Deere JD20C, CAT TO4, C4
- C - SAE 10W-30 - Transmission Drive Train Oil John Deere JD20C, CAT TO4, C4
- D - SAE 5W-30/5W-20 – Transmission Drive Train Oil John Deere JD20D, CAT TO4, C4
- E - MIL-H-5606A Hydraulic Oil

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 by 0.1383
 To convert LB-FT to N-m, multiply by 1.356

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°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 |