

2. Lubricants must be at operating temperature when draining.
3. During regular lubrication service, visually check the entire unit with regard to capscrews, nuts and bolts being properly secured.
4. Spot check several capscrews and nuts for proper torque. If any are found loose, a more thorough investigation must be made.
5. If a defect is detected which requires special maintenance service, stop the drill operation until the defect has been corrected. If necessary, contact the local Drilling Solutions distributor for assistance.

Lubrication Table

Periodic lubrication requirements are listed in the following Lubrication Chart. These requirements include lubricant checks and greasing designated areas of the drill.

Table 14:

Description	Fluid	Remarks
8 Hours or Daily		
Truck Engine Oil	API CG4, SAE 15W40	Check dipstick. Fill to "FULL".
Truck Engine Coolant	50/50 Mixture of Water & Antifreeze	Check at radiator cap with radiator cool to touch. Fill to "full" level.
Compressor Oil	XHP605 (HP)	Check at receiver tank sight gauge. Fill to "full" level.
Hydraulic Oil	ISO AW32	Check at sight gauge on reservoir. Fill to "full" level.
Compressor Oil	XHP605 (HP)	Check at receiver tank sight gauge. Fill to "full" level.
Fuel/Water Separator		Drain collected water.
Fuel Tanks	#2 Diesel Fuel	Fill to fill cap of (each) tank
Rotary Tophead Oil	SAE 80W90 Gear Oil	Check at sight gauge on rotary tophead. Fill to "full" level.
Derrick Pivot Pin	MPG-EP2 Grease	5 shots at each grease point
Rod Holder Option	MPG-EP2 Grease	5 shots at each grease point
Carousel Bearings	MPG-EP2 Grease	5 shots at each grease point
Sheaves & Sprockets	MPG-EP2 Grease	5 shots at each grease point
Cylinders (All)	MPG-EP2 Grease	5 shots at each grease point
Jib Hoist & Boom	MPG-EP2 Grease	5 shots at each grease point

Description	Fluid	Remarks
8 Hours or Daily (continued)		
Gearbox Driveshaft	MPG-EP2 Grease	5 shots at each grease point
Breakout Wrench	MPG-EP2 Grease	5 shots at each grease point
Leveling Jacks Sliding Surface	MPG-EP2 Grease	5 shots at each grease point
Mud Pump Shaft Seal	MPG-EP2 Grease	5 shots at each grease point
Drive Lines & U-Joints	MPG-EP2 Grease	5 shots at each grease point
Retract Gate Arms	MPG-EP2 Grease	5 shots at each grease point
50 Hours		
Batteries	Distilled Water	Check fluid levels in each battery. Fill cells as required.
Pump Drive Gearbox	SAE 80W90	Check at gearbox oil level port.
Transmission Oil	MIL-L-2104B SAE 50	Check dipstick. Fill to "FULL".
Truck Power Steering	SAE10W40	Check dipstick. Fill to "FULL".
100 Hours		
Jib Hoist	Texaco Meropa 150 or equivalent GL2/GL3	Drain, then refill jib hoist with 2 pints (1 liter) of oil.
Casing Hoist		Drain, then refill casing hoist with 4 pints (1.9 liter) of oil.
250 Hours		
Cummins ISX565 Engine	API CG4, SAE 15W40	Drain used oil, replace oil filter(s), refill engine with 48 qt. (45.4 liter) of oil.
Engine SCA Level	SCA	See Actual Mfg. Manual
Truck Differentials	SAE 80W90	Change truck axle(s) oil. Refer to actual manufacturer's manuals.
Rotary Tophead and Swivel	MPG-EP2 Grease	Apply until relief fitting shows grease leak.
500 Hours		
Pump Drive Gearbox	SAE 80W90 Gear Oil	Drain, then refill gearbox to oil level port.
Water Injection Pump	SAE40 (anti-rust)	Drain, then refill to oil level port.

Description	Fluid	Remarks
Jib Hoist	Texaco Meropa 150 or equivalent GL2/GL3	Check oil level at oil level fill port. Add oil if necessary.
Casing Hoist	Texaco Meropa 150 or equivalent GL2/GL3	Check oil level at oil level fill port. Add oil if necessary.
Carrier Engine Oil	API CG4, SAE 15W40	Drain used oil, replace oil filter(s), refill engine per engine manufacturer's instructions.
Carrier Engine Cooling System.	50/50 Mixture of Water & Antifreeze	Drain and flush engine cooling system. Refill per engine manufacturer's instructions.
Carrier Drivelines and U-Joints	MPG-EP2 Grease	5 shots at each grease point on drivelines and u-joints.
1000 Hours		
Truck Transmission Oil	SAE 50	Change transmission filter and oil. Refer to actual manufacturer's manuals.
Compressor Oil	XHP605 (HP)	Drain, then refill receiver tank with approximately 25 gallon (94.6 liter) of fluid.
Hydraulic Oil	ISO AW32	Drain, clean and then refill hydraulic tank with approximately 88 gallon (333 liter) of oil.
Rotary Tophead Oil	SAE 80W90 Gear Oil	Drain, then refill rotary head with 4 quarts (3.78 liter) of oil.
Pump Drive Gearbox	SAE 80W90 Gear Oil	Drain, then refill gearbox with 4.5 quarts (4.25 liter) of oil.
Jib Hoist	Texaco Meropa 150 or equivalent GL2/GL3	Drain, then refill jib hoist with 2 pints (1 liter) of oil.
Casing Hoist		Drain, then refill casing hoist with 4 pints (1.9 liter) of oil.
Water Injection Pump	SAE40 (anti-rust)	Drain, then refill with 10 ounces (295 ml) of oil.
4000 Hours		
Engine Coolant	50/50 Mixture of Water & Antifreeze	Drain and flush engine cooling system. Replenish coolant. See Actual Manufacturer's Service Manual.

Refill Capacities

The following fluid capacities are provided for servicing personnel who must perform drill maintenance in remote locations where complete shop facilities and resources are not available. These capacities will give the servicing personnel an approximation of the fluid capacities of the components to be serviced. Always ensure that the specified method of checking for accurate fluid levels is used.

Table 15: Approximate Refill Capacities

Component	Approximate Quantity
Systems	
Hydraulic Tank (ISO AW32)	88 gallon (333 liter)
Compressor Oil (receiver tank)	25 gallon (94.6 liters) XHP605
Rotary Tophead Oil (SAE 80W90)	1 gallon (3.78 liter)
Pump Drive Gearbox (SAE 80W90)	4.5 quart (4.25 liter)
Winch (Meropa 150)	4 quart (4 liter)
Sand Reel (Meropa 150)	2 pints (1 liter)
Water Injection Pump (SAE 40W anti-rust)	10 ounce (295 milliliter)
DHD Lubricator (Rock Drill Oil)	7 gallon (26.5 liter)
Carrier Engine	
Cummins ISX565 Engine (SAE 15W40)	48 quart (45.4 liter)
Engine Coolant (50/50 water/antifreeze)	28 quart (26.5 liter)
Fuel Tank (#2 ASTMD-975-60T)	Two (2) 100 gallon (378.5 liter) tanks

Hydraulic Oil

The quality of the hydraulic oil is important to the satisfactory performance of any hydraulic system. The oil serves as the power transmission medium, system coolant and lubricant. Selection of the proper oil is essential to ensure proper system performance and life.

The drill left the factory filled with **HUMBLE HYDRAULIC H** oil. The following shows the specifications:

Table 16: Hydraulic Oil Specification

EXXON HUMBLE HYDRAULIC H 32					
ISO Viscosity Grade	Flash °C (°F)	Pour °C (°F)	Viscosity		Viscosity Index
			cSt at 40°C	cSt -100°C	
32	206 (403)	-18 (0)	32	5.4	95

Grade AW32 is a general specification. Grade ISOAW32 is a general specification. Hydraulic oil must conform to Parker Hydraulics Pump Division HF-O Standards (4-11-78) and ISO Viscosity Grade 32.

Table 17: Approved Oils

The following are approved oils for Parker Hydraulics Pump Division HF-O Standard.	
AMOCO	AMOLITE: HF OIL NO. 21
EXXON	NUTO - H 32
GULF	HARMONY AW32
ILLINOIS OIL PRODUCTS	SUPREME R&O ANTIWEAR HYD. OIL
SUN OIL	SUNVIS 816 WR (32)
TEXACO	RANDO OIL NO. 32
TEXACO	AWX (WITH EC HI TEC ADD PACKS)
ATLANTIC RICHFIELD CO. (ARCO)	DURO AW-32

Lubricant Oil & Grease

Extreme Pressure Multipurpose Lubricant

This gear lubricant is compounded to achieve high load carrying capacity and meet the requirements of either API-GL-5 or MIL-L-2105C. Unless otherwise specified, SAE-90 viscosity oil may be used for year round service.

Table 18: Extreme Purpose Multipurpose Lubricant

Application	Quantity	Type
Rotary Tophead	1 gallon (3.78 liter)	S.A.E. 90W Gear Oil
Planetary Drive Gearbox	4.5 quart (4.24 liter)	80W90 Gear Oil

Low temperature usage is restricted as follows:

Table 19: Low Temperature Usage

EP Multipurpose Lubricant	
SAE Viscosity Number	Ambient Temperature F°/(C°)
75W	-40°F (-40°C)
80W	-15°F (-26°C)
85W	+10°F (-12°C)
90W	+20°F (-7°C)
140W	+40°F (+5°C)
250W	+50°F (+10°C)

Hoist/Winch Lubricant

The following table represents the lubricant used in the Jib Hoist and the Casing Hoist.

Table 20: Hoist/Winch Lubricant Specifications

<i>Temperature Range</i>	<i>Required Lubricant</i>
-30°F to 80°F (-34.47°C to 26.69°C)	Texaco Pinnacle 150
-10°F to 80°F (-23.35°C to 26.69°C)	Texaco Meropa 150 or an equivalent AGMA #4EP
50°F to 130°F (10°C to 54.49°C)	Texaco Meropa 220 or an equivalent AGMA #5EP

Water Injection Pump Lubricant

The required lubricating oil for the 25 gallon Cat water injection pump is as follows:

Table 21: Water Injection Pump Lubricant Recommendation

<i>Component</i>	<i>Quantity</i>	<i>Type</i>
Water Injection Pump	84 ounces (2.48 liters)	SAE40W (anti-rust)

Compressor Fluids

The TH60 Waterwell Drill is available as a high pressure drill only. Therefore, use only **XHP605** compressor oil.

Table 22: Compressor Fluids

Design Operating Pressure	Ambient Temperature	Specification
350 psi	-10°F to 125°F (-23°C to 52°C)	IR XHP605. ISO viscosity grade 68, group 3 or 4 with rust inhibitors designed for air compressor service.

NOTE: Compressor oil carryover (oil consumption) may be greater with the use of alternate fluids.

Engine Lubricating Oil

The use of quality engine lubricating oils, combined with appropriate oil drain and filter change intervals, is a critical factor in maintaining engine performance and durability.

For the latest applicable engine lubricating oil specifications, contact the engine manufacturer, your dealer or your local Drilling Solutions distributor. Drills leave the factory with API CG4, SAE 15W40 oil, as shown below.

Table 23: Engine Lubricating Oil Specification (from factory)

Description	Specification
Manufacturer and Type:	AMOCO 300
SAE Viscosity Grade:	15W-40
API Service Category:	CG4, MIL-L-2104C
Approved Oils:	Pennzoil Long Life 15W-40
	Texaco Ursa Super Plus 15W-40

Extreme Pressure Multipurpose Grease

This is a lithium soap base grease with a high load carrying capacity. The following properties are recommended:

Table 24: High Load Properties

EP Multipurpose Grease	
Timkin OK Load	40 lb. (18.14 kg) minimum
Dropping Point	350°F (177°C) minimum
Oil Viscosity	75 SUS minimum at 210°F (99°C)
Water Resistance	Excellent

Under normal operating conditions, the following consistency grades are recommended:

Table 25: Normal Operating Properties

Normal Operating Condition Consistency Grades	
NLGI Number 0	Subzero fahrenheit temperatures
NLGI Number 1 or Number 2	Ambient temperatures of 0°F to 100°F or (-17.8°C - 38°C)
NLGI Number 2 or Number 3	Temperatures over 100°F (38°C)

Multi-Purpose Grease

With the exception of the rotary head, the following grease can be used:

Table 26: Multi-Purpose Grease Specification

Description	Specifications
Manufacturer:	Amalie Oil Company
Type:	Multi-Purpose Grease, EP1 (#673-6819)
Quantity:	120 lb. Drum (54.4 kg)
Soap Type & Color:	LI-12-OH, Light Brown
NLGI Grade:	2
Work Penetration, D17, 77°F (25°C):	265 - 295
Dropping Point, 0-2265°C (0-2265°F):	177 (350)
Rust, D-1743 (max):	1
Timken, D-2905, OK Load:	-
Filler, WT.:	-
Oxidation, D-942 (100 hrs):	7
VIS @ 100°C (212°F) cSt:	15.5
VIS @ 210°F (99°C) SUS:	82
Pour Point Degree Celsius:	-15°C
Pour Point Degree Fahrenheit:	+5°F
Product Number:	5819

Rotary Tophead Grease

Atlas Copco recommends using Exxon Mobil Ronex Extra Heavy Duty Moly 2 grease for the rotary tophead grease points. The following shows the specifications:

Table 27: Rotary Tophead Grease Specification

Description	Specifications
Manufacturer:	Exxon Mobil
Type:	Ronex Extra Heavy Duty Moly 2
Quantity:	1 lb. (.45 kg)
Thickener Type:	Lithium Complex
Pumpable Down To:	-10°C (14°F)
NLGL Grade:	2
Color:	Gray - Black
Base Oil Viscosity, ASTM D	
CST @ 40°C:	460
SUS @ 100°F:	2500
Dropping Point, ASTM D 225:	250+°C (380+°F)
Rust Protection, ASTM D 1743:	Pass
Texture:	Smooth
Moly Percentage:	3
Note 1:	MOLY 2 is a compound with special extreme pressure and anti-wear additives to protect bearing surfaces at high load carrying capability.
Note 2:	For applications requiring lower pumpable temperatures, contact engineering.

Coolant Specifications

Coolant

Coolant is normally composed of three elements: Water, Additives and glycol.

Water

Water is used in the cooling system to transfer heat. Distilled or deionized water is recommended for use in the engine cooling systems. DO NOT use the following types of water in cooling systems: hard water, softened water that has been conditioned with salt, and sea water. If distilled water or deionized water is not available, use water with the properties that are listed in the following table.

Table 28: Minimum Acceptable Water Requirements

Property	Maximum Limit
Chloride (Cl)	40 mg/L (2.4 grains/US gallon)
Sulfate (SO ₄)	100 mg/L (5.9 grains/US gallon)
Total Hardness	170 mg/L (10 grains/US gallon)
Total Solids	340 mg/L (20 grain/US gallon)
Acidity	pH of 5.5 to 9.0

Additives

Additives help to protect the metal surfaces of the cooling system. A lack of coolant additives or insufficient amounts of additives enable the following conditions to occur: corrosion, formation of mineral deposits, rust, scale, pitting and erosion from cavitation of the cylinder liner and foaming of the coolant. Additives must be added at the proper concentration. Overconcentration of additives can cause the inhibitors to drop out-of-solution. The deposits can enable the following problems to occur:

1. Formation of gel compounds
2. Reduction of heat transfer
3. Leakage of the water pump seal
4. Plugging of radiators, coolers and small passages

Glycol

Glycol in the coolant helps to provide protection against the following conditions: boiling, freezing and cavitation of the water pump and the cylinder liner. For optimum performance, use a 1:1 mixture of a water/glycol solution.

General Information

Cummins **strongly** recommends the use of fully formulated antifreeze or coolant containing a precharge of supplemental additive (SCA). The antifreeze or coolant **must** meet the specifications outlined in The Maintenance Council (TMC) Recommended Practice (RP) 329 (ethylene glycol) or RP 330 (propylene glycol). The use of fully formulated antifreeze or coolant significantly simplifies cooling system maintenance.

Fully formulated **antifreeze** contains balanced amounts of antifreeze, DCA and buffering compounds, but does **not** contain 50 percent water.

Fully formulated **coolant** contains balanced amounts of antifreeze, SCA and buffering compounds already pre-mixed 50/50 with deionized water.

Fully Formulated Coolant/Antifreeze

Cummins Engine Company, Inc. recommends using either a 50/50 mixture of good quality water and fully formulated antifreeze, or fully formulated coolant when filling the coolant system. The fully formulated antifreeze or coolant **must** meet TMC RP329 or TMC RP330 specifications.

NOTE: Use of products meeting TMC RP329 or TMC RP330 is necessary for 1500 hour and 6000 hour service intervals.

NOTE: Low silicate antifreeze meeting ASTM D4985 is inadequate for these extended service intervals.

Table 29: Coolant / Antifreeze

Water Quality	
Calcium Magnesium (Hardness)	Maximum 170 ppm as (CaCO ₃ + MgCO ₃)
Chloride	40ppm as (Cl)
Sulfur	100 ppm as (SO ₄)

Good quality water is important for cooling system performance. Excessive levels of calcium and magnesium contribute to scaling problems, and excessive levels of chlorides and sulfates cause cooling system corrosion.

Fully formulated antifreeze **must** be mixed with quality water at a 50/50 ratio (40 percent to 60 percent working range). A 50/50 mixture of antifreeze and water gives a -34°F (-36°C) freezing point and a 228°F (110°C) boiling point, which is adequate for locations in North America. The actual lowest freezing point of ethylene glycol antifreeze is 68 percent. Using higher concentrations of antifreeze will raise the freezing point of the solution and increase the possibility of a silica gel problem.

Fuel Oil

Cummins Fuel Oil



Do not mix gasoline, alcohol or gasohol with diesel fuel. This mixture can cause an explosion.

Cummins Engine Company recommends the use of ASTM No. 2D fuel. The use of No. 2 diesel fuel will result in optimum engine performance. At operating temperatures below 32°F (0°C), acceptable performance can be obtained by using blends of No. 2D and No. 1D. The use of lighter fuels can reduce fuel economy.

The viscosity of the fuel **must** be kept above 1.3 cSt at 212°F (100°C) to provide adequate fuel system lubrication.

Cummins diesel engines have been developed to take advantage of the high energy content and generally lower cost of No. 2 Diesel Fuels. Experience has shown that a Cummins diesel engine will also operate satisfactorily on No. 1 fuels or other fuels within the specifications shown in the following table.

Table 30: Cummins Specification for Distillate Diesel Fuel

Specifications	Requirements	ASTM Test
Viscosity	1.3 TO 5.8 Centistokes per second at 104°F (1.3 to 5.8 mm per second at 40°C)	D-445
Cetane Number	40 minimum (exception: in cold weather or in service with prolonged idle, a higher cetane number is desirable)	D-613
Sulfur Content	Not to exceed 1 percent by weight	D-129 OR D-1552
Water and Sediment	Not to exceed 0.1 percent by volume	D-1796

Specifications	Requirements	ASTM Test
Carbon Residue	Not to exceed 0.25 percent by weight on 10 percent volume residue.	Ramsbottom D-524 or Conradson D-189
Flash Point	At least 125°F (52°C) or legal temperature if higher than 125°F (52°C)	D-93
Density	30°F to 40°F (-1°C to 6°C) API gravity at 60°F (16°C). (0.816 to 0.876 Sp. Gr.	D-287
Cloud Point	10°F (6°C) below lowest ambient temp at which the fuel is expected to operate	D-97
Active Sulfur	Copper strip corrosion not to exceed No. 2 rating after 3 hours at 122°F (49°C)	
Ash	Not to exceed 0.02 percent by weight	D-482
Distillation	The distillation curve must be smooth and continuous. At least 90 percent of the fuel must evaporate at less than 725°F (385°C)	D-86

CAT Fuel Oil

Diesel engines have the ability to burn a wide variety of fuels. These fuels are divided into two general groups. The two groups are called the preferred fuels and the permissible fuels. The preferred fuels provide maximum engine service life and performance. The preferred fuels are distillate fuels. These fuels are commonly called diesel fuel, furnace fuel, gas oil or kerosene. The permissible fuels are crude oils or blended fuels. Use of these fuels can result in higher maintenance costs and in reduced engine service life. Diesel fuels that meet specifications in the following table will help to provide maximum engine service life and performance. In North America, diesel fuel that is identified as No. 1-D or No. 2-D in “ASTM D975” generally meet the specifications. Specifications and requirements shown in the table are for diesel fuels that are distilled from crude oil. Diesel fuels from other sources could exhibit detrimental properties that are not defined or controlled by this specification.

Table 31: Caterpillar Specifications for Distillate Diesel Fuel

Specifications	Requirements	ASTM Test
Aromatics	35% maximum	D1319
Ash	0.02% maximum (weight)	D482
Carbon Residue on 10% Bottoms	0.35% maximum (weight)	D524

Specifications	Requirements	ASTM Test
Cetane Number	40 minimum (DI engines)	D613
	35 minimum (PC engines)	
Cloud Point	The cloud point must not exceed the lowest expected ambient temperature	
Copper Strip Corrosion	No. 3 maximum	D130
Distillation	10% at 540°F (282°C) maximum	D86
	90% at 680°F (360°C) maximum	
Flash Point	legal limit	D93
API Gravity	30 minimum	D287
	45 maximum	
Pour Point	10°F (6°C) minimum below ambient temp	D97
Sulfur	3% maximum	D3605 or D1552
Kinematic Viscosity	1.4 cSt minimum and 20.0 cSt maximum at 104°F (40°C)	D445
Water and Sediment	0.1% maximum	D1796
Water	0.1% maximum	D1744
Sediment	0.05% maximum (weight)	D473
Gums and Resins	10 mg. per 100 mL maximum	D381
Lubricity	3100g minimum	D6078
	0.018 inch (0.45mm) maximum at 140°F (60°C)	
	0.015 inch (0.38mm) maximum at 77°F (25°C)	