KOMATSU

P&H

Lubrication Specifications and Requirements

77XR-S-M-LS-EN-0004

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Preface

This manual is provided as a guide to personnel involved with the operation, maintenance and repair of Komatsu Mining Corp. equipment. We recommend that such personnel review and become familiar with the general procedures and information contained in this manual. In addition, we recommend that this manual be kept readily available for reference when repairs or maintenance are necessary.

Read and become familiar with this manual and any other general safety practices before attempting any procedures.

Due to the complexities of mining equipment and the environment in which it operates, situations may arise which are not directly discussed in detail in this manual. When such a situation arises, past experience, availability of equipment and common sense play a large part in what steps are to be taken. In addition, a Komatsu Mining Corp. service center representative is available to answer your questions and assist you upon request.

Komatsu Mining Corp. reserves the right to continually improve its products and associated documentation. Therefore, physical alterations to Komatsu equipment may not be identified in this manual. Revisions may be frequently made to this manual in an effort to ensure that information remains current as alterations occur to the equipment. If you find an error or have other feedback regarding this manual, please contact Product Training and Publications at *Pro.Train.Pub@mining.komatsu*.

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Revision Record – 77XR-S-M-LS

Version	Revision Description	Page(s)	Author	Date
1	Initial release		RW	6/12/2018
2	Channel point Celsius correction	10	RW	12/2/2019
3	Propel transmission lubricant description change (normal/heavy duty to temperature range)	17	RW	5/27/2021
4	Image updates		RW	8/18/2021

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General

Lubricant Specifications

NOTE: Without reference to specific lubricant manufactures' products, this manual makes reference only to the appropriate lubricant specifications. Contact your service center office for lubricant specifications. Each material specification pertaining to lubricants provides the equipment owner with the minimum requirements for the lubricant. Conformance to these requirements does not constitute the only basis of acceptance. Lubricants must be judged further on their satisfactory field performance. In order for equipment to perform properly, the lubricant supplier and the equipment owner must work together to determine if the type of lubricant being considered will meet the lubricant requirements (that is, specifications and performance). The lubricant supplier must confirm that the lubricant meets specifications; the equipment owner must confirm that the lubricant is suitable for and performs in the operating environment.

Operating in Cold Conditions

Automatic lubrication systems can malfunction when the lubricant becomes too cold to flow smoothly or vent properly. This can cause the system cycle to end before lube points are properly lubricated.

Possible Effects Of Excessively Cold Lubricant

- Cold grease can make it difficult to pump the lubricant. A restriction to flow in one area can cause a local pressure drop to some components. The pressure switch on the lubrication control panel may reach the set point pressure before it is high enough to cycle all the injectors. The lube pump turns off prematurely before the lube points get the needed lubricant.

If cold weather problems occur, contact your service center representative to assist in choosing which of the following solutions should be selected.

Possible Solutions

- Use a grease more appropriate for colder temperatures. Refer to the lubrication specifications in this section of this manual for details.
- Slow the lubrication pump to allow more time for the cold grease to move through the lube piping. Refer to the Automatic Lubrication System Adjustment section of this *Lubrication Specifications and Requirements* system manual for more details.

Viscosity

The viscosity is a critical parameter in determining film thickness under operating conditions. Too low viscosity will allow tooth surfaces to contact each other. Viscosity varies exponentially with operating temperature.

The viscosity grade selection is dependent on the maximum and minimum operating temperatures. If the extreme or peak operating sump temperatures are not known, measure the sump oil temperature during a period of extreme or peak ambient temperature, after working the machine continuously for at least 1/2 shift.

Maximum oil viscosity (and, therefore, its suitability for application in cold weather) is also temperature-dependent and is primarily determined by the pour point of the oil. Refer to minimum operating sump temperatures below.

Table 1: Gear Oil Operating Limits

Oil Grade	Spec.	Viscosity (cSt)		Max. Operating Sump Temp. (Flash Point)		Min. Operating Sump Temp. (Pour Point)	
		@ 40°C	@ 100°C	°C	°F	°C	°F
ISO VG 32	474A	31.5	5.3	220	427	-27	-17
ISO VG 150	497E	152	16	28	82	-24	-11
ISO VG 320	497G	320	24	37	98	-18	0
PAO 32		30.4	5.7	230	446	-40	-40
PAO ISO VG 320		313.3	39.5	229	444.2	-39	-38.2
SAE 10W		37.7	6.1	232	449.6	-30	-22
SAE 15W–40		98	14	226	438.8	-30	-22
SAE 30		95.1	10.9	230	446	-36	-32.8
SAE 80W–90		139	14.5	210	410	-27	-16.6
SAE 75W–90 Synthetic		120	15.9	205	401	-48	-54.4
SAE 80W–140		248	25	138	280	-4	25
SAE 75W–140 Synthetic		182	25	203	397.4	-45	-49

The channel point of an oil is about 8°F to 14°F (4.5°C to 8°C) below the pour point. If the ambient temperature drops below the pour point, the oil will not flow through a pump. This condition is unacceptable, even though some lubrication of gearing might be possible if the gearing dips into oil in a sump. If the ambient temperature falls below the channel point, no lubrication is possible as the oil will become semi-solid and will be displaced (channeled) as the gearing dips into the sump. This condition will result in destruction of the gearing.

If it is desired to use a single grade of oil year round, users must be certain that at no time will either the maximum or minimum operating sump temperature be exceeded for the grade of oil being used.

The minimum operating sump temperature represents the pour point of the oil, but it is still possible to operate the machine if the ambient temperature drops below the pour point. Temperature below the pour point is mainly a concern if the machine is not operating. If a machine has been shut down for an extended period of time, and the ambient temperature drops below the pour point during this time, observe carefully while the motions are run slowly under no load. Warm up the oil to the point where it will flow before putting the gearing under load. This task is critical to avoid serious damage to gearing. If the sump temperature is still below the pour point, a lighter grade of oil should be used.

Oil selection will affect filter performance. When selecting filter elements, the viscosity, grade, and operating temperature must be considered. The viscosity of the oil will change with temperature. Normally, a 10 PSI (0.69 bar) pressure drop is permitted across filters. To ensure that the filter element type and mesh is appropriate for the oil viscosity at the highest and lowest temperature, the oil temperature, oil viscosity at that temperature, and the flow through the filter must be known. Generally, the curves for filter elements are available from filter suppliers.

The selection of gear case oils must be made on the basis of conformance to Specification 497 or 474, on the minimum viscosity requirements of 400 cSt at maximum operating temperature, and on the pour point of the oil vs. the minimum ambient temperature.

ISO Grade

It is recommended that only oils with an ISO grade designation be used. If a type of oil other than an ISO grade is to be used, consult with the manufacturer. Oils of the same ISO grade will typically have similar viscosity and pour point parameters. If unsure, compare proposed oil's properties with those listed in the Viscosity section of this *Lubrication Specifications and Requirements* system manual. If significantly different, consult the manufacturer regarding suitability.

NOTE: If the lubrication service recommendations in this manual conflict with those of the original equipment manufacturer, the original equipment manufacturer's specifications take precedence.

⚠ CAUTION

Grease lubricants with different formulation bases are incompatible. Before using a different grease, check to be sure that the base of the new grease is compatible with the original. If not, all components in contact with the lubricant, including shafts and bearings, must be thoroughly purged of the old grease, removed from the system, and cleaned with solvent. Component failure will result if thorough cleaning is not done.

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Oil Bath Lubrication

All gear drives, including the pump drive transmission, and some of the other rotating equipment on the blasthole drill, are lubricated through self-contained oil bath reservoirs. Most of the equipment units that have self-contained lubricant reservoirs lubricate their internal components by immersion in the oil bath, or by splashing lubricant from the surface of the oil bath. The equipment within this category includes the following:

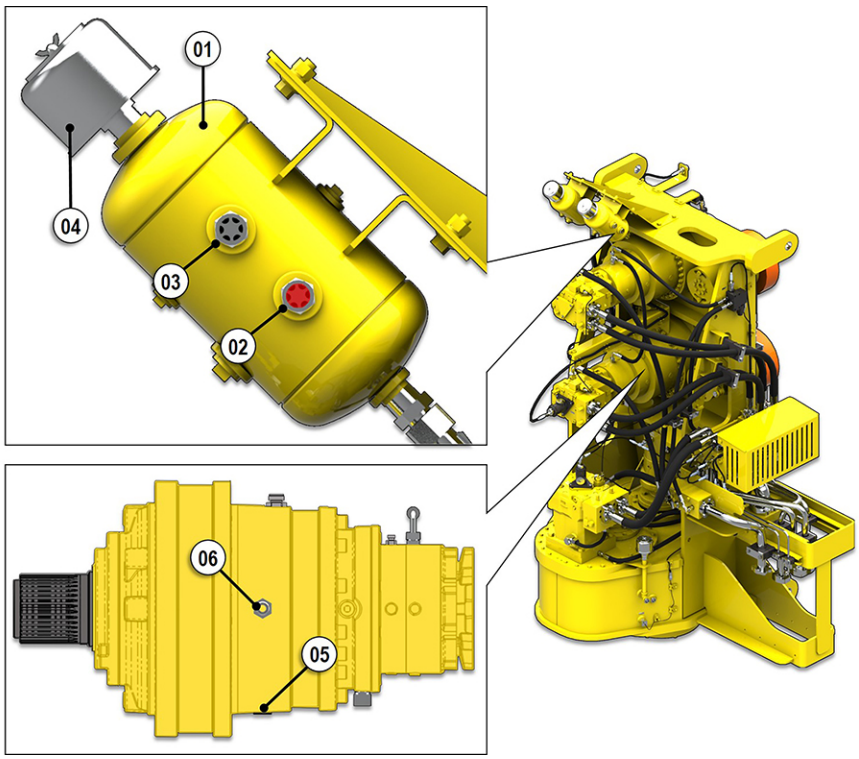
Hoist/Pulldown Planetary Transmission

Refer to ***Figure 1*** **: Hoist/Pulldown Planetary Transmission Lubrication**.

The drill utilizes dual hoist/pulldown planetary transmissions on the rotary carriage. Each planetary transmission has a corresponding reservoir assembly to ensures constant lubrication during carriage traversing. The left reservoir is dedicated to the lower transmission, while the right reservoir is dedicated to the upper transmission.

Note: Fluid levels depicted in red for clarity, actual color may vary.

Figure 1: Hoist/Pulldown Planetary Transmission Lubrication



01 - Hoist/Pulldown Planetary Transmission Reservoir

02 - Lower Sight Glass

03 - Upper Sight Glass

04 - Breather Assembly

05 - Drain Plug

06 - Reservoir Connection Fitting

The hoist/pulldown planetary transmissions uses PAO ISO VG 320 gear oil. Each hoist/pulldown planetary transmission and reservoir has a oil capacity of approximately 5.28 gallons (20 L)

Check the oil level at the hoist/pulldown planetary transmission reservoirs (**01,** ***Figure 1***) before each shift or after each 8 hours of operation. Before the transmissions have been operated, oil should just be seen in the lower sight glass (**02,** ***Figure 1***). After the transmissions have been in operation, the oil will heat up and expand; oil *may* be seen in the upper sight glass (**03,** ***Figure 1***).

If before operation, oil is not visible in the lower sight glass (**02,** ***Figure 1***); more oil is required. It is filled through the breather location. The breather assembly (**04,** ***Figure 1***) is secured with a wing nut. When removed, oil is poured in through the opening.

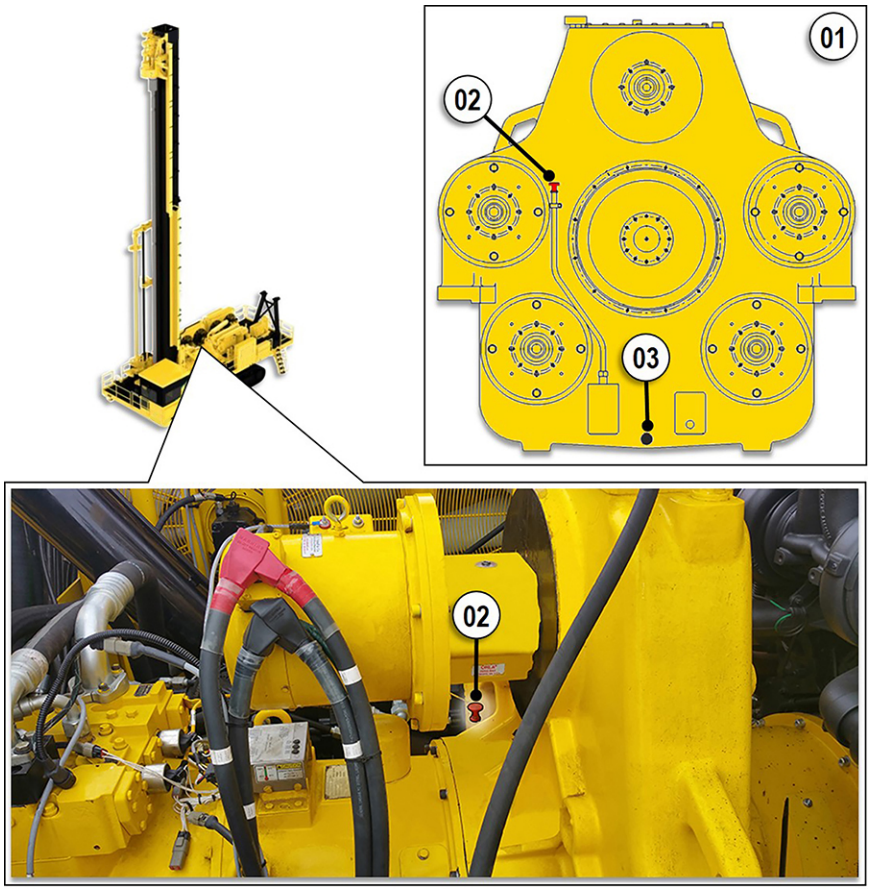
The entire hoist/pulldown planetary transmission is drained via the drain plug (**05,** ***Figure 1***) in the bottom of the gear multiplication section. Change oil as specified. Refer to Life Cycle Management.

Hydraulic Pump Drive Transmission

Refer to ***Figure 2*** **: Hydraulic Pump Drive Transmission Lubrication**.

The hydraulic pump drive transmission converts the output energy from the diesel engine and divides it up and applies it through the five outputs. The hydraulic pump drive transmission fluid is checked via the dipstick. The drain plug is located on the bottom of the hydraulic pump drive transmission.

Figure 2: Hydraulic Pump Drive Transmission Lubrication



01 - Hydraulic Pump Drive Transmission (Side View)

02 - Dipstick

03 - Drain Plug (drains out below deck)

The hydraulic pump drive transmission (**01,** ***Figure 2***) uses ISO VG 150 gear oil. The oil capacity is approximately 9.8 gallons (37 L). Check the oil level at the dipstick (**02,** ***Figure 2***) before each shift or after each 8 hours of operation. Change the oil as specified, in or as indicated by oil analysis. Refer to Life Cycle Management.

Propel Transmission

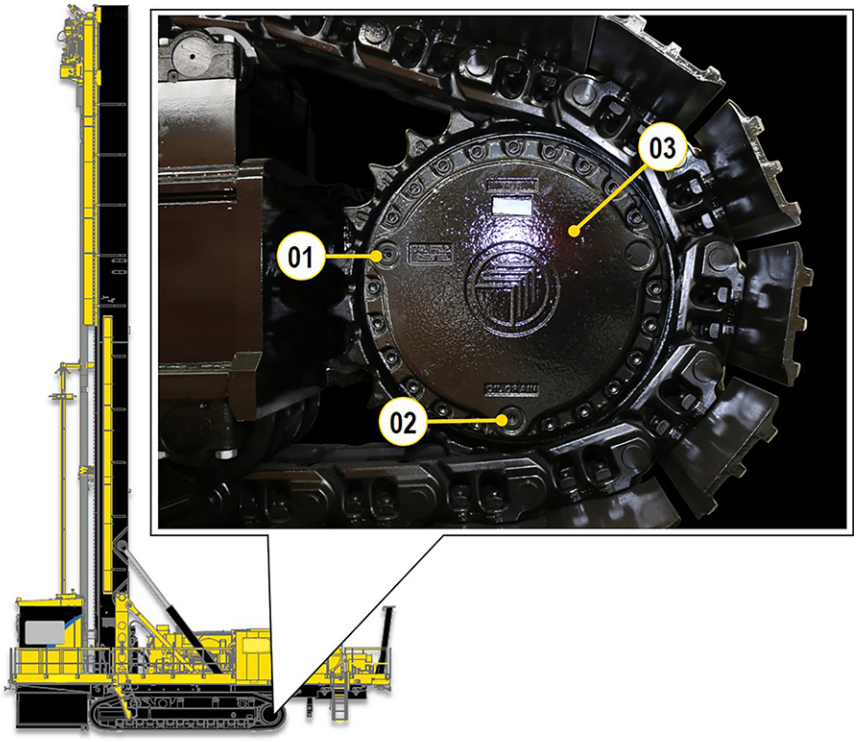
Refer to ***Figure 3*** **: Propel Transmission Lubrication**.

The propel transmissions are located on the front of the crawler assemblies. They multiply the torque from the propel hydraulic motors and drive the crawler tracks. Each housing (**03,** ***Figure 3***) contains a fill/level check plug (**01,** ***Figure 3***) and a drain plug (**02,** ***Figure 3***). When the fill/level check plug is removed, the oil level should be visible. **Note:** The orientation of the propel transmission housing may vary based on the propel requirements of each drill, and its unique site specific operating environment.

⚠ WARNING

Allow the propel transmission(s) to completely cool down before attempting to remove the fill/level check plug. During propel operation, the transmissions will pressurize the lubricant within the housing. Removing the fill/level check plug, while the lubricant is pressurized could cause injuries and severe burns.

Figure 3: Propel Transmission Lubrication



01 - Fill/Level Check Plug **02 - Drain Plug** **03 - Housing**

The propel transmissions can use either mineral or synthetic gear oil (in most instances). The site's working temperature range, determines the lubricant.

Each propel transmission has a capacity of 4.5 gallons (17 L).

Table 2: Propel Transmission Recommended Lubricants

-40°F to -4°F (-40°C to -20°C)	-4°F to 86°F (-20°C to 30°C)		50°F to 113°F (10°C to 45°C)	
SAE 75W–90	SAE 80W–90	SAE 75W–90 Synthetic	SAE 85W–140	SAE 75W–140 Synthetic

If low, add oil as required. Change oil as specified. Refer to Life Cycle Management.

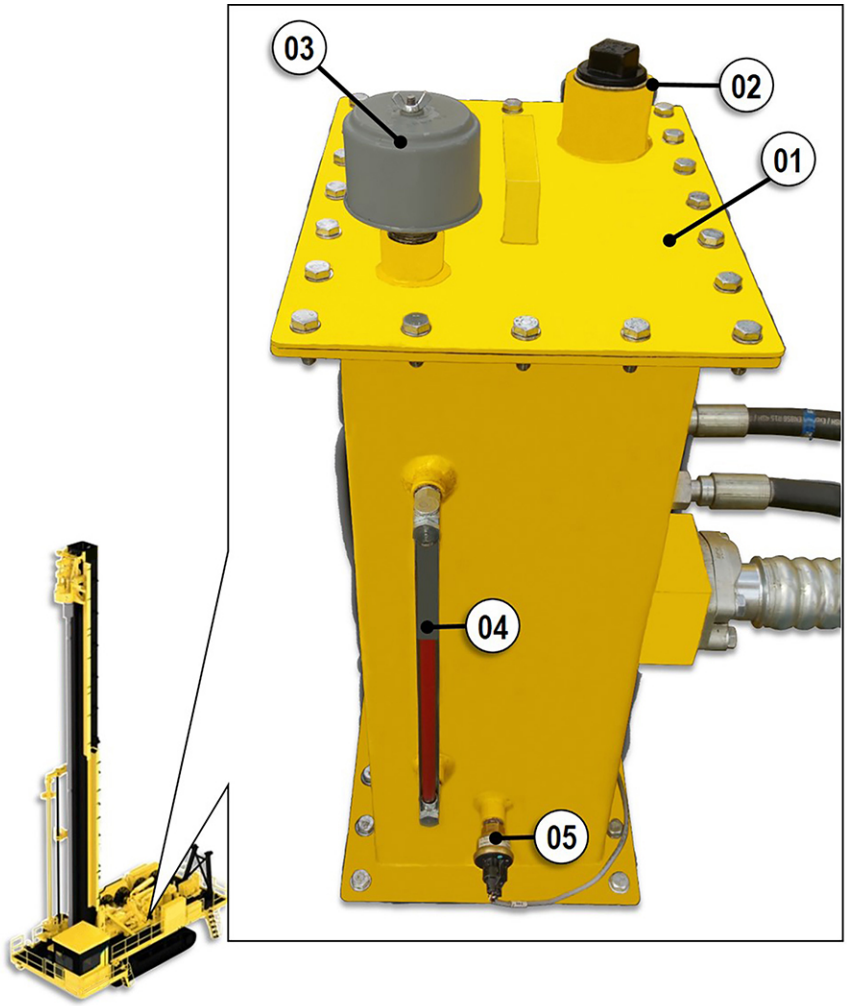
Torque Converter

Refer to ***Figure 4*** **: Torque Converter Remote Reservoir**.

The torque converter is locate just behind the engine, adjacent to the pump drive transmission. A remote reservoir (**01,** ***Figure 4***) with a sight glass (**04,** ***Figure 4***) is viewable from the right hand walk way, next to the air compressor. On top of the reservoir is a tank breather (**03,** ***Figure 4***). The fill plug (**02,** ***Figure 4***) is also located on the top of the reservoir. A low level indicator sensor (**05,** ***Figure 4***) is mounted towards the lower most portion of the tank. It is protected by a steel bracket to prevent inadvertent damage (not shown in ***Figure 4***). When the torque converter reservoir oil is low, a message will be displayed on the operator's touch screen.

Note: Fluid levels are depicted in red for clarity, actual color may vary.

Figure 4: Torque Converter Remote Reservoir



01 - Torque Converter Remote Reservoir

02 - Sight Glass

03 - Breather

04 - Fill Plug

05 - Low Level Indicator Sensor

The torque converter uses SAE 15W-40 oil. The reservoir is filled with approximately 17 gallons (64 L) of oil. Check the oil level sight glass before each shift or after each 8 hours of operation. Change the oil as specified, in or as indicated by oil analysis. Refer to Life Cycle Management.

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Oil Pressure Lubrication

The rotary gear case and the air compressor have enclosed, dedicated oil lubrication systems.

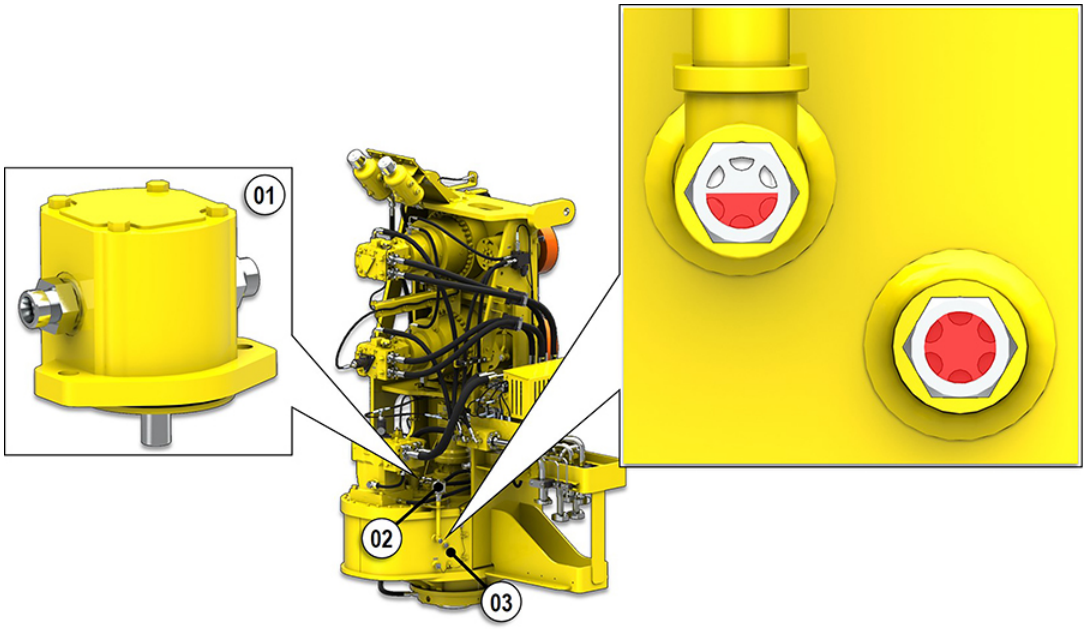
Rotary Gear Case

Refer to ***Figure 5*** **: Rotary Gear Case Lubrication**.

The hoist/pulldown gear case sight glass is located on the lower portion of the rotary gear case. The sight glasses and gear case breather are located to the right of the rotary hydraulic motor. Oil should completely fill the lower sight glass when the oil is cold. During use, oil may be visible half way up, the upper sight glass. If oil is needed, it is filled through the breather tube in the upper sight glass. The breather is easily removed via a top mounted wing nut.

Note: Fluid levels are depicted in red for clarity, actual color may vary.

Figure 5: Rotary Gear Case Lubrication



01 - Oil Lubrication Pump **02 - Rotary Gear Case Breather** **03 - Oil Level Sight Glasses**

The rotary gear case uses ISO VG 320 oil with EP additives. The oil capacity is approximately 31.7 gallons (120 L).

Check oil level at the sight glass daily and add oil as required. Change oil as specified in the ***Lubrication Schedule*** or as indicated by oil analysis.

Air Compressor

Oil Tank

Refer to ***Figure 6*** **: Air Compressor Oil Tank Lubrication**.

The air compressor requires a constant supply of oil, while in use. Oil that is contained within the air compressor oil tank (**01,** ***Figure 6***) is circulated through the air compressor, after first being cooled and filtered. The circulated oil is used for lubrication, cooling, and to create the seal between the helical rotors of the air compressor. As the rotors spin, intake air is compressed and oil is mixed with the compressed air. The combination of pressure and friction raises the temperature of both the air and compressor oil. The heated mixture is sent back to the air compressor oil tank, where the oil separator filter (**05,** ***Figure 6***) removes the oil from the air. Oil trapped in the oil separator filter is returned back to the compressor, through the scavenge outlet. Air exits the tank through the ball valve (air outlet) (**08,** ***Figure 6***) before travelling on throughout the remainder of the main air system. The oil tank is protected by an overpressure relief valve (**09,** ***Figure 6***).

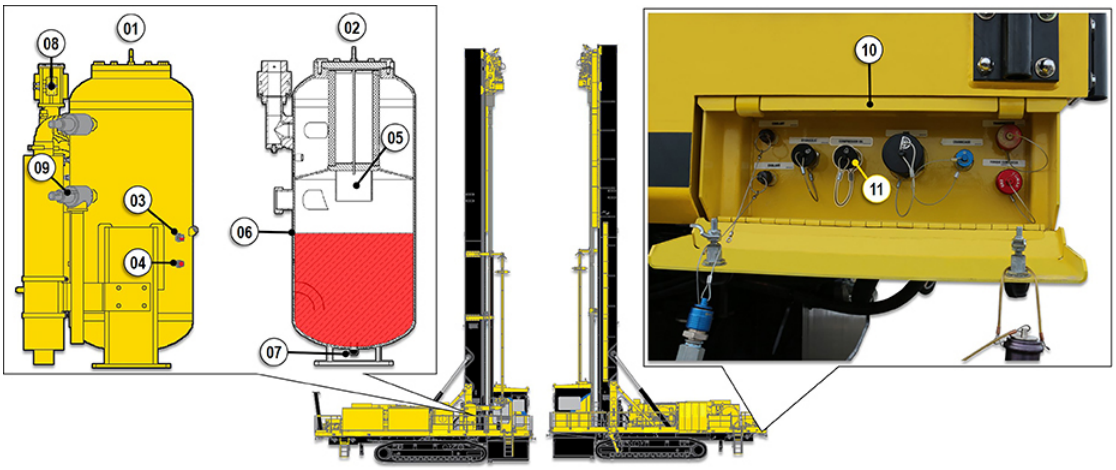
Oil follows a constant cycle of cooling, filtering, use, and recirculation during compressor operation.

The compressor oil tank fluid level (**06,** ***Figure 6***) is verified by viewing the upper sight glass (**03,** ***Figure 6***) and lower sight glass (**04,** ***Figure 6***). Oil should be completely filled in the lower sight glass when the compressor is off. When the compressor is running, oil may be visible in the upper sight glass. If more oil is needed, it should be added through the remote fluid fill location on the front, right corner of the machine (**10,** ***Figure 6***). The compressor oil fill (**11,** ***Figure 6***) is located to the left of the diesel fuel, fill cap.

The oil tank for the air compressor is located on the drill's deck, adjacent to the rear left deck access ladder.

Note: Fluid levels are depicted in red for clarity, actual color may vary.

Figure 6: Air Compressor Oil Tank Lubrication



01 - Air Compressor Oil Tank

02 - Air Compressor Oil Tank (Cross-Section)

03 - Upper Sight Glass

04 - Lower Sight Glass

05 - Oil Separator Filter

06 - Fluid Level

07 - Tank Drain Plug

08 - Ball Valve (Air Outlet)

09 - Overpressure Relief Valve

10 - Remote Fluid Fill Location

11 - Compressor Oil Fill

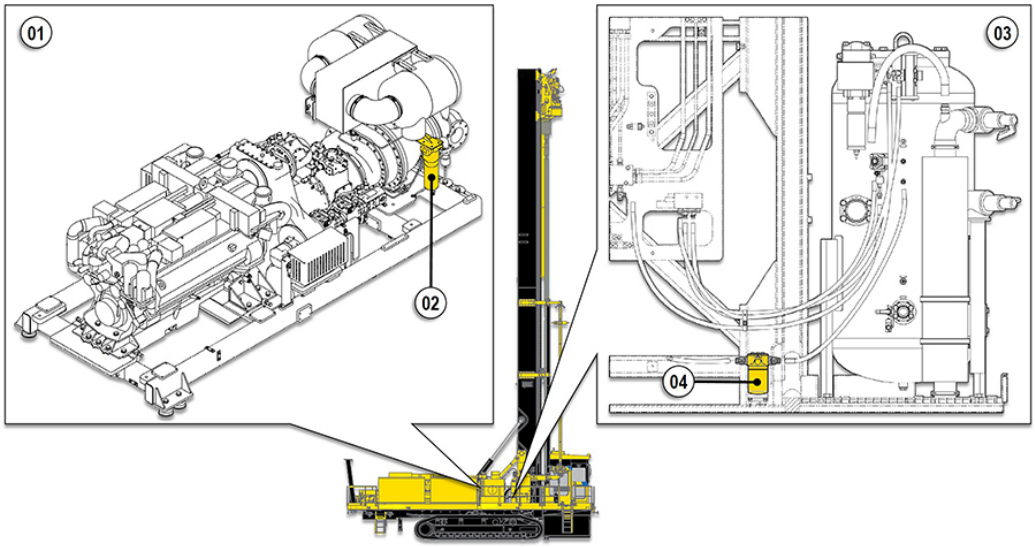
The air compressor uses PAO 32 in all ambient temperatures. The oil capacity is 80 gallons (303 L). Check the oil level at the tank sight gauge each shift or after each 8 hours of operation. Change the oil as specified in or as indicated by oil analysis.

Main Air System Oil Filters

Refer to ***Figure 6*** **: Air Compressor Oil Tank Lubrication** and ***Figure 7*** **: Air Compressor Oil Filters**.

Compressor oil exits the tank and passes through a tank outlet shut-off valve. Oil enters a thermal bypass control valve that circulates compressor oil through a section of the hydraulic radiator. A temperature sensor measures the compressor oil temperature on exit. Cooled oil enters into the compressor oil filter (**02,** ***Figure 7***) located on the side of the air compressor. Before filtered oil can enter the compressor, an oil stop valve must be energized by the pilot circuit of the compressor air and oil pressure line. When the compressor is operating and producing air, the oil stop valve is engaged and allows oil to enter the compressor. Compressor oil travels through the compressor for lubrication, cooling, and sealing. When the linear actuator is engaged, air is drawn in through the two top mounted inlet air filters. A combination of compressed air and oil is sent through the outlet side of the air compressor. After exiting the compressor, sensors measure the air and oil mixture pressure and temperature. The combination compressed air and oil mix enters the middle of the tank. Oil is separated from the mixture, by the oil separator filter (**06,** ***Figure 7***). Air continues through the air outlet ball valve, located on top of the tank, before travelling on throughout the remainder of the main air system. Oil is trapped by the oil separator and stays in tank. Some of the oil stays suspended in the bottom of the oil separator filter. To clear the remaining oil out of the bottom of the oil separator filter, a scavenge line pulls the oil out of the side of the tank. The scavenged oil passes through a scavenge filter (**04,** ***Figure 7***) before being sucked into the air compressor, where it is combined with cooled and filtered oil.

Figure 7: Air Compressor Oil Filters



01 - Power Unit Assembly

02 - Compressor Oil Filter

03 - Section View Between the Air Compressor and Drill Mast

04 - Scavenge Filter

Oil filters associated with the main air compressor are:

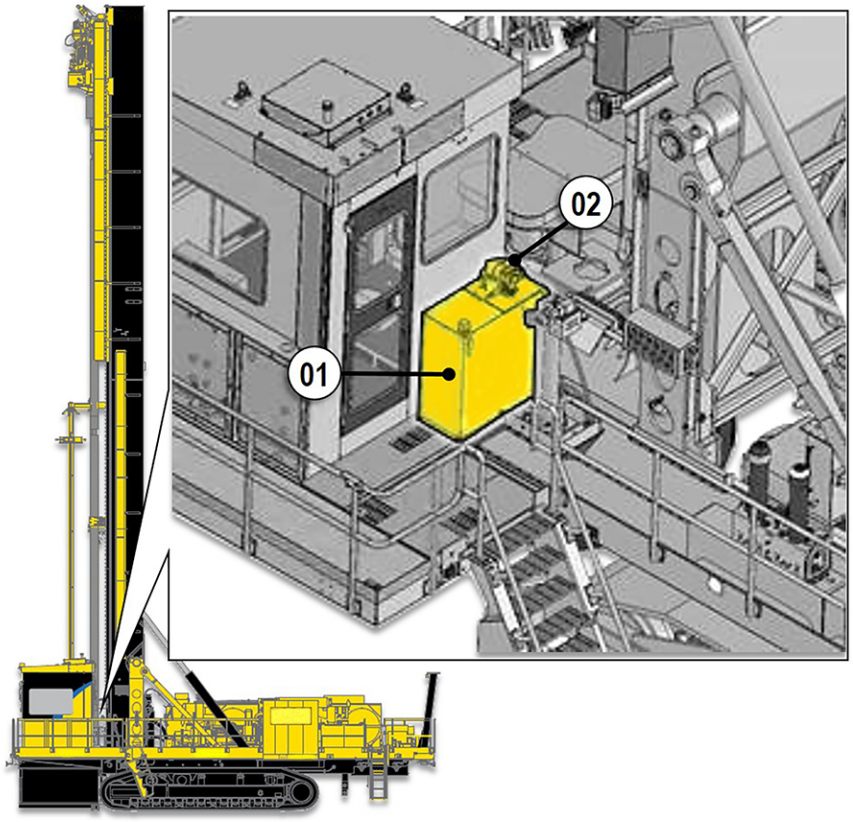
- The compressor oil filter (**02,** ***Figure 7***) mounted on the side of the air compressor. It is a replaceable-element filter that filters the majority of the oil entering the compressor from the oil tank. Refer to the *Preventative Maintenance* system manual to check or replace the filter elements.
- The oil separator filter (**06,** ***Figure 6***) is an integral part of the compressor oil tank. It removes the oil vapor from the outgoing pressurized air. Refer to the *Main Air* system manual to check or replace the oil separator filter.
- The scavenger oil filter (**04,** ***Figure 7***), is a spin-on filter that filters oil collected in the bottom of the tank mounted, oil separator filter. The oil is drawn out from the separator filter during compressor operation. Refer to the *Preventative Maintenance* system manual to replace the oil scavenger filter.

Optional Bit Lubricant

Refer to ***Figure 8*** **: Optional Bit Lubricant Tank and Pump**.

The drill can/may be optioned with a bit lubricant injection system. The system will inject a specialty lubricant, that during drilling operations, reduces friction and wear of the drill bit. The lubricant tank (**01,** ***Figure 8***) and pump (**02,** ***Figure 8***) are located adjacent to the operator's compartment front, right door. The lubricant tank contains a low level indicator sensor. When the lubricant capacity is low, a message will be displayed on the operator's touch screen.

Figure 8: Optional Bit Lubricant Tank and Pump



01 - Bit Lubricant Tank **02 - Bit Lubricant Pump**

The specific bit lubricant is determined by recommendations from the drill bit manufacture. The tank has a capacity of 60 gallons (227 L). Refill as use and need dictates.

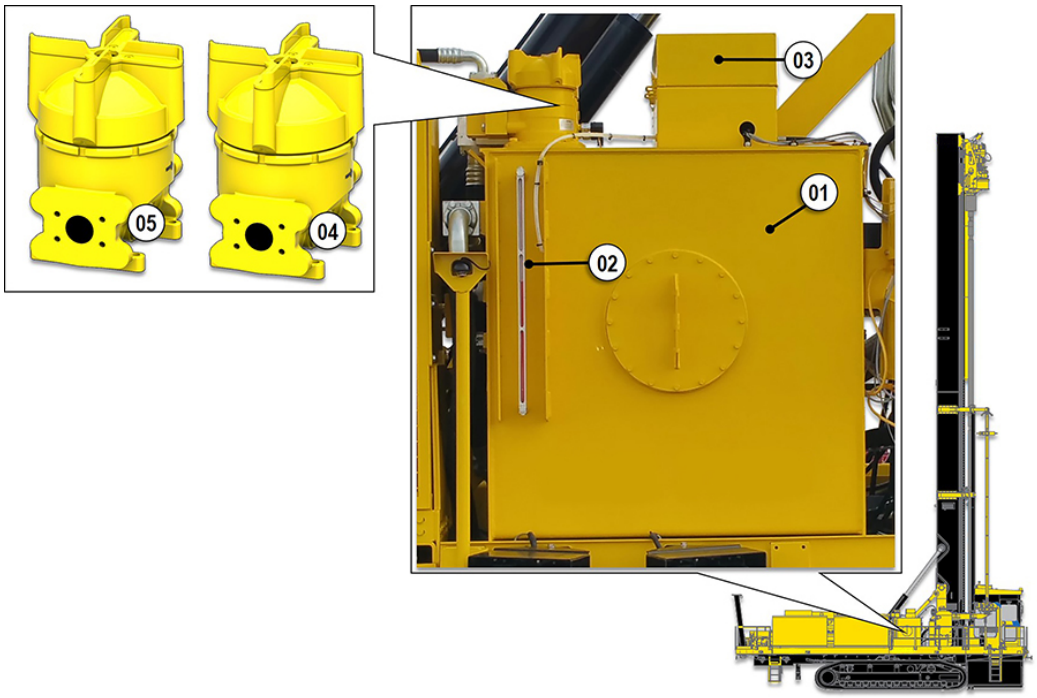
Hydraulic Tank

Refer to ***Figure 9*** **: Hydraulic Tank Components**, ***Figure 10*** **: Hydraulic Tank, Top Enclosure**, and ***Figure 11*** **: Hydraulic Tank Schematic (Typical)**.

Hydraulic oil is used by the hydraulic systems to provide power and lubrication. The oil is stored in the hydraulic tank which is located on the left side of the machine.

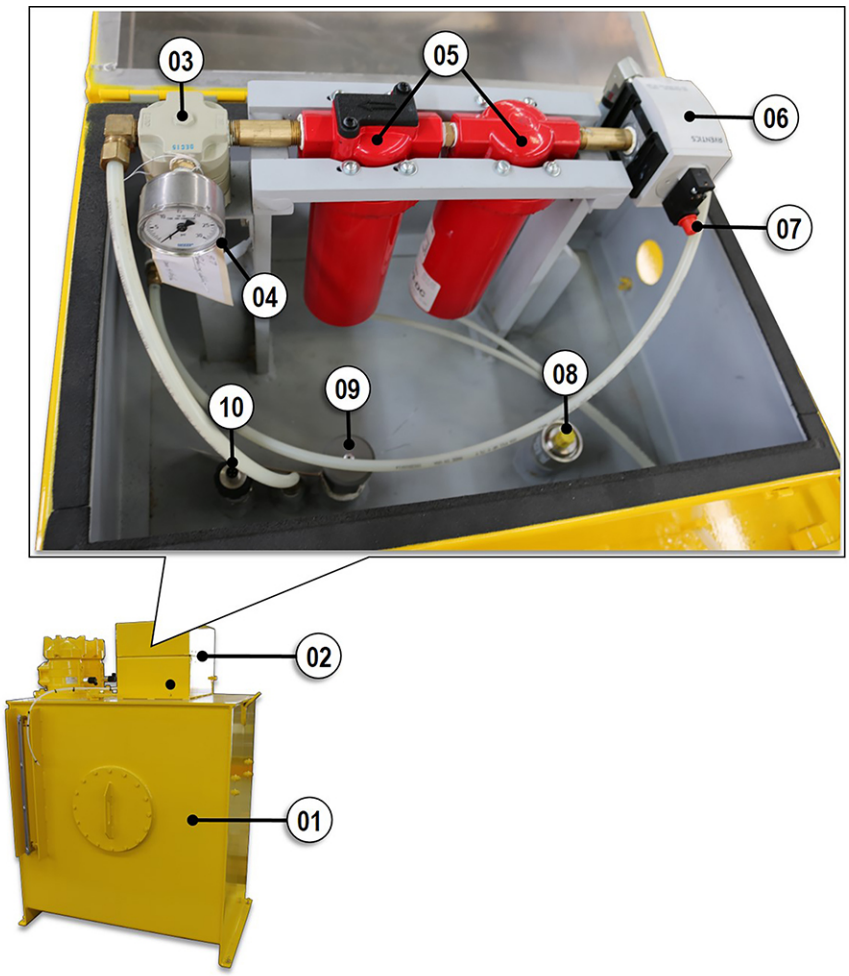
The hydraulic system uses ISO VG 32 or an equivalent hydraulic oil. Check the sight gauge at the beginning of each shift or after 8 hours of operation and add oil as necessary.

Figure 9: Hydraulic Tank Components



01 - Hydraulic Tank
02 - Sight Glass
03 - Tank Top Enclosure
04 - Kidney Loop Filter (FL2)
05 - Return Filter (FL1)

Figure 10: Hydraulic Tank, Top Enclosure



01 - Hydraulic Tank Assembly
02 - Tank Top Enclosure
03 - Reducing Valve
04 - Pressure Gauge
05 - 2 Stage Air Filter
06 - Shut-Off Valve
07 - Air Muffler
08 - Level Transducer
09 - Relief Valve
10 - 50 PSI (3.45 Bar) Pressure Transducer

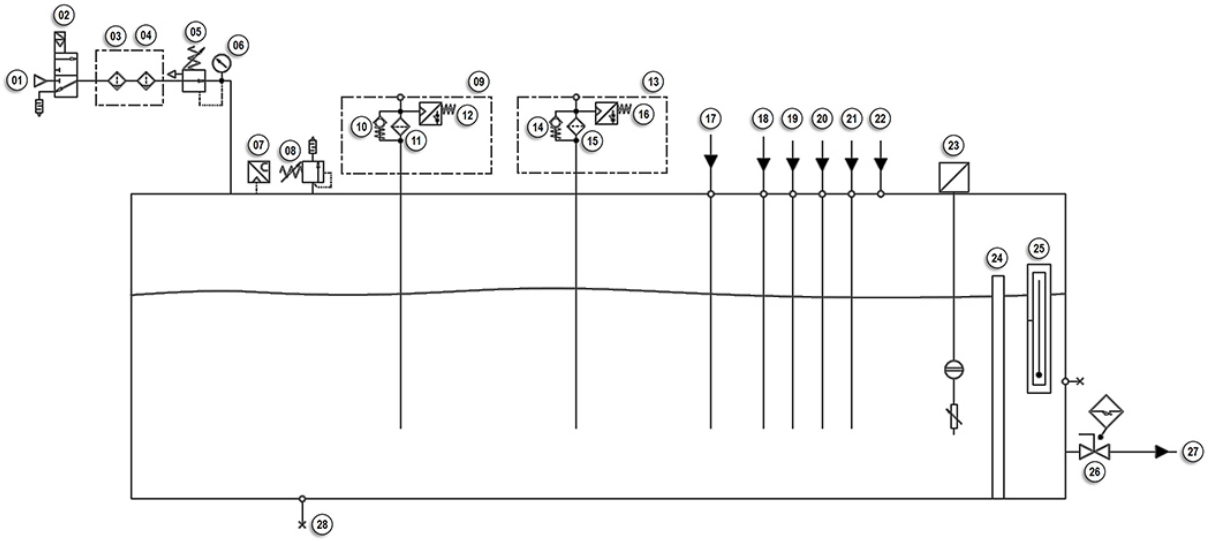
Refer to the *Preventative Maintenance* system manual for inspection intervals and service procedures for the return filters and breather. Change the filters and the breathers when indicated.

Drain, flush, and refill the hydraulic system as specified in or as indicated by oil analysis.

NOTE: The stated capacity of the hydraulic tank is 300 gallons (1,136 L); however, the placard next to the sight gauge is the final determiner of maximum and minimum oil levels, depending on the physical condition of the drill (mast up or down, levelling jacks extended or retracted).

NOTE: It is recommended that a sample of oil be drawn from the hydraulic tank once a month, for the first year of operation. After the first year of operation, the interval for sampling can be increased to quarterly. This sample should be about 2 quarts (2 L) and should be taken when the oil is warmed through normal operation. The sample should be analyzed by a qualified lubrication specialist to determine whether it is suitable for continued use. The interval between oil changes may be extended based upon the operating conditions and on the care used in handling oils and in keeping them clean during the handling process.

Figure 11: Hydraulic Tank Schematic (Typical)



01 - From Air Tank

02 - Pressurizing Solenoid

03 - Filter (3 µm)

04 - Filter (0.01 µm)

05 - Pressure Reducing Valve 8 PSI (0.55 Bar)

06 - Pressure Gauge

07 - Tank Pressure Transducer

08 - Relief Valve 10 PSI (0.69 Bar)

09 - Return Filter (FL1)

10 - Spring Loaded, Check Valve 87 PSI (6.0 Bar)

11 - Filter Element (10 µm)

12 - 29 PSI (2.0 Bar)

13 - Kidney Loop Filter (FL2)

14 - Spring Loaded, Check Valve 87 PSI (6.0 Bar)

15 - Filter Element (5 µm)

16 - 29 PSI (2.0 Bar)

17 - From Chassis, Carriage, & Propel Drains

18 - From Main Relief Valve Drains

19 - From Left Hand Hydrostat Case Drains

20 - From Right Hand Hydrostat Case Drains

21 - From Auxiliary Pump Case Drains & Hydrostat Pump Control Valve Drains

22 - From Mast Valve Drains

23 - Level/Temperature Transducer

24 - Baffle

25 - Sight Glass

26 - Plug Shut-Off Valve

27 - To Suction Header

28 - Drain

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Manual Lubrication Points

WARNING

Inadvertent machine movement can cause serious injury and/or death. Do not perform maintenance work on a machine without first disabling the operator controls. Follow lockout/tagout procedures to prevent inadvertent machine startup during maintenance.

Lube Points Without Fittings

Miscellaneous pins, levers, and linkages that move but are not considered wear surfaces should be lubricated by administering a few drops of motor oil. Refer to Life Cycle Management for periodicity.

Table 3: Miscellaneous Pins, Levers, and Linkages Lubricants

< 20°F (< -7°C)	+20° to 110°F (-7° to 43°C)	> 110°F (> 43°C)
SAE 10W	SAE 15W–40	SAE 30

Lube Points with Grease Fittings

Lubrication points that are provided with grease fittings use extreme pressure lithium grease, Material Specification 472. The NLGI grade of the grease must be appropriate for the prevailing ambient temperature range. 472C is the preferred grade for all temperature ranges; however, at lower ambient temperature ranges, 472A or 472B may be recommended by the lubrication supplier.

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Automatic Lubrication System

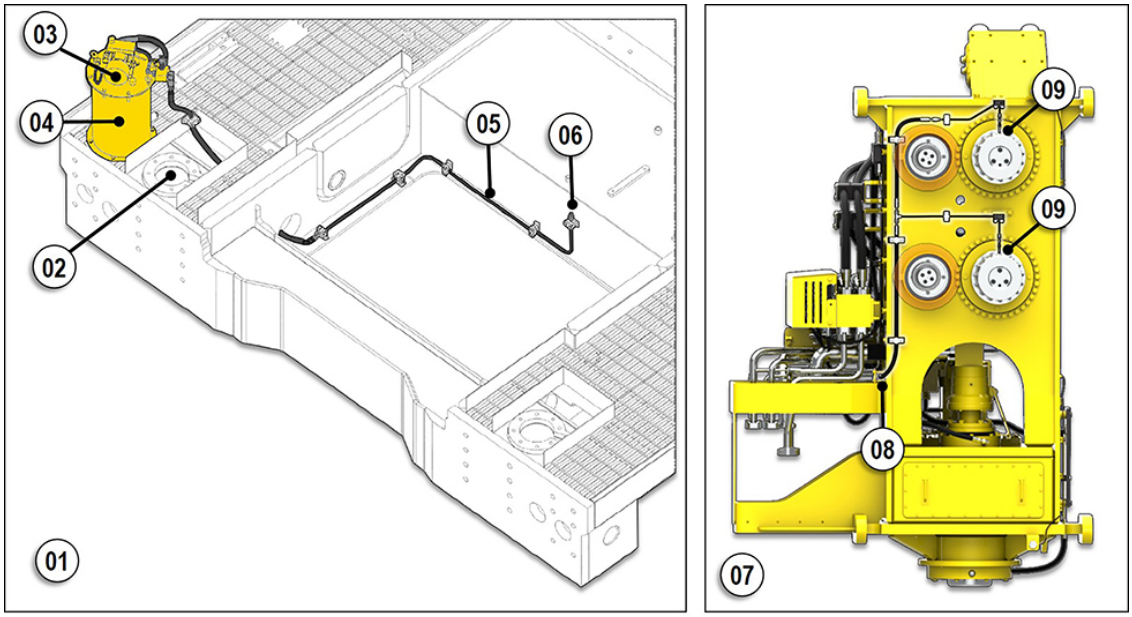
Refer to ***Figure 12*** **: Automatic Lubrication Components**.

The drill utilizes an automatic lubrication system that applies grease to the pulldown pinions on the rotary carriage.

The auto lube electrical pump (**03,** ***Figure 12***) and auto lube tank (**04,** ***Figure 12***) are located on the drill's deck (**01,** ***Figure 12***) next to the rear, left side leveling jack location (**02,** ***Figure 12***). When the pump is actuated grease is distributed through the chassis feed line (**05,** ***Figure 12***) where it connects to the mast supply line (**06,** ***Figure 12***). The mast supply line, is bundled with the group of hydraulic and electrical hoses that travel with the rotary carriage. The mast supply line connects to the carriage supply line (**08,** ***Figure 12***). The carriage supply line utilizes a combination of hard and flexible lines that are clamped and mounted onto the rotary carriage. Mounted directly above the pulldown pinions are the open gear lubricant pinion brushes (**09,** ***Figure 12***). Each brush uses steel bristles to apply grease and clean away debris as the pinion rotates. The pump is actuated to force grease through the system on a timer.

The automatic lubrication system supplies measured amounts of open gear lubricant, to the pinions brushes. The lubrication cycle will only run when the carriage is moving up, so the lube is pulled into the teeth of the rack and pinion as they mesh. The open gear lube (OGL) grade of the grease must be appropriate for the prevailing ambient temperature range. Check the lubricant level in the grease tank weekly. Refill the reservoir as necessary.

Figure 12: Automatic Lubrication Components



01 - Drill Deck (Frame)

02 - Rear, Left Side Leveling Jack Location

03 - Auto Lube Electrical Pump

04 - Auto Lube Tank

05 - Chassis Feed Line (Under Deck)

06 - To Mast Supply Line

07 - Rotary Carriage (Rear Side)

08 - Carriage Supply Line

09 - Open Gear Lubricant Pinion Brushes

Grease Pump Operation

Refer to ***Figure 13*** **: Grease Tank Assembly**.

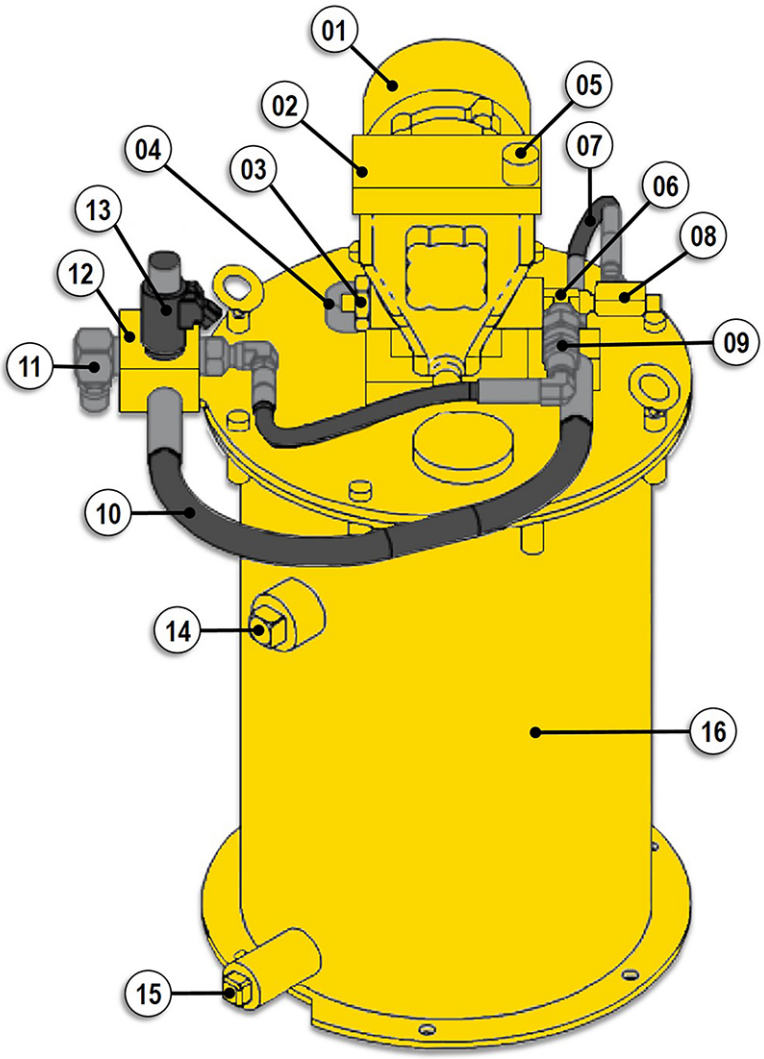
The automatic lubrication system is activated by signals from timers in the machine controller. Typically, the controller will start an automatic lubrication cycle every 60 minutes when the drill is in one of the drilling modes. The system can also be operated manually through the operator's touch screen.

When the cycle starts, the electric motor (**01,** ***Figure 13***) drives the grease pump (**02,** ***Figure 13***). On the suction stroke, the pump draws grease from the bottom of the tank (**16,** ***Figure 13***). Grease is drawn through the pump inlet filter, pickup tube, and pump internal inlet check valve until it fills the pump cavity. On the discharge stroke, grease in the pump cavity is sent through the internal pump outlet check valve, outlet hose (**07,** ***Figure 13***) and on to the grease filter (**12,** ***Figure 13***). The pump has a dual output (**03 & 06,** ***Figure 13***) options, but only one output is currently used (**06,** ***Figure 13***). Mounted adjacent to the pump outlet hose is the grease pump atmospheric relief valve (**08,** ***Figure 13***). If there is a problem in the system and the pump pressure reaches 4,000 PSI (276 bar), the relief valve will open and grease will vent to the atmosphere.

During any lube cycle, the grease vent solenoid valve (**13,** ***Figure 13***) is closed. This prevents grease in the grease filter manifold (**12,** ***Figure 13***) from flowing through the vent valve and back to the tank (**10,** ***Figure 13***). Instead grease is directed into the manifold and out to the chassis feed line (**11,** ***Figure 13***). At the conclusion of lubrication cycle, the grease vent solenoid opens to relieve pressure in the system.

The tank has an approximate capacity of 8 to 10 gallons (30.3 to 37.9 L). When the grease level is low, the machine controller will display a message on the operator's touch screen. Lubricant is added to the tank via the check/fill plug (**14,** ***Figure 13***).

Figure 13: Grease Tank Assembly



01 - Electric Motor
02 - Grease Pump
03 - Tank Breather
04 - Pump Outlet (Not Used)
05 - Pump Housing Inspection Cap/Pressure Gauge Port
06 - Tank to Pump Hose
07 - Pump Outlet
08 - Grease Pump Atmospheric Relief Valve
09 - Pump to Filter Hose
10 - Return to Tank Hose
11 - To Chassis Feed Line
12 - Grease Filter Manifold
13 - Grease Vent Solenoid
14 - Check/Fill Plug
15 - Drain Plug
16 - Grease Tank

Automatic Lubrication System Components

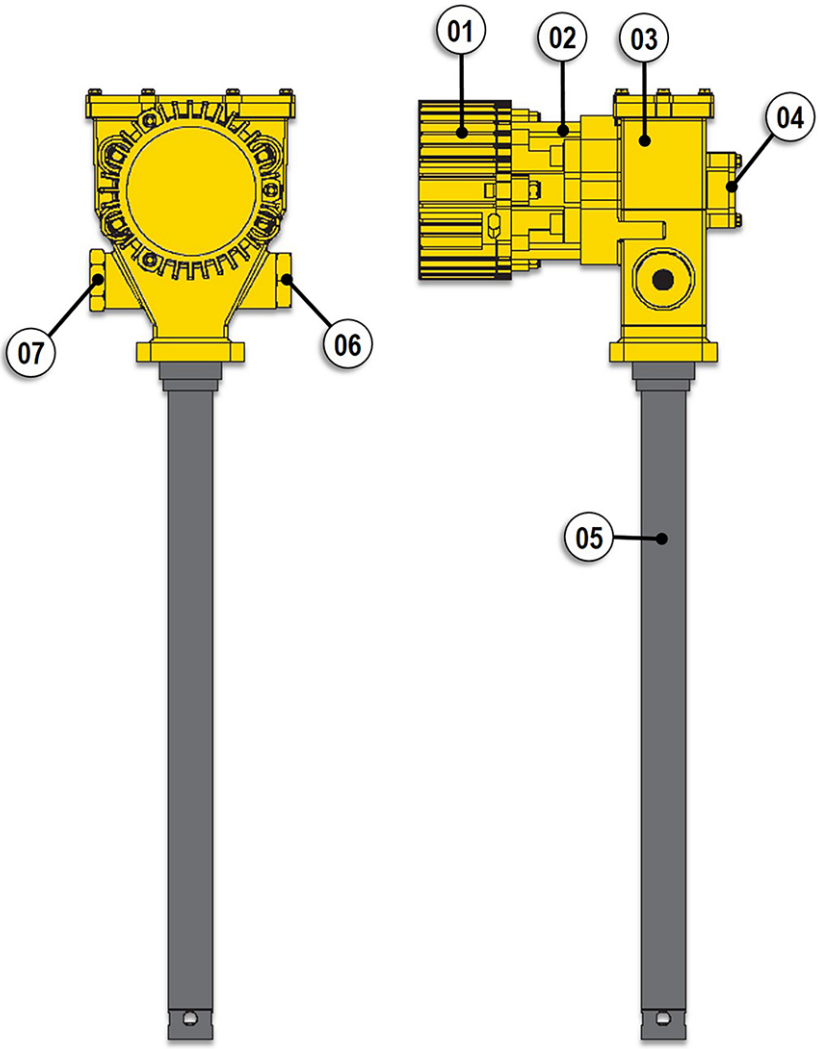
Grease Pump with Electric Motor

Refer to ***Figure 14*** **: Grease Pump**.

The grease pump is a rotary electric pump that utilizes a 24 volt DC motor and a single stage planetary drive.

The electric motor (**01,** ***Figure 14***) spins an eccentric shaft which translates rotational energy into reciprocating motion. The pump cylinder reciprocates inside of the pickup tube housing (**05,** ***Figure 14***). The cylinder draws grease from the bottom of the tank, up through the pickup tube housing. The pump is double acting and creates grease output on both up and down strokes of the cylinder. On the down stroke, the pump cylinder extends into the grease. Through a combination of both physical displacement of the cylinder and the vacuum created within the volume of material, grease is drawn in through the bottom. Simultaneously grease is discharged through the outlet of the pump. The volume of grease on intake, is twice what is output during one cycle of the pump. On upstroke, the inlet check is closed and 1/2 of the grease taken in during the previous stroke is pushed though the outlet check and discharged.

Figure 14: Grease Pump



01 - 24 Volt DC Electric Motor
02 - Gearbox Housing
03 - Pump Housing
04 - Bearing Cover
05 - Pickup Tube Housing
06 - Pump Outlet
07 - Pump Outlet (Not Used)

Removal

Before You Begin

An appropriate lifting device, such as the *optional* deck crane or other external lifting devices is required for removal of the grease pump and motor assembly.

⚠ WARNING

Hazardous voltage can cause burns, injury, or death. Disconnect, lock open, and tag the power source which feeds this device to prevent power from being applied while inspection and repairs are being performed. Before beginning repairs, try the operational controls to verify that the intended power source is disconnected.

⚠ CAUTION

High-pressure oil or grease can spray and penetrate skin or eyes causing severe injury and/or death. Use extreme caution when working around operating lubrication system and wear appropriate face and body protective devices. Shut down, lock out, and tag the machine before performing inspection, service, and maintenance of the lubrication system. Obtain medical aid immediately for lube spray into eyes or penetration into the skin. Be sure that the hydraulic and air systems are not pressurized before loosening or removing any connections or parts for maintenance.

⚠ WARNING

Dropping or mishandling of heavy drill parts can cause severe injury and/or death. Always move heavy components using the auxiliary winch, or suitable lifting device, and slings for removal and installation. Provide support for components, which may release or move any during maintenance.

Step 1: The machine must be locked out and tagged out at both the master battery and master starter lockouts. This ensures power will not be inadvertently applied, while service is being performed.

Step 2: Disconnect and tag the power connection that plugs into the side of electrical motor (on the rear of the grease pump). Note: Both red and black power connections for the electric motor are wired into the connector plug.

Step 3: Disconnect the output side fitting assembly with the grease output to filter hose and grease pump atmospheric relief valve.

Step 4: Secure an appropriate lifting device around the grease pump and motor assembly.

Step 5: Remove the four hex head mounting bolts and washers that secure the grease pump and motor assembly to the grease tank.

Step 6: Using an appropriate lifting device, lift the grease pump and motor assembly straight up. Note: Do not allow the pickup tube to contact the sides of the tank, while raising it. This will prevent any potential damage between the pickup tube, the assemblies contained inside it, and the tank.

⚠ WARNING

It will be necessary to guide the grease pump and motor assembly, while it is being supported by the optional deck crane or other external lifting device. Care should be taken to avoid entanglement between the grease pump and motor assembly, and any chains, straps, or other means used to support the load. Serious injury could occur in any entanglement situation, or when pinched between the load being supported and surrounding components.

Step 7: Do not set the grease pump and motor assembly directly on the deck or ground. Place cribbing under the grease pump and motor assembly to prevent it from being damaged.

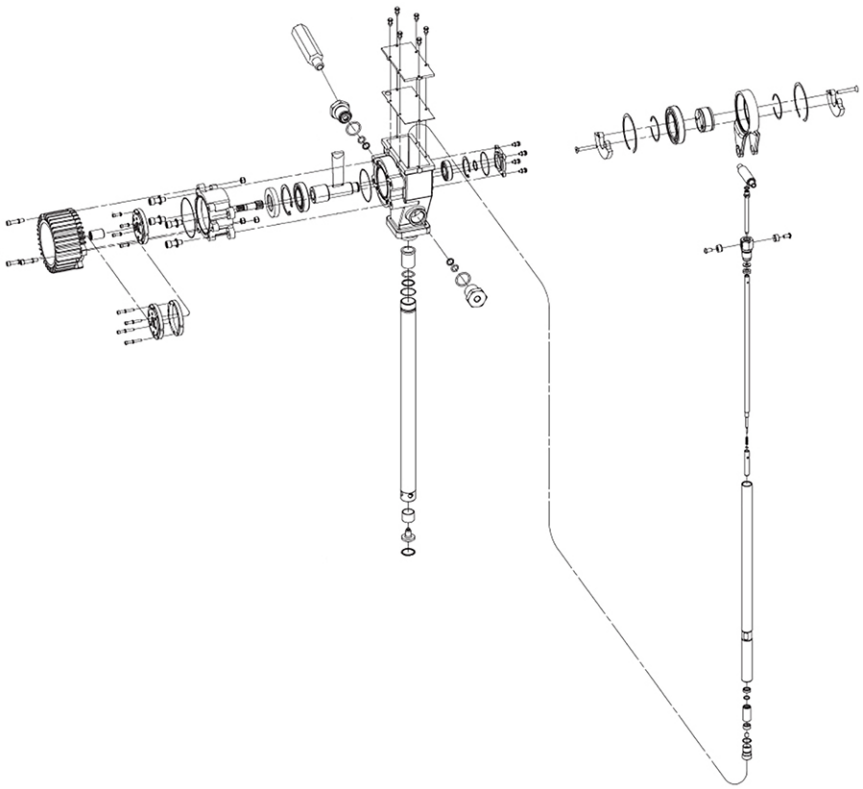
Cleaning, Inspection, & Repair

Refer to ***Figure 15*** **: Grease Pump Component Explosion**.

Refer to the *Miscellaneous Procedures* system manual for general mechanical maintenance procedures, and to the *Hydraulic System* system manual for general hydraulic component maintenance procedures.

Disassembly and repair of this pump requires special tools and methods. If the pump malfunctions, replace it and send the old unit to a qualified repair facility.

Figure 15: Grease Pump Component Explosion



NOTE: Refer to your electronic parts manual for an in depth illustration showing the pump breakdown and for replacement parts information.

Installation

Before You Begin

An appropriate lifting device, such as the *optional* deck crane or other external lifting devices is required for installation of the grease pump and motor assembly.

⚠ WARNING

Hazardous voltage can cause burns, injury, or death. Disconnect, lock open, and tag the power source which feeds this device to prevent power from being applied while inspection and repairs are being performed. Before beginning repairs, try the operational controls to verify that the intended power source is disconnected.

⚠ CAUTION

High-pressure oil or grease can spray and penetrate skin or eyes causing severe injury and/or death. Use extreme caution when working around operating lubrication system and wear appropriate face and body protective devices. Shut down, lock out, and tag the machine before performing inspection, service, and maintenance of the lubrication system. Obtain medical aid immediately for lube spray into eyes or penetration into the skin. Be sure that the hydraulic and air systems are not pressurized before loosening or removing any connections or parts for maintenance.

⚠ WARNING

Dropping or mishandling of heavy drill parts can cause severe injury and/or death. Always move heavy components using the auxiliary winch, or suitable lifting device, and slings for removal and installation. Provide support for components, which may release or move any during maintenance.

Step 1: Secure an appropriate lifting device around the grease pump and motor assembly.

Step 2: Using an appropriate lifting device, lift the grease pump and motor assembly straight down onto the grease tank. Align the four bolt holes in the pump assembly with the corresponding holes in the grease tank. **Note:** Do not allow the pickup tube to contact the sides of the tank, while lowering it. This will prevent any potential damage between the pickup tube, the assemblies contained inside it, and the tank.

⚠ WARNING

It will be necessary to guide the grease pump and motor assembly, while it is being supported by the optional deck crane or other external lifting device. Care should be taken to avoid entanglement between the grease pump and motor assembly, and any chains, straps, or other means used to support the load. Serious injury could occur in any entanglement situation, or when pinched between the load being supported and surrounding components.

Step 3: Install the four mounting hex head bolts and washers that secure the base of the grease pump to the tank. Torque the fasteners to 8 (lbf·ft) (11 N·m).

Step 4: Connect the output side fitting assembly (with the grease output to filter hose and grease pump atmospheric relief valve), to the grease pump.

Step 5: Connect the power connection to the side of the electrical motor (on the rear of the grease pump).

Step 6: Remove the master battery and master starter lockouts, and return the machine to service.

Step 7: From the operator's touch screen initiate a manual lubrication cycle and raise the rotary carriage. Verify the pump motor is running and distributing grease to the two pulldown pinions on the rotary carriage.

Adjustment

Refer to ***Figure 16*** **: Grease Pump Speed Adjustment**.

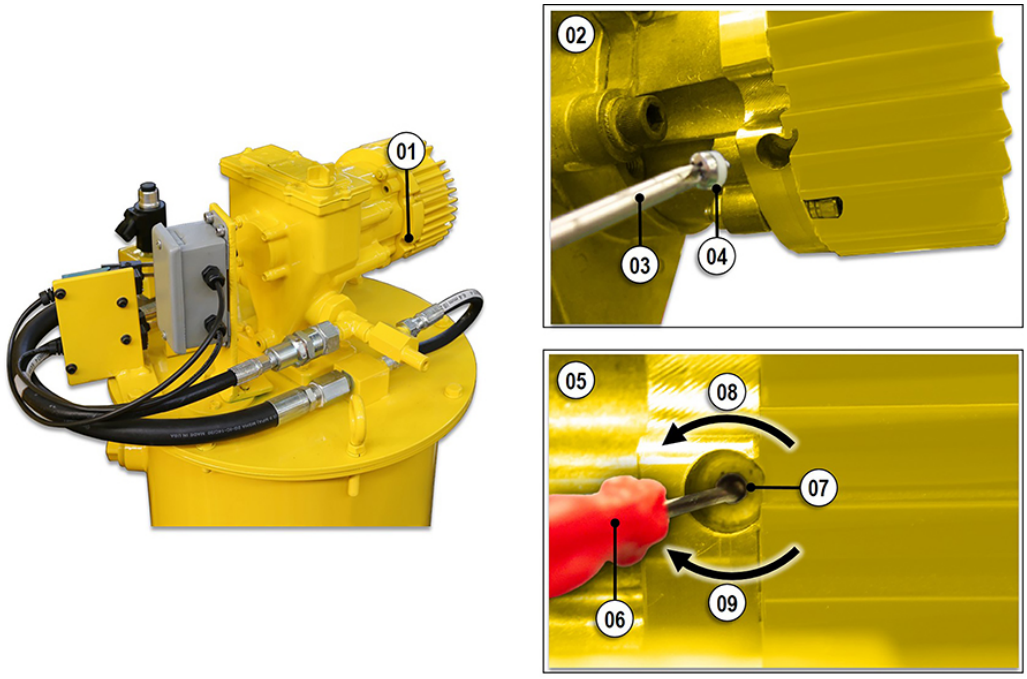
From the factory the grease pump is adjusted to distribute open gear lubricant through the pulldown pinion brushes every time the rotary carriage is lifted, after a lubrication cycle is initiated. A lubrication cycle can be initiated either automatically by the machine controller or manually by the operator.

The pump speed can be adjusted to disperse more or less lubricant. If operating conditions require switching to an OGL with a higher or lower viscosity, the pump can be adjusted to accommodate. Also as temperatures approach the upper or lower end of the operational range of the current OGL, it may require adjusting the pump speed.

As the temperature decrease the viscosity increases, and the lubricant becomes thicker and requires more energy to move. If ambient temperatures are near the lower end of the OGL temperature operating range, increasing the pump speed will push more lubricant through the system.

As the temperature increase the viscosity decrease, and the lubricant becomes thinner and requires less energy to move. If ambient temperatures are near the upper end of the OGL temperature operating range, decreasing the pump speed will push less lubricant through the system.

Figure 16: Grease Pump Speed Adjustment



01 - Grease Pump Speed Adjuster Screw Location

02 - Grease Pump Motor Underside

03 - Phillips Head Screw Driver

04 - Cover Screw and White Plastic Washer

05 - Grease Pump Motor Underside

06 - Flat Head Screw Driver

07 - Brass Pump Speed Adjuster Screw Location

08 - Clockwise Turn: Increase Pump Speed (RPM)

09 - Counter-Clockwise Turn: Decreases Pump Speed (RPM)

The pump can be adjusted while power is applied and when the pump is running.

To adjust the grease pump, proceed as follows:

Step 1: Locate the grease pump speed adjuster screw location (**01, *Figure 16***). The adjuster location is on the opposite side of the pump as the power connectors. The access hole is located on the grease pump motor underside (**02, *Figure 16***).

Step 2: Using a Phillips head screw driver (**03, *Figure 16***), remove the cover screw and white plastic washer (**04, *Figure 16***).

Step 3: Insert a flat head screw driver (**06, *Figure 16***) into the brass pump speed adjuster screw location (**07, *Figure 16***). **Note:** The flat head screw driver needs to have a tip width of 0.1 inches (2.54 mm) and a tip thickness of 0.025 inches (0.635 mm).

Step 4: To increase the speed of the pump (RPM) turn the adjuster screw clockwise (**08, *Figure 16***).

Step 5: To decrease the speed of the pump (RPM) turn the adjuster screw counter-clockwise (**09, *Figure 16***).

Step 6: Run a manual lubrication cycle from the operator's touch screen and raise the rotary carriage. Verify that an appropriate amount of OGL was applied to the pulldown pinions.

Step 7: Once the pump is applying the correct amount of lubricant for the conditions, reinstall the cover screw and white plastic washer (**04,** ***Figure 16***) into the grease pump speed adjuster screw location (**01,** ***Figure 16***).

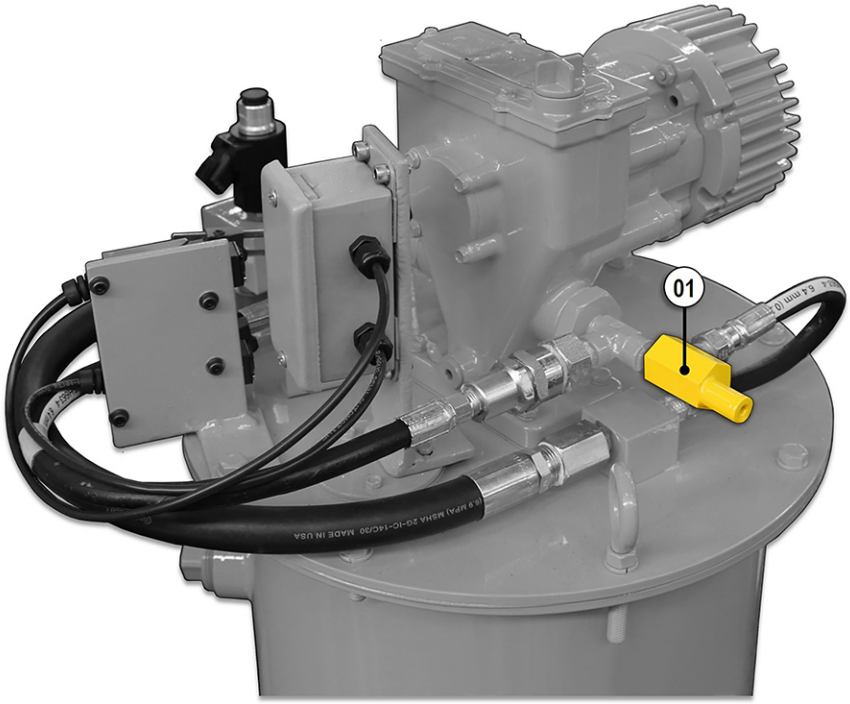
Grease Pump Atmospheric Relief Valve

Refer to ***Figure 17*** **: Grease Pump Atmospheric Relief Valve**.

Before You Begin
The grease pump atmospheric relief valve protects against an over pressure event occurring between the tank and pump. In the event that the pump pressure reaches 4,000 PSI (276 bar), the relief valve will open and grease will vent to the atmosphere. The relief valve is positioned to expel grease over the left side railing of the machine.

The grease pump atmospheric relief valve is not adjustable, and cannot be repaired by the user.

Figure 17: Grease Pump Atmospheric Relief Valve



01 - Grease Pump Atmospheric Relief Valve

WARNING

Inadvertent machine movement can cause serious injury and/or death. Do not perform maintenance work on a machine without first disabling the operator controls. Follow lockout/tagout procedures to prevent inadvertent machine startup during maintenance.

To replace the valve, proceed as follows.

Step 1: The machine must be locked out and tagged out at both the master battery and master starter lockouts.

Step 2: Be sure that no pressure exists in any of the grease system circuits.

⚠ CAUTION

High-pressure oil or grease can spray and penetrate skin or eyes causing severe injury and/or death. Use extreme caution when working around operating lubrication system and wear appropriate face and body protective devices. Shut down, lock out, and tag the machine before performing inspection, service, and maintenance of the lubrication system. Obtain medical aid immediately for lube spray into eyes or penetration into the skin. Be sure that the hydraulic and air systems are not pressurized before loosening or removing any connections or parts for maintenance.

Step 3: Unscrew the valve from the pump outlet.

Step 4: Install a new valve. Be sure that the connection is tight.

Grease Tank Level Limit Switches

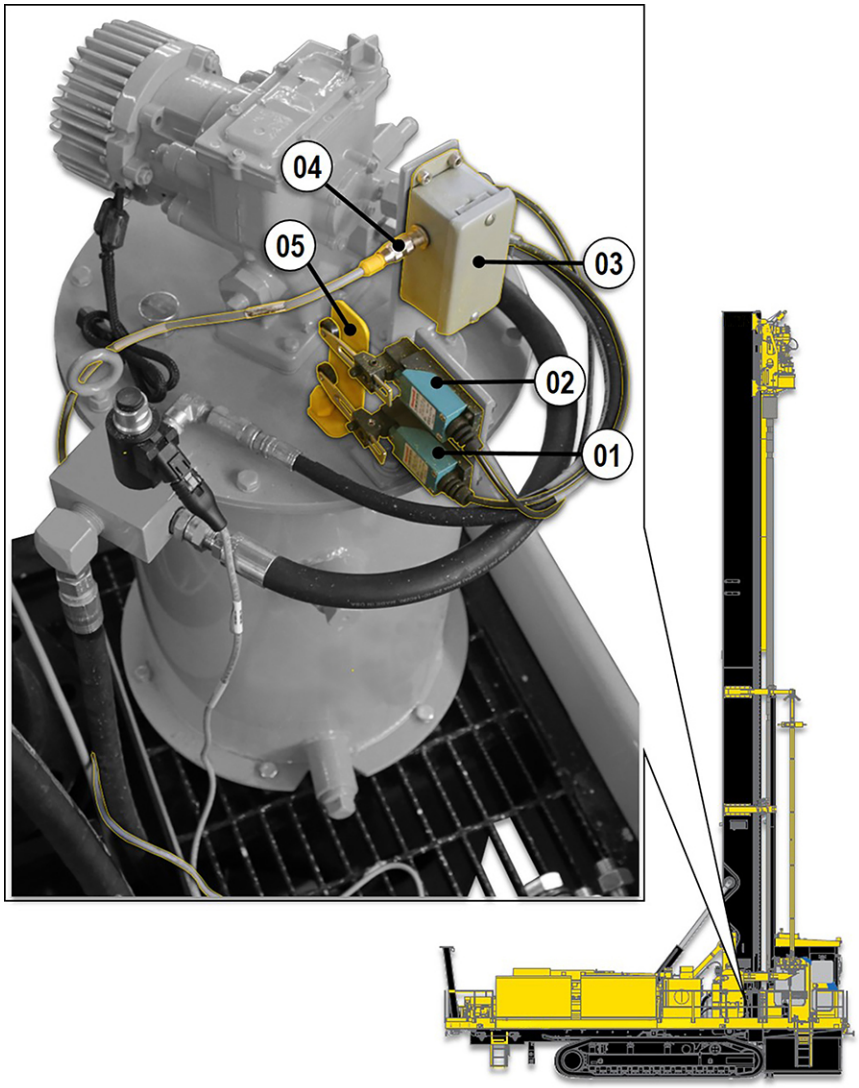
Refer to ***Figure 18*** **: Grease Tank Level Limit Switches**.

The grease system uses two limit switches, to determine the grease level in the tank. A tank follower bracket (**05,** ***Figure 18***) behind the roller levers is attached to a follower rod that connects to a follower inside the grease tank. When the tank is full the rod is pushed up by the follower, when the tank is low the rod is pulled down. When pushed up, the high level grease limit switch (**02,** ***Figure 18***) is engaged. When pushed down, the lower level grease limit switch (**01,** ***Figure 18***) is engaged.

When either switch is engaged, information is transmitted through the communication junction box (**03,** ***Figure 18***) and on to the machine controller via the communication line (**04,** ***Figure 18***)

When the grease tank level is low, a message will be displayed on the operator's touch screen.

Figure 18: Grease Tank Level Limit Switches



01 - Low Level Grease Limit Switch

02 - High Level Grease Limit Switch

03 - Communication Junction Box

04 - Communication Line

05 - Tank Follower Bracket

Removal

Before You Begin

WARNING

Hazardous voltage can cause burns, injury, or death. Disconnect, lock open, and tag the power source which feeds this device to prevent power from being applied while inspection and repairs are being performed. Before beginning repairs, try the operational controls to verify that the intended power source is disconnected.

Step 1: The machine must be locked out and tagged out at both the master battery and master starter lockouts. This ensures power will not be inadvertently applied, while service is being performed.

Step 2: Disconnect and tag the wiring from the limit switch to the communications junction box.

Step 3: From the backside of the limit switch metal bracket remove the first M5 socket head cap screw and washer. Hold onto the switch, to prevent the switch from falling free while removing the remaining M5 socket head cap screw and washer.

Step 4: Remove the limit switch.

Repair

Refer to the *Miscellaneous Procedures* system manual for general mechanical maintenance procedures, and to the electrical *Control System* system manual for general electrical component maintenance procedures. Replace the limit switches if faulty.

Installation

Step 1: Install the pressure switch onto the bracket. Hold it in position, while aligning the mounting holes on the switch, with the corresponding holes on the bracket.

Step 2: Insert the two M5 socket head cap screws and washers from the reverse of the bracket, into the body of the limit switch.

Step 3: Connect the wiring from the communication junction box to the limit switch

Step 4: Remove the master battery and master starter lockouts, and return the machine to service.

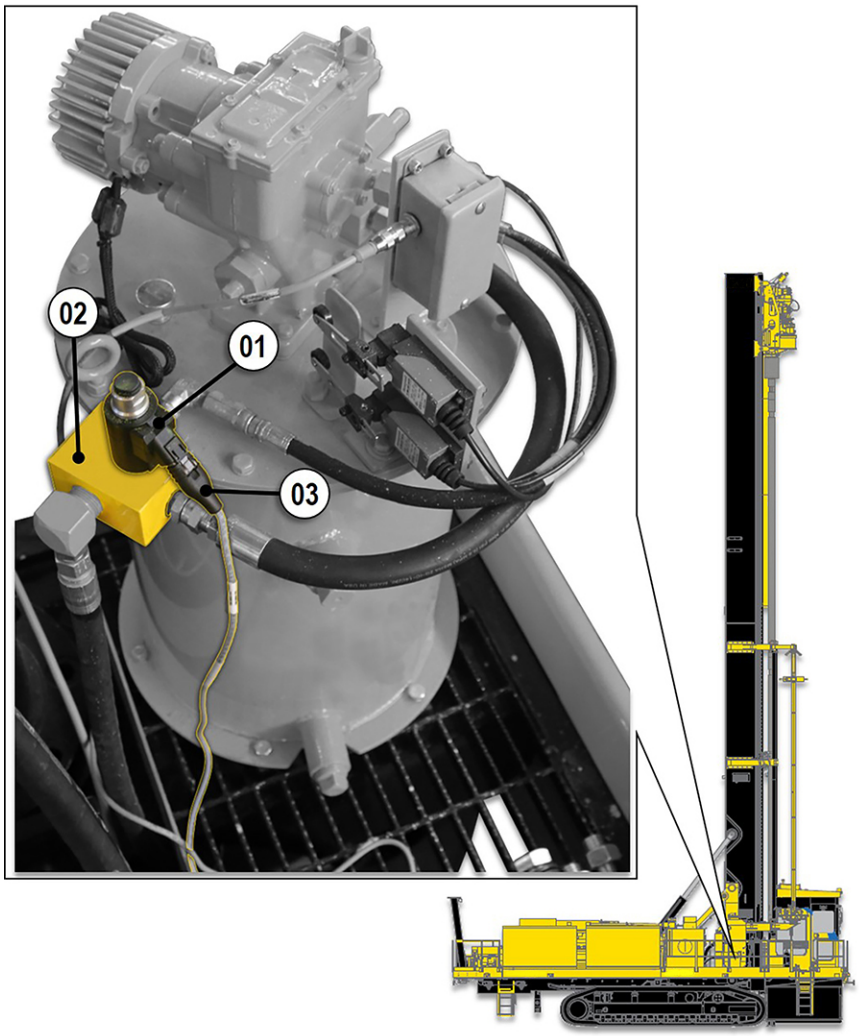
Grease Vent Solenoid Valve

Refer to ***Figure 19*** **: Grease Vent Solenoid Valve**.

The automatic lubrication system uses one grease vent solenoid valve.

The grease vent solenoid valve (**01,** ***Figure 19***) is located on top of the grease filter body (**02,** ***Figure 19***). It is used to depressurize the grease system after a lube cycle. The solenoid is actuated by the machine controller via the communication line (**03,** ***Figure 19***).

Figure 19: Grease Vent Solenoid Valve



01 - Grease Vent Solenoid 02 - Grease Filter Body 03 - Communication Line

Removal

Before You Begin

⚠ CAUTION

High-pressure oil or grease can spray and penetrate skin or eyes causing severe injury and/or death. Use extreme caution when working around operating lubrication system and wear appropriate face and body protective devices. Shut down, lock out, and tag the machine before performing inspection, service, and maintenance of the lubrication system. Obtain medical aid immediately for lube spray into eyes or penetration into the skin. Be sure that the hydraulic and air systems are not pressurized before loosening or removing any connections or parts for maintenance.

Step 1: The machine must be locked out and tagged out at both the master battery and master starter lockouts. This ensures power will not be inadvertently applied, while service is being performed.

Step 2: Tag and remove the electrical connector from the solenoid.

Step 3: If the solenoid is not actuating the valve, remove the screws on top of the valve to detach the solenoid. Inspect the valve for signs of malfunction. If the valve is damaged, replace the entire solenoid valve.

Step 4: Check operation of the solenoid with a 24VDC power source. If faulty, replace the solenoid. Check operation of the valve after installation.

Repair

Refer to the *Miscellaneous Procedures* system manual for general mechanical maintenance procedures, and to the *Hydraulic System* system manual for general hydraulic component maintenance procedures. Repair of the solenoid valve is limited to the replacement of worn or damaged parts.

Installation

Step 1: Thread the grease vent solenoid valve into the grease filter body. Do not over tighten the solenoid during installation.

Step 2: Plug in the communication line connector into the grease vent solenoid valve body.

Step 3: Return the machine to service.

Step 4: Run a manual lubrication cycle via the operator's touch screen and raise the rotary carriage. Have an assistant stand on deck by the grease vent solenoid and verify at the end of the lubrication cycle that the solenoid actuates.

Bleeding the System

During component replacement procedures, or as a means of resolving a lubrication fault, it may become necessary to remove air from the supply or feeder lines. Air can be introduced into the lubrication system for several reasons:

- Because lubricant levels in the reservoir become too low before refilling.
- Because the lubrication pump is improperly primed.
- During component replacement.

The following procedures are provided for bleeding air from the automatic lubrication system.

⚠ WARNING

Inadvertent movement of the drill during the following procedures can result in injury and/or death. Be sure that an operator is stationed at the controls to prevent inadvertent operation of any drill components.

To purge air from system:

Step 1**:** Fill the reservoir with grease until it reaches the fill/check plug.

Step 2**:** Manually engage a lubrication cycle from the operator's touch screen and raise the rotary carriage. Visually check to see if any lubricant was dispensed.

Step 3: Repeat Step 2, until lubricant is seen coming out of the OGL brushes and onto the pulldown pinions.

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Troubleshooting

Table 4: Troubleshooting Guide

Problem	Possible Cause	Remedy
Grease pump does not run	Circuit breaker off	Turn on the circuit breaker.
	Faulty grease pump	Repair or replace the grease pump.
Grease pump does not build pressure	Leak at hoses or connections	Check the condition of the hoses and tightness of connections. Replace faulty hoses. Tighten all connections.
	Pockets of air in system	Bleed the lube lines.
	Obstructed pump inlet	Clean the pump inlet and check valves as required. Drain and clean the tank interior to remove debris as required.
	Faulty vent valve	Repair or replace the valve.
	Faulty pump	Repair or replace the grease pump.
Grease pump operates but cycle does not complete	Faulty pressure switch	Repair or replace the pressure switch.
	Faulty vent valve	Clean, repair, or replace the valve.
Lack of grease at lube point	Leaking lines	Inspect the hose from the lube points for loose connections or ruptured hose. Correct deficiencies.
	Blocked line	If the unit is not working, disconnect the supply hose and flush at the fitting with a grease gun to clear the line. Connect the supply hose.
Inadequate grease at lube points	No grease supply	Check the grease tank and replenish as required.
	Incorrect viscosity	Check the grease weight. Grease may be too heavy for operating environment.
	Leaking lines	Inspect applicable lines for leakage. Correct deficiencies.
	Faulty grease pump	Repair or replace the grease pump.

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