COMPACT EQUIPMENT

Revised: 31 July 2025

ASSOCIATE SUPERINTENDENT CONTACT INFORMATION

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PURPOSE

The goal of the Compact Equipment Skills activity is to evaluate students' ability to perform tasks related to small gasoline and diesel engines with a horsepower rating of 30 or less. Participants will work with compact engines as well as the tools and equipment associated with them.

Students should be familiar with using precision measuring instruments, specialty tools for compact engines, general mechanics tools, and the principles of theory and repair related to compact engines.

GENERAL INFORMATION

The activity may involve problem-solving and calculations. A calculator is highly recommended.

Participants in this activity will be expected to work with compact engines so that the engines operate optimally. Students might be asked to complete an activity that includes one or more of the following skills.

POSSIBLE ACTIVITIES FOR THE 2025 EVENT

Note: Compact Equipment is defined here as being 30 horsepower or less.

- Select and use appropriate tools and instruments to disassemble and reassemble hydraulic systems accurately and precisely.
- Identify components of travel systems used in compact equipment.
- Identify manufacturer specifications (as found in operator's manuals).

Competencies

- Identify compact equipment travel components.
- Determine proper maintenance and service principles used in compact equipment.
- Apply knowledge of hydraulic systems as they relate to compact equipment.
- Identify components in a typical travel system.

Agriculture, Food and Natural Resources Content Standards

- CS.08.02.01.a. Use the appropriate procedures for the use and operation of specific tools and equipment.
- CS.08.02.01.b. Demonstrate safety precautions when using tools for a specific task around bystanders.
- PST.03.01 Troubleshoot, service, and repair components of internal combustion engines using manufacturers' guidelines.
- PST.03.01.01.a. Identify components and systems of internal combustion engines.
- PST.03.01.01.c. Evaluate service and repair needs for internal combustion engines using a variety of performance tests (e.g., manuals, computer-based diagnostics, etc.).
- PST.03.01.02.c. Inspect, analyze, and repair internal combustion engines used in AFNR power, structural, and technical systems.

Suggested Resources for Activity

In addition to the general references specified for the Agricultural Technology and Mechanical Systems CDE, the following references are suggested for the Compact Equipment Skill Activity. Note: Specific references are listed below, but others may be added at a later date:

Please review the general references for the Agricultural Technology and Mechanical Systems CDE (ATMS handbook can be found at FFA.org, https://ffa.box.com/v/2025-Ag-Tech-Mech-Sys-Handbook

- Koel, L., Mazur, G., Moniz, B. J, and Radcliff, B. (2019). *Agricultural Technical Systems and Mechanics* (2nd) Ed.
- Herren, R. V. (2010). *Agricultural Mechanics: Fundamentals & Applications, (6th or 7th ed.)* Clifton, Park NY: Delmar.
- Hancock, J.P., Edgar, D.W., Pate, M.L., Dyer, L.A., and Hoover, W.B. (2024). *Agricultural Mechanics and Technology Systems* (2nd Ed.).

Other Reference Material *Additional Manuals may be posted at a later date.*

https://www.cat.com/en_GB/articles/ci-articles/diy-service-and-maintenance-for-mini-excavators.html

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Introduction

Proper repair is important to the safe operation and the reliable operation of this machine. This document outlines basic recommended procedures. Some of the procedures require special tools, devices, or work methods.

Before you perform any repairs or before you perform any maintenance, read all safety information. Understand all safety information before you perform any repairs or before you perform any maintenance.

Safety information can be found in this document and the following documents for your machine:

- Operation and Maintenance Manual
- Testing and Adjusting Manual
- Disassembly and Assembly Manual
- Warning labels that are located on the machine and engine

If these hazard warnings are not heeded, bodily injury or death could occur to you or other persons.

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Basic Precautions

WARNING

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Always observe the list of basic precautions that follows:

Safety Messages

There are several specific safety messages on this machine. The exact location of the hazards and the description of the hazards are reviewed in this section. Please become familiarized with all safety messages.

Make sure that all of the safety messages are legible. Clean the safety messages or replace the safety messages if you cannot read the words. Replace the illustrations if the illustrations are not legible. When you clean the safety messages, use a cloth, water, and soap. Do not use solvent, gasoline, or other harsh chemicals to clean the safety messages. Solvents, gasoline, or harsh chemicals could loosen the adhesive that secures the safety messages. Loose adhesive will allow the safety messages to fall.

Replace any safety message that is damaged, or missing. If a safety message is attached to a part that is replaced, install a safety message on the replacement part. Any Caterpillar dealer can provide new safety messages.

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Protective Equipment

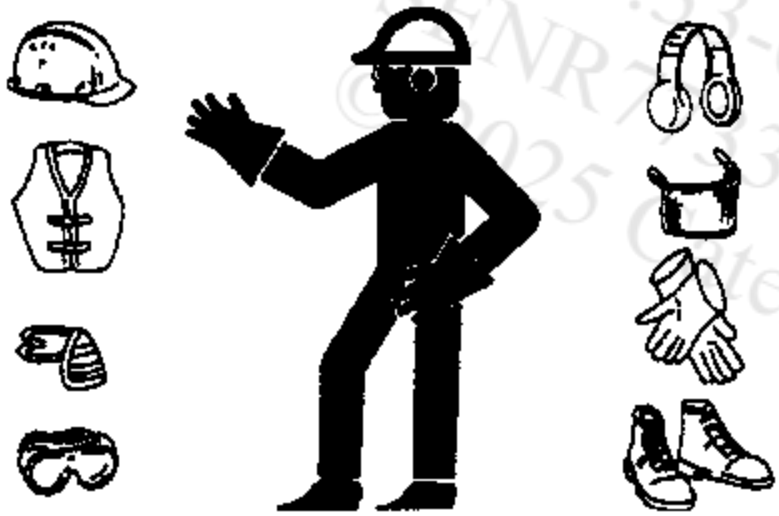

Illustration 1 g00702020

When you work around the machine, always wear protective equipment that is required by the job conditions. Protective equipment includes the items that follow: hard hat, protective glasses and protective shoes. In particular, wear protective glasses when you use a hammer or when you use a sledge hammer. When you weld use the appropriate protective equipment that is required by the job conditions. Protective equipment for welding includes the items that follow: gloves, welding hood, goggles and apron. Do not wear loose clothing or jewelry that can catch on parts of the machine.

Mounting and Dismounting

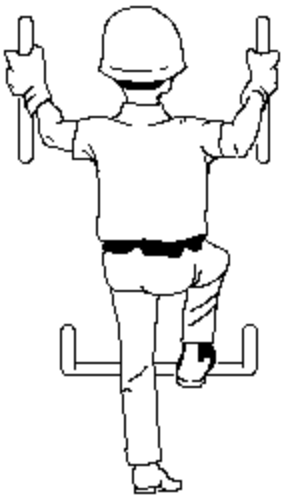

Illustration 2 g00037860

Use steps and handholds whenever you mount the machine. Use steps and handholds whenever you dismount the machine. Before you mount the machine, clean the step and the handholds. Inspect the step and handholds. Make all necessary repairs.

Face the machine whenever you mount the machine and whenever you dismount the machine. Maintain a three-point contact with the step and with handholds.

Note: Three-point contact can be two feet and one hand. Three-point contact can also be one foot and two hands.

Do not mount a moving machine. Do not dismount a moving machine. Never jump off the machine. Do not try to mount the machine when you carry tools or supplies. Do not try to dismount the machine when you are carrying tools or supplies. Use a hand line to pull equipment onto the platform. Do not use any controls as handholds when you enter the operator station or when you exit the operator station.

Lifting

If any component that weighs more than 23 kg (50 lb) is lifted, a hoist should be used. If any component is difficult to move due to the size, the grip, or any other difficulties, a hoist should be used.

Specifications for Cables, Chains, and Lifting Devices

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Use approved cables, chains, and lifting devices in order to lift components. Refer to the manufacturer's weight's in order to determine the application when you select the following items: cable, chain and lifting devices. When you lift a component, the lift angle is critical. Refer to the Illustration that follows in order to see the effect of the lift angle on the working load limit.

Note: The lifting devices that are shown in this publication are not Caterpillar parts.

Make sure that all chains, hooks, slings, and any other lifting devices are in good condition.

Ensure that the hooks are equipped with a safety latch. Do not place a side load on the lifting eyes during a lifting operation.

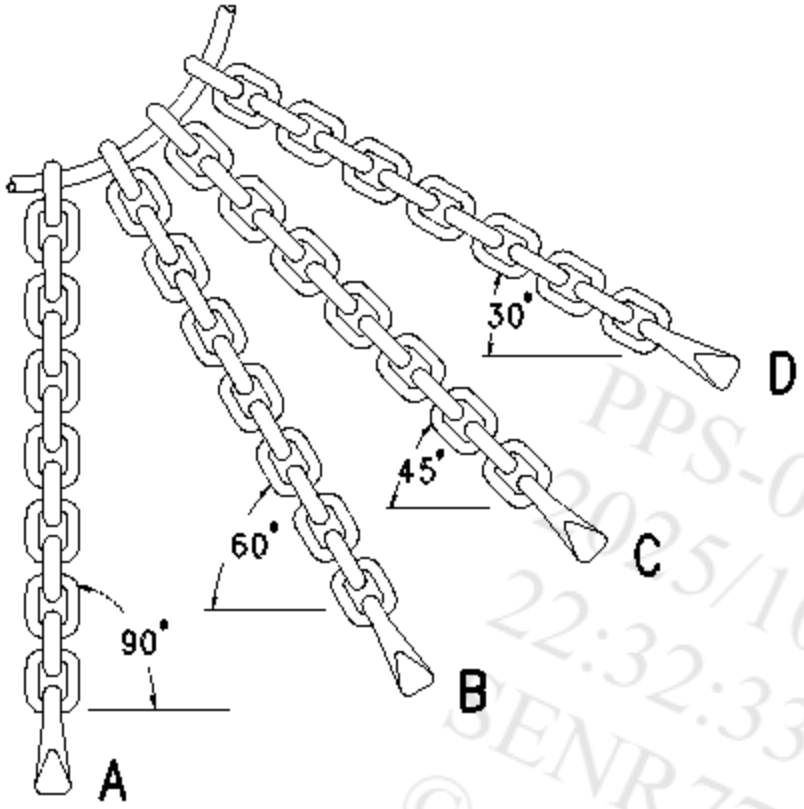

Illustration 3 g00629745

Lift angles for lifting slings.

(A) The load capacity is 100% of the working load limit for the sling.

(B) The load capacity is 86% of the working load limit for the sling.

(C) The load capacity is 70% of the working load limit for the sling.

(D) The load capacity is 50% of the working load limit for the sling.

Hot Fluids and Parts

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To avoid burns, be alert for hot parts on machines which have just been stopped and hot fluids in lines, tubes and compartments.

Be careful when you remove filler caps, breathers and plugs on the machine. Hold a rag over the cap or plug in order to prevent being sprayed by pressurized liquids. When the machine has just been stopped, the possibility of hot fluids is greater.

Corrosion Inhibitor

Corrosion inhibitor contains alkali. Avoid contact with the eyes. Do not allow corrosion inhibitor to contact the skin for extended periods of time. Avoid repeated contact with the skin. Do not drink corrosion inhibitor. In case of contact, immediately wash skin with soap and water. For contact with the eyes, flush the eyes with large amounts of water for at least 15 minutes. **Seek medical attention.**

Batteries

Do not smoke when an inspection of the battery electrolyte level is made. Never disconnect any charging unit circuit or battery circuit cable from the battery when the charging unit is operating. A spark can cause an explosion from the flammable vapor mixture of hydrogen and oxygen that is released from the electrolyte through the battery outlets. Do not allow battery electrolyte to make contact with the skin or with the eyes. Battery electrolyte is an acid. In case of contact with battery electrolyte, immediately wash the skin with soap and water. For contact with the eyes, flush the eyes with large amounts of water for at least 15 minutes. **Seek medical attention.**

Pressurized Items

Pressure can be trapped in a hydraulic system. Releasing trapped pressure can cause sudden machine movement or attachment movement. Use caution if you disconnect hydraulic lines or fittings. High pressure oil that is released can cause a hose to whip. High pressure oil that is released can cause oil to spray. Fluid penetration can cause serious injury and possible death.

Pressure can be trapped in the hydraulic circuit long after the engine has been stopped. The pressure can cause hydraulic fluid or items such as pipe plugs to escape rapidly if the pressure is not relieved correctly.

Do not remove any hydraulic components or parts until pressure has been relieved or personal injury may occur. Do not disassemble any hydraulic components or parts until pressure has been relieved or personal injury may occur. Refer to the Service Manual for any procedures that are required to relieve the hydraulic pressure.

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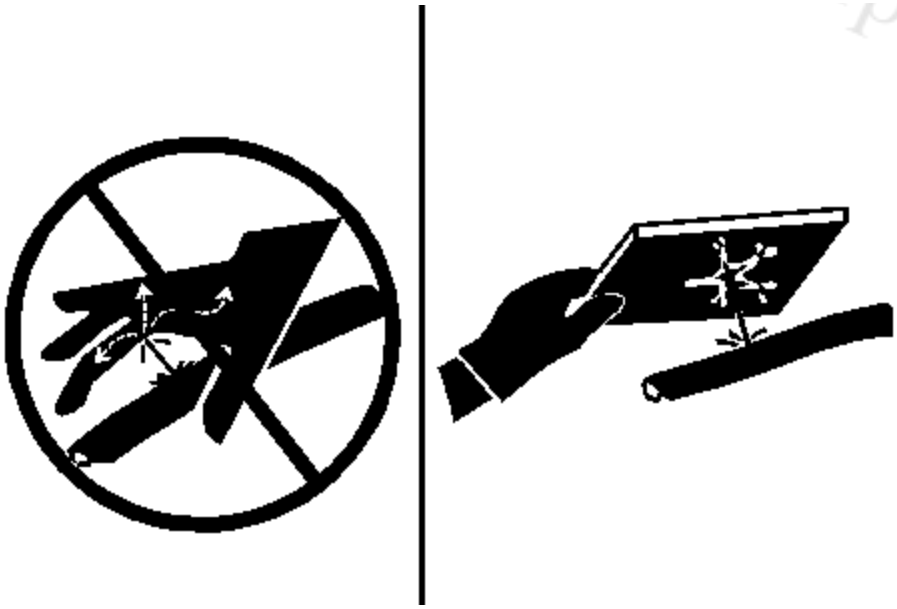

Illustration 4 g00687600

Always use a board or a piece of cardboard when you check for a leak. Leaking fluid under pressure can penetrate body tissue. Fluid penetration can cause serious injury and possible death. A pin hole leak can cause severe injury. If fluid is injected into your skin, you must get treatment immediately. Seek treatment from a doctor that is familiar with this type of injury.

Relieve all pressure in air, oil or water systems before any lines, fittings or related items are disconnected or removed. Always make sure that all raised components are blocked correctly. Be alert for possible pressure when you disconnect any device from a system that utilizes pressure.

Fuel lines that are damaged and fuel lines that are loose may leak. This could result in a fire if the fluid comes in contact with a source of ignition. Lubrication lines that are damaged and lubrication lines that are loose can leak. This could result in a fire if the fluid comes in contact with a source of ignition. Hydraulic lines, tubes, and hoses that are damaged can leak. This could result in a fire if the fluid comes in contact with a source of ignition. Hydraulic lines, tubes, and hoses that are loose can leak. This could result in a fire if the fluid comes in contact with a source of ignition. Do not bend or strike high pressure lines. Do not install lines which have been bent or damaged. Check lines, tubes and hoses carefully. Do not use your bare hand to check for leaks. If fluids are injected into your skin, you must get treatment immediately. Seek treatment from a doctor that is familiar with this type of injury.

Pressure air or water can cause personal injury. When pressure air or water is used for cleaning, wear a protective face shield, protective clothing, and protective shoes. The maximum air pressure for cleaning purposes must be below 205 kPa (30 psi). When you use a pressure washer, keep in mind that the nozzle pressures are very high. The nozzle pressures are frequently above 13790 kPa (2000 psi). Follow all of the recommended practices that are provided by the manufacturer of the pressure washer.

General Hazard Information

Illustration 5 g00104545

Attach a "Do Not Operate" warning tag or a similar warning tag to the start switch or to the controls before you service the equipment or before you repair the equipment. These warning tags (Special Instruction, SEHS7332) are available from your Caterpillar dealer.

When possible, make all repairs with the machine parked on a level, hard surface. The machine should be blocked in order to prevent the machine from rolling.

Know the width of your equipment in order to maintain proper clearance when you operate the equipment near fences or near boundary obstacles.

Be aware of high voltage power lines and power cables that are buried. If the machine comes in contact with these hazards, serious injury or death may occur from electrocution.

Make sure that all protective guards and all covers are secured in place on the equipment. If a guard, a cover, or a shield must be removed in order to perform the repair work, use extra caution.

Keep the equipment free from foreign material. Remove debris, oil, tools, and other items from the deck, from walkways, and from steps.

Secure all loose items such as lunch boxes, tools, and other items that are not a part of the equipment.

Know the appropriate work site hand signals and the personnel that are authorized to give the hand signals. Accept hand signals from one person only.

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Do not smoke when you service an air conditioner. Also, do not smoke if refrigerant gas may be present. Inhaling the fumes that are released from a flame that contacts air conditioner refrigerant can cause bodily harm or death. Inhaling gas from air conditioner refrigerant through a lighted cigarette can cause bodily harm or death.

Use all cleaning solutions with care. Report all necessary repairs.

Do not allow unauthorized personnel on the equipment.

Disconnect the battery and discharge any capacitors before starting work on the machine.

Do not work on any machine that is supported only by lift jacks or a hoist. Always use blocks or jack stands in order to support the machine before performing any service of disassembly.

Make sure that the work area around the machine is safe and be aware of any hazardous conditions that may exist. If an engine is started inside an enclosure, make sure that the engine's exhaust is properly vented.

Always use tools that are in good working condition. Ensure that you understand the proper use of the tools before performing any service work.

Replace all fasteners with the same part number. Do not use a lesser quality fastener if replacements are necessary.

You should be prepared to stop an engine that has been recently overhauled. You should also be prepared to stop the machine if the fuel system has been recently worked on. If the engine has not been assembled correctly or if the fuel setting is not adjusted properly , the engine can possibly overspeed. This may cause bodily injury, death or property damage. You should be prepared to shut off the fuel and air supply to the engine in order to stop the engine.

Caution should be used when any cover plate is removed. Slowly back off the last two bolts or the last two nuts that are located at opposite ends of the cover or device. Then, pry the cover loose in order to relieve any spring or other pressure, before removing the last two bolts or nuts completely.

Repairs that require welding should be performed only with the benefit of the appropriate reference information. Repairs that require welding should be performed only by personnel that are adequately trained and knowledgeable in welding procedures. Refer to Instruction Manual, SEGV2549, "Techniques of Structural Repair Course". The type of metal that is being welded should be determined prior to making any repairs. The correct procedures and materials should be used in order to provide a weld that is equivalent in strength to the parent material.

Do not damage wiring during the removal operations. Wiring should be reinstalled so that the wiring is not damaged. Wiring should also be installed so that the wiring will not be damaged during normal operation of the equipment. Do not connect wiring to a line that may contain fluid.

Always use lift arm supports in order to keep the lift arms raised. Keep all work tools tilted downward when repair work is being formed with the lift arms in the raised position. Prior to performing any maintenance or repairs, ensure that all hydraulic pressure has been relieved.

Tighten connections to the correct torque. Make sure that all heat shields, clamps and guards are installed correctly in order to avoid excessive heat, vibration or rubbing against other parts during operation. Shields that protect against oil spray onto hot exhaust components in the event of a line, tube or seal failure must be installed correctly.

Do not operate a machine if there is damage to any rotating parts. Do not operate a machine if any rotating parts will contact any other part during operation. Any high speed rotating component that has been damaged or altered should be checked for balance before reusing. Ensure that all safety devices are properly installed and that all safety devices are functioning correctly.

On track-type machines, be careful when servicing or separating tracks. Use caution when a track pin is removed or installed. Pieces of the track pin may break off and the pieces may become a flying hazard. Wear protective glasses. The tracks can unroll quickly, when the tracks are separated. Keep a safe distance from the front and the rear of the machine, when the tracks are separated. The machine can move unexpectedly when both tracks are disengaged from the sprockets. Always block the machine in order to prevent the machine from moving. Use caution when a bucket pin, a ripper tooth, or any other item is removed or installed. Pieces of those items may also break off and those pieces may become a flying hazard.

Unless you are instructed otherwise, perform maintenance with the equipment in the servicing position. Refer to Operation and Maintenance Manual for the procedure for placing the equipment in the servicing position.

Containing Fluid Spillage

Care must be taken in order to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the equipment. Prepare to collect the fluid with suitable containers before opening any compartment or disassembling any component that contains fluids.

Refer to Special Publication, NENG2500, "Tools and Shop Products Guide" for the following items:

- Tools that are suitable for collecting fluids and equipment that is suitable for collecting fluids
- Tools that are suitable for containing fluids and equipment that is suitable for containing fluids

Obey all local regulations for the disposal of liquids.

Asbestos Information

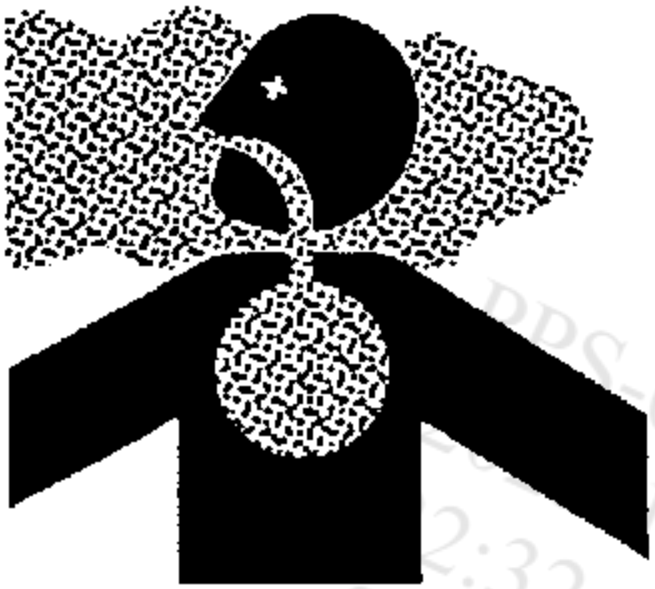

Illustration 6 g00702022

Caterpillar equipment and replacement parts that are shipped from Caterpillar are asbestos free. Caterpillar recommends the use of only genuine Caterpillar replacement parts. Use the following guidelines when you handle any replacement parts that contain asbestos or when you handle asbestos debris.

Use caution. Avoid inhaling dust that might be generated when you handle components that contain asbestos fibers. Inhaling this dust can be hazardous to your health. The components that may contain asbestos fibers are brake pads, brake bands, lining material, clutch plates, and some gaskets. The asbestos that is used in these components is usually bound in a resin or sealed in some way. Normal handling is not hazardous unless airborne dust that contains asbestos is generated.

If dust that may contain asbestos is present, there are several guidelines that should be followed:

- Never use compressed air for cleaning.
- Avoid brushing materials that contain asbestos.
- Avoid grinding materials that contain asbestos.
- Use a wet method in order to clean up asbestos materials.
- A vacuum cleaner that is equipped with a high efficiency particulate air filter (HEPA) can also be used.
- Use exhaust ventilation on permanent machining jobs.

- Wear an approved respirator if there is no other way to control the dust.
- Comply with applicable rules and regulations for the work place. In the United States, use Occupational Safety and Health Administration (OSHA) requirements. These OSHA requirements can be found in "29 CFR 1910.1001".
- Obey environmental regulations for the disposal of asbestos.
- Stay away from areas that might have asbestos particles in the air.

Dispose of Waste Properly

Illustration 7 g00706404

Improperly disposing of waste can threaten the environment. Potentially harmful fluids should be disposed of according to local regulations.

Always use leakproof containers when you drain fluids. Do not pour waste onto the ground, down a drain, or into any source of water.

Crushing Prevention and Cutting Prevention

Support the equipment properly before you perform any work or maintenance beneath that equipment. Do not depend on the hydraulic cylinders to hold up the equipment. Equipment can fall if a control is moved, or if a hydraulic line breaks.

Do not work beneath the machine component of the machine unless the machine component is properly supported.

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Unless you are instructed otherwise, never attempt adjustments while the machine is moving or while the engine is running.

Never jump across the starter solenoid terminals in order to start the engine. Unexpected machine movement could result.

Whenever there are equipment control linkages the clearance in the linkage area will change with the movement of the equipment or the machine. Stay clear of areas that may have a sudden change in clearance with machine movement or equipment movement.

Stay clear of all rotating and moving parts.

If it is necessary to remove guards in order to perform maintenance, always install the guards after the maintenance is performed.

Keep objects away from moving fan blades. The fan blade will throw objects or cut objects.

Do not use a kinked wire cable or a frayed wire cable. Wear gloves when you handle wire cable.

When you strike a retainer pin with force, the retainer pin can fly out. The loose retainer pin can injure personnel. Make sure that the area is clear of people when you strike a retainer pin. To avoid injury to your eyes, wear protective glasses when you strike a retainer pin.

Chips or other debris can fly off an object when you strike the object. Make sure that no one can be injured by flying debris before striking any object.

Burn Prevention

Do not touch any part of an operating engine. Allow the engine to cool before any maintenance is performed on the engine. Relieve all pressure in the air system, in the oil system, in the lubrication system, in the fuel system, or in the cooling system before any lines, fittings or related items are disconnected.

Coolant

When the engine is at operating temperature, the engine coolant is hot. The coolant is also under pressure. The radiator and all lines to the heaters or to the engine contain hot coolant.

Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

Check the coolant level only after the engine has been stopped.

Ensure that the filler cap is cool before removing the filler cap. The filler cap must be cool enough to touch with a bare hand. Remove the filler cap slowly in order to relieve pressure.

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Cooling system conditioner contains alkali. Alkali can cause personal injury. Do not allow alkali to contact the skin, the eyes, or the mouth.

Oils

Hot oil and hot components can cause personal injury. Do not allow hot oil to contact the skin. Also, do not allow hot components to contact the skin.

Remove the hydraulic tank filler cap only after the engine has been stopped. The filler cap must be cool enough to touch with a bare hand. Follow the standard procedure in this manual in order to remove the hydraulic tank filler cap.

Fire Prevention and Explosion Prevention

Illustration 8 g00704000

All fuels, most lubricants, and some coolant mixtures are flammable.

Flammable fluids that are leaking or spilled onto hot surfaces or onto electrical components can cause a fire. Fire may cause personal injury and property damage.

Remove all flammable materials such as fuel, oil, and debris from the machine. Do not allow any flammable materials to accumulate on the machine.

Store fuels and lubricants in properly marked containers away from unauthorized persons. Store oily rags and any flammable materials in protective containers. Do not smoke in areas that are used for storing flammable materials.

Do not operate the machine near any flame.

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Exhaust shields (if equipped) protect hot exhaust components from oil spray or fuel spray in case of a break in a line, in a hose, or in a seal. Exhaust shields must be installed correctly.

Do not weld on lines or on tanks that contain flammable fluids. Do not flame cut lines or tanks that contain flammable fluid. Clean any such lines or tanks thoroughly with a nonflammable solvent prior to welding or flame cutting.

Check all electrical wires daily. Repair any wires that are loose or frayed before you operate the machine. Clean all electrical connections and tighten all electrical connections.

Dust that is generated from repairing nonmetallic hoods or nonmetallic fenders can be flammable and/or explosive. Repair such components in a well ventilated area away from open flames or sparks.

Inspect all lines and hoses for wear or for deterioration. The hoses must be properly routed. The lines and the hoses must have adequate support and secure clamps. Tighten all connections to the recommended torque. Leaks can cause fires.

Illustration 9 g00704059

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Use caution when you are refueling a machine. Do not smoke while you are refueling a machine. Do not refuel a machine near open flames or sparks. Always stop the engine before refueling. Fill the fuel tank outdoors.

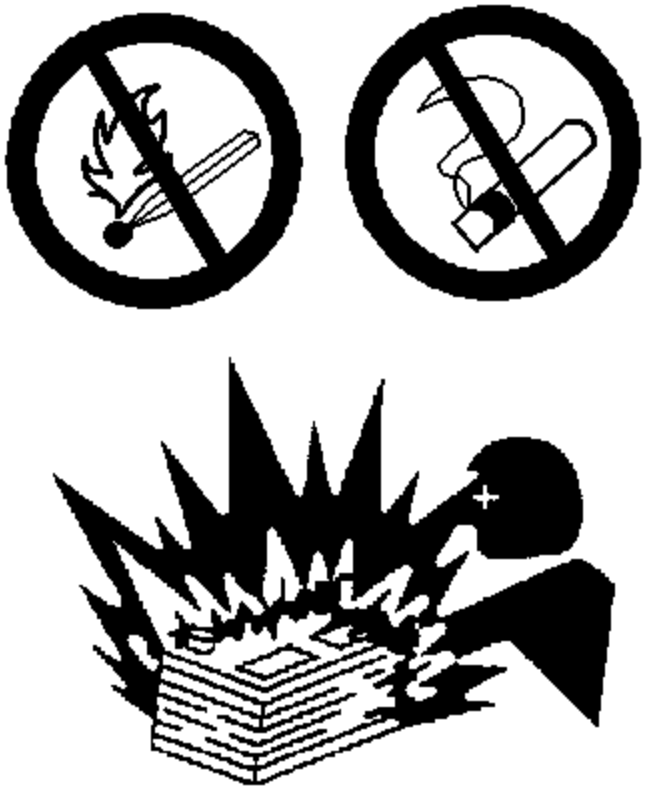

Illustration 10 g00704135

Gases from a battery can explode. Keep any open flames or sparks away from the top of a battery. Do not smoke in battery charging areas.

Never check the battery charge by placing a metal object across the terminal posts. Use a voltmeter or a hydrometer.

Improper jumper cable connections can cause an explosion that can result in injury. Refer to the Operation and Maintenance Manual for specific instructions.

Do not charge a frozen battery. This may cause an explosion.

Fire Extinguisher

Make sure that a fire extinguisher is available. Be familiar with the operation of the fire extinguisher. Inspect the fire extinguisher and service the fire extinguisher regularly. Obey the recommendations

on the instruction plate.

Ether

Ether is flammable and poisonous.

Use ether in well ventilated areas. Do not smoke while you are replacing an ether cylinder or while you are using an ether spray.

Do not store ether cylinders in living areas or in the operator compartment of a machine. Do not store ether cylinders in direct sunlight or in temperatures above 49 °C (120 °F). Keep ether cylinders away from open flames or sparks.

Dispose of used ether cylinders properly. Do not puncture an ether cylinder. Keep ether cylinders away from unauthorized personnel.

Do not spray ether into an engine if the machine is equipped with a thermal starting aid for cold weather starting.

Lines, Tubes and Hoses

Do not bend high pressure lines. Do not strike high pressure lines. Do not install any lines that are bent or damaged.

Repair any lines that are loose or damaged. Leaks can cause fires. Consult your Caterpillar dealer for repair or for replacement parts.

Check lines, tubes and hoses carefully. Do not use your bare hand to check for leaks. Use a board or cardboard to check for leaks. Tighten all connections to the recommended torque.

Replace the parts if any of the following conditions are present:

- End fittings are damaged or leaking.
- Outer coverings are chafed or cut.
- Wires are exposed.
- Outer coverings are ballooning.
- Flexible part of the hoses are kinked.
- Outer covers have embedded armoring.
- End fittings are displaced.

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Make sure that all clamps, guards, and heat shields are installed correctly. During machine operation, this will help to prevent vibration, rubbing against other parts, and excessive heat.

Tire Information

Explosions of air inflated tires have resulted from heat-induced gas combustion inside the tires. Explosions can be caused by heat that is generated by welding, by heating rim components, by external fire, or by excessive use of brakes.

A tire explosion is much more violent than a blowout. The explosion can propel the tire, the rim components, and the axle components as far as 500 m (1500 ft) or more from the machine. Both the force of the explosion and the flying debris can cause property damage, personal injury, or death.

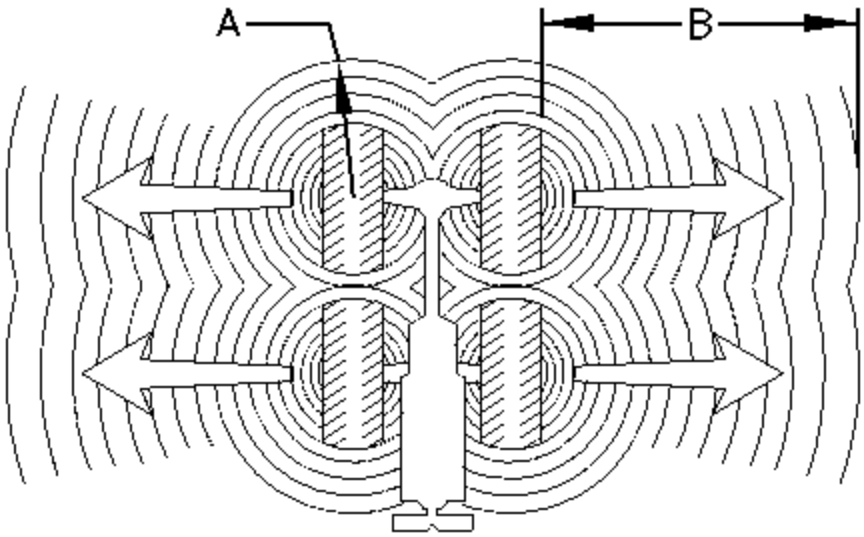

Illustration 11 g00337832

(A) At least 15 m (50 ft)

(B) At least 500 m (1500 ft)

Do not approach a warm tire. Maintain a minimum distance, as shown. Stay outside the shaded area in Illustration 11.

Do not use water or calcium as a ballast for the tires. Dry nitrogen gas is recommended for inflation of tires. If the tires were originally inflated with air, nitrogen is still preferred for adjusting the pressure. Nitrogen mixes properly with air.

Nitrogen inflated tires reduce the potential of a tire explosion because nitrogen does not aid combustion. Nitrogen helps to prevent oxidation of the rubber, deterioration of rubber, and corrosion

of rim components.

To avoid overinflation, proper nitrogen inflation equipment and training in the usage of the equipment are necessary. A tire blowout or a rim failure can result from improper equipment or from misused equipment.

When you inflate a tire, stand behind the tread and use a self-attaching chuck.

Servicing tires and rims can be dangerous. Only trained personnel that use proper tools and proper procedures should perform this maintenance. If correct procedures are not used for servicing tires and rims, the assemblies could burst with explosive force. This explosive force can cause serious personal injury or death. Carefully obey the specific instructions from your tire dealer.

Work Tools

Make sure that all necessary guarding is in place on the host machine and on the work tool.

While you are performing any maintenance, any testing, or any adjustments to the work tool stay clear of the following areas: cutting edges, pinching surfaces and crushing surfaces.

PPS-000B5752
2025/10/01
22:32:23-05:00
i02145477
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PPS-000B5752
2025/10/01
22:32:33-05:00
SENR7733
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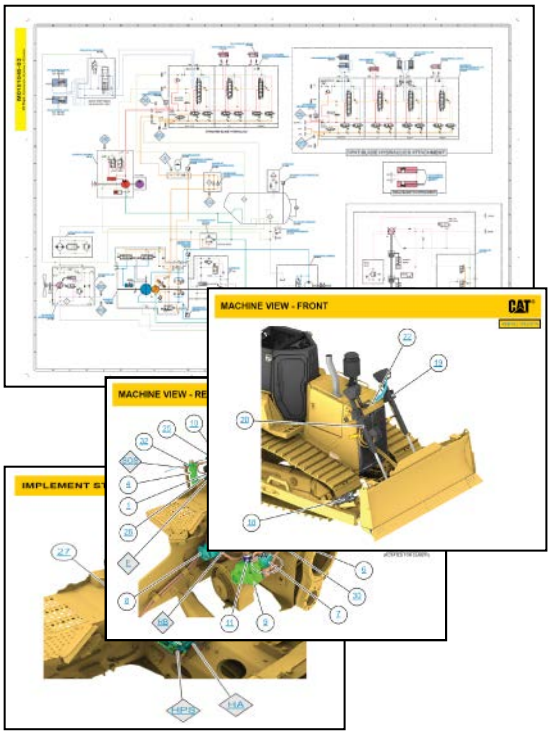
SCHEMATIC FEATURES AND TIPS

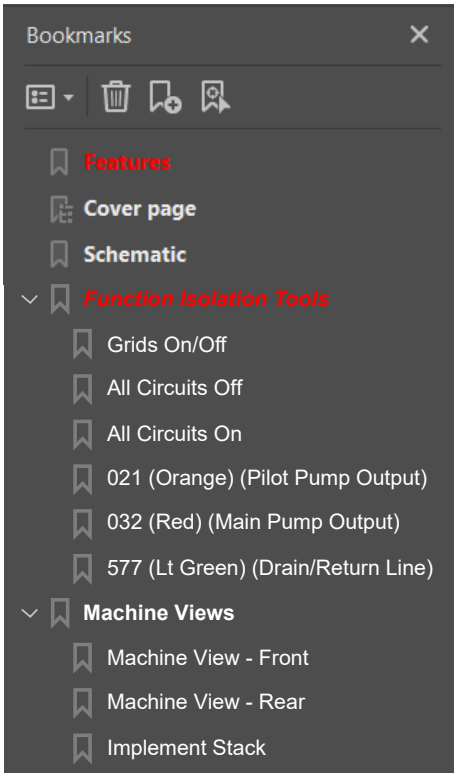
Make sure your Adobe Acrobat Reader is up to date in order to access the latest features of this schematic.

GET
Adobe Acrobat Reader

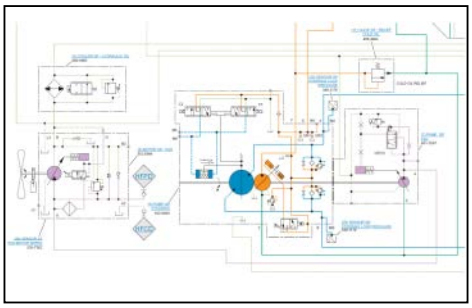
SAVE
a copy of this schematic

THE BOOKMARKS PANEL WILL ALLOW YOU TO QUICKLY NAVIGATE TO POINTS OF INTEREST.

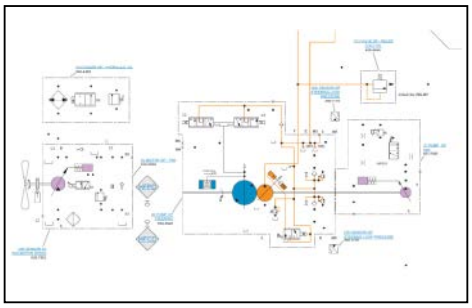




THE FUNCTION ISOLATION TOOLS ISOLATE CIRCUITS FOR TRACING HYDRAULIC LINES

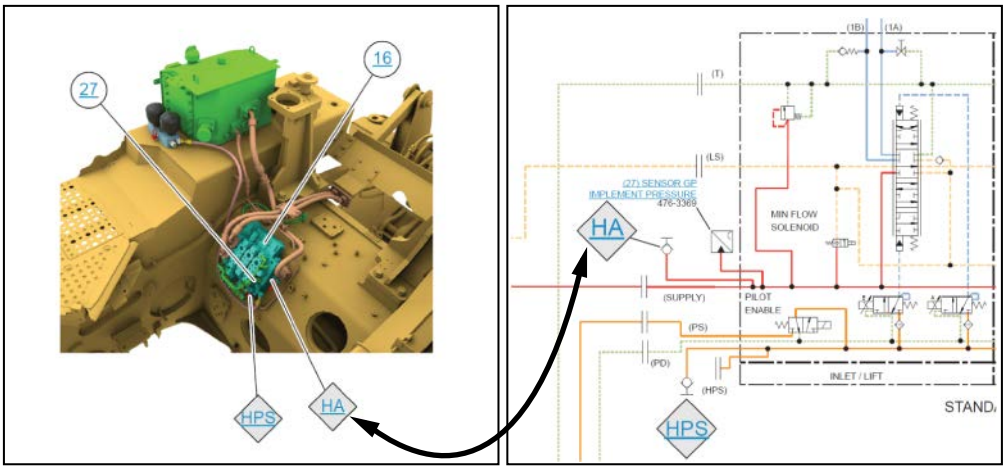


STANDARD VIEW



021 (Orange) (Pilot Output) CIRCUIT ISOLATED

UTILIZE HYPERTEXT TO NAVIGATE TO COMPONENTS AND THEIR MACHINE LOCATION QUICKLY. HYPERTEXT IS INDICATED BY TEXT THAT IS BLUE AND UNDERLINED.



VIEW ALL CALLOUTS

WHEN ONLY ONE CALLOUT IS SHOWING ON A MACHINE VIEW, CLICKING ON THIS BUTTON WILL MAKE ALL OF THE CALLOUTS VISIBLE. THIS BUTTON IS TYPICALLY LOCATED IN THE TOP RIGHT CORNER OF EVERY MACHINE VIEW PAGE.

CLICK HERE TO VIEW THE SCHEMATIC SYMBOLS AND DEFINITIONS PAGE

ELECTRICAL SYMBOLS			
Pressure Switch	Temperature Switch	Level Switch	Circuit Breaker
BASIC HYDRAULIC SYMBOLS			
Fluid Conditioner	Pump or Motor	Spring (Adjustable)	Variability

HOTKEYS (Keyboard Shortcuts)		
	FUNCTION	KEYS
	Zoom In	"CTRL" / "+"
	Zoom Out	"CTRL" / "-"
	Fit to Page	"CTRL" / "0" (zero)
	Hand Tool	"SPACEBAR" (hold down)
	Find	"CTRL" / "F"
	Search	"CTRL" / "SHIFT" / "F"

Due to different monitor sizes and PDF reader preferences there may be some variance in linked schematic locations. This document is best viewed at a screen resolution of 1024 X 768.

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SCHEMATIC SYMBOLS AND DEFINITIONS

VALVES

ENVELOPES

One Position | Two Position | Three Position

PORTS

Two-way | Three-Way | Four-Way

CONTROL

Normal Position (A B / P T) | Shifted Position (A B / P T) | Infinite Position

CHECK

Basic Symbol | Spring Loaded | Shuttle | Pilot Controlled

INTERNAL PASSAGEWAYS

FLOW IN ONE DIRECTION	FLOW ALLOWED IN EITHER DIRECTION	PARALLEL FLOW / CROSS FLOW
Infinite Positioning	Two Position	Three Position

CYLINDERS

Single Acting | Double Acting

ACCUMULATORS

Spring Loaded | Gas Charged

PUMPS

FIXED DISPLACEMENT

Unidirectional | Bidirectional

VARIABLE DISPLACEMENT NON- COMPENSATED

Unidirectional | Bidirectional

MOTORS

FIXED DISPLACEMENT

Unidirectional | Bidirectional

VARIABLE DISPLACEMENT NON- COMPENSATED

Unidirectional | Bidirectional

BASIC HYDRAULIC COMPONENT SYMBOLS

Pump or Motor	Variability
Fluid Conditioner	Spring (Adjustable)
Spring	Pressure Compensation
Control Valves	Line Restriction (Variable)
Restriction	Line Restriction (Fixed)
Line Restriction Variable and Pressure Compensated	2-Section Pump (MAIN AUX.)
Attachment	Pump: Variable and Pressure Compensated
Hydraulic Energy Triangles	Pneumatic Energy Triangles

PILOT CONTROL

RELEASED PRESSURE

External Return | Internal Return

REMOTE SUPPLY PRESSURE

Simplified | Complete | Internal Supply Pressure

ROTATING SHAFTS

Unidirectional | Bidirectional

COMBINATION CONTROLS

Solenoid | Solenoid or Manual | Solenoid and Pilot | Solenoid and Pilot or Manual | Servo | Thermal | Detent

LINES

Crossing | Joining

MEASUREMENT

Pressure | Temperature | Flow

MANUAL CONTROL

Push-pull Lever | Manual Shutoff | General Manual | Push Button | Pedal | Spring

FLUID STORAGE RESERVOIRS

Vented | Pressurized | Return Above Fluid Level | Return Below Fluid Level

HYDRAULIC SYMBOLS - ELECTRICAL

Transducer (Fluid) | Transducer (Gas / Air) | Generator | Electric Motor | Pressure Switch | Pressure Switch (Adjustable) | Temperature Switch | Electrical Wire

ELECTRICAL SYMBOLS

Pressure Switch | Temperature Switch | Level Switch | Flow Switch | Circuit Breaker

BASIC ELECTRICAL COMPONENT SYMBOLS

Fuse: A component in an electrical circuit that will open the circuit if too much current flows through it.

Switch (Normally Open): A switch that will close at a specified point (temp, press, etc.). The circle indicates that the component has screw terminals and a wire can be disconnected from it.

Switch (Normally Closed): A switch that will open at a specified point (temp, press, etc.). No circle indicates that the wire cannot be disconnected from the component.

Ground (Wired): This indicates that the component is connected to a grounded wire. The grounded wire is fastened to the machine.

Ground (Case): This indicates that the component does not have a wire connected to ground. It is grounded by being fastened to the machine.

Reed Switch: A switch whose contacts are controlled by a magnet. A magnet closes the contacts of a normally open reed switch; it opens the contacts of a normally closed reed switch.

Sender: A component that is used with a temperature or pressure gauge. The sender measures the temperature or pressure. Its resistance changes to give an indication to the gauge of the temperature or pressure.

Relay (Magnetic Switch): A relay is an electrical component that is activated by electricity. It has a coil that makes an electromagnet when current flows through it. The electromagnet can open or close the switch part of the relay.

Solenoid: A solenoid is an electrical component that is activated by electricity. It has a coil that makes an electromagnet when current flows through it. The electromagnet can open or close a valve or move a piece of metal that can do work.

Magnetic Latch Solenoid: An electrical component that is activated by electricity and held latched by a permanent magnet. It has two coils (latch and unlatch) that make electromagnet when current flows through them. It also has an internal switch that places the latch coil circuit open at the time the coil latches.

HARNESS AND WIRE SYMBOLS

Wire, Cable, or Harness Assembly Identification: Includes Harness Identification Letters and Harness Connector Serialization Codes (see sample).

AG-C4 111-7898 | L-C12 3E-5179

Part Number: for Connector Plug

1 2

Plug | Receptacle Pin or Socket Number

Harness Identification Letter(s): (A, B, C, AA, AB, AC, ...)

Harness Connector Serialization Code: The "C" stands for "Connector" and the number indicates which connector in the harness (C1, C2, C3, ...)

L-C12 3E-5179

5A

Fuse (5 Amps) | 9X-1123 Component Part Number

325-AG135 | PK-14

Harness identification code: This example indicates wire group 325, wire 135 in harness "AG".

Wire Gauge* | Wire Color

Wire gauge is shown in AWG (American Wire Gauge) but could also be shown in metric denoted with mm

1 2

Deutsch connector: Typical representation of a Deutsch connector. The plug contains all sockets and the receptacle contains all pins.

1 2

Sure-Seal connector: Typical representation of a Sure-Seal connector. The plug and receptacle contain both pins and sockets.

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CAT LET'S DO THE WORK.

M0130191-02
February 2025

Schematic

304, 305 CR, 305 SR, 305.5 CR Mini Hydraulic Excavator Hydraulic System

AX61-UP
AN41-UP
5G51-UP
5X51-UP
AX51-UP
5C51-UP
4Z41-UP

Volume 1 of 2: 304, 305 CR, 305.5 CR Schematic
Volume 2 of 2: 305 SR Schematic

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COMPONENT LOCATION
VOLUME 1 - 304, 305 CR, 305.5 CR SCHEMATIC

Description	Schematic Location	Machine Location
Accumulator - Hydraulic (Uncharged)	F-5	1
Cap - Pressure (Hydraulic Tank)	C-3	2
Cooler Gp - Hydraulic Oil	C-5	3
Cylinder Gp - Angle Blade	J-14	4
Cylinder Gp - Blade	G-15	5
Cylinder Gp - Boom	E-2	6
Cylinder Gp - Boom Swing	E-14	7
Cylinder Gp - Bucket	G-2	8
Cylinder Gp - Coupler	G-1	9
Cylinder Gp - Stick	H-4	10
Cylinder Gp - Thumb	H-1	11
Drive Gp - Final (Left)	I-16	12
Drive Gp - Final (Right)	H-16	13
Filter Element As - Oil	B-6	14
Filter Gp - Oil (Hydraulic Filter)	B-6	15
Motor Gp - Swing	E-13	16
Pump Gp - Main Hydraulic	C-14	17
Sensor Gp - Pressure (Ejector) (Calibration)	F-5	18
Sensor Gp - Pressure (Ejector) (Pump)	J-7	19
Strainer As - Suction	A-7	20
Swivel Gp	I-12	21
Tank And Filter Gp - Hydraulic	A-6	22
Valve As - Ball	H-1	23
Valve As - Ball (Shut Off) (1 Way)	C-3	24
Valve Gp - Check (Back Pressure)	C-5	25
Valve Gp - Check (Cooler Bypass)	E-5	26
Valve Gp - Diverter	F-13	27
Valve Gp - Load Control (Boom)	D-3	28
Valve Gp - Load Control (Stick)	H-4	29
Valve Gp - Main Control	I-10	30
Valve Gp - Solenoid And Manifold (Quick Coupler)	F-3	31

COMPONENT LOCATION
VOLUME 2 - 305 SR SCHEMATIC

Description	Schematic Location	Machine Location
Accumulator - Hydraulic (Uncharged)	F-5	51
Cap - Pressure (Hydraulic Tank)	C-3	52
Cooler Gp - Hydraulic Oil	C-5	53
Cylinder Gp - Blade	G-15	54
Cylinder Gp - Boom	E-2	55
Cylinder Gp - Boom Swing	E-14	56
Cylinder Gp - Bucket	G-2	57
Cylinder Gp - Stick	H-4	58
Drive Gp - Final (Left)	H-16	59
Drive Gp - Final (Right)	I-16	60
Filter Element As - Oil	B-6	61
Filter Gp - Oil (Hydraulic Filter)	B-6	62
Motor Gp - Swing	E-13	63
Pump Gp - Main Hydraulic	B-14	64
Sensor Gp - Pressure (Ejector) (Calibration)	F-5	65
Sensor Gp - Pressure (Ejector) (Pump)	I-8	66
Strainer As - Suction	A-7	67
Swivel Gp	I-12	68
Tank And Filter Gp - Hydraulic	A-6	69
Valve As - Ball (Shut Off) (1 Way)	C-3	70
Valve Gp - Check (Back Pressure)	C-5	71
Valve Gp - Check (Cooler Bypass)	E-5	72
Valve Gp - Load Control (Boom)	D-3	73
Valve Gp - Load Control (Stick)	H-4	74
Valve Gp - Main Control	I-10	75

TAP LOCATION
VOLUME 1 - 304, 305 CR, 305.5 CR SCHEMATIC

Tap Number	Description	Schematic Location
AA	Pump Delivery Pressure Port	C-12
BB	Pilot Pressure Port	J-8
CC	Travel Speed Pressure Port	C-9
SOS	Oil Sampling Port	J-8

TAP LOCATION
VOLUME 2 - 305 SR SCHEMATIC

Tap Number	Description	Schematic Location
AA	Pump Delivery Pressure Port	C-12
BB	Pilot Pressure Port	J-8
CC	Travel Speed Pressure Port	C-9
SOS	Oil Sampling Port	H-11

M0130191-02 VOL 1 of 2

42 Page, (Dimensions: 56 inches x 35 inches)

ANGLE BLADE

(4) CYLINDER GP - ANGLE BLADE
305 CR: 575-7042
304: 575-7028

2 SPD

(12) DRIVE GP - FINAL (RIGHT)
305 CR, 305.5 CR: 575-7189
304 - 575-7188
NOTE F

WP-A

WP-B

(13) DRIVE GP - FINAL (LEFT)
305 CR, 305.5 CR: 575-7189
304 : 575-7188
NOTE F

WP-B

WP-A

2 SPD

BLADE LIFT

(5) CYLINDER GP - BLADE
305 CR, 305.5 CR: 575-7041 (STD)
304: 575-7027 (STD)
304: 575-7031 (ANGLE BLADE ONLY)

(21) SWIVEL GP
616-2561 (8 PORT BLADE)
583-1555 (10 PORT)
NOTE F

H
I
D
B
C
A
G
P
F
E

TVL RT FWD (5A)

TVL RT REV (5B)

TVL LT FWD (4A)

TVL LT REV (4B)

BLADE HE (3A)

BLADE RE (3B)

NOTE G

(30) VALVE GP - MAIN CONTROL (NOTE G)
580-4136 (BANK 9) (305 CR & 305.5 CR)
580-4137 (BANK 10) (305 CR & 305.5 CR)
582-8196 (BANK 9) (304)
582-8197 (BANK 10) (304)

BB

SOS

(19) SENSOR GP - PRESSURE (EJECTOR) (PUMP)
344-7391

SOL24:IMP FUNCTION 2

SOL25:IMP FUNCTION 2

IMP FUNCTION 2

IMP FUNCTION 2 (11A)

IMP FUNCTION 2 (11B)

SOL20:TVL RT FWD

SOL21:TVL RT REV

SOL22:AUX1 SUPPLY B

SOL23:AUX1 RETURN A

AUX (6A)

AUX (6B)

TVL RT

AUX 1

STK HE (7A)

STK RE (7B)

SOL16:TVL LT FWD

SOL17:TVL LT REV

SOL18: STK RE

SOL19:STK HE

STICK

BKT HE (8A)

BKT RE (8B)

TVL LT

SOL12:BL DN HE

SOL13:BL UP RE

SOL14: BKT RE

SOL15: BKT HE

BUCKET

BLADE LIFT

(18) SENSOR GP PRESSURE (EJECTOR) (CALIBRATION)
344-7391

(1) ACCUMULATOR HYDRAULIC (UNCHARGED)
397-6929

(26) VALVE GP - CHECK (COOLER BYPASS)
602-0421

(27) VALVE GP - DIVERTER
372-8897

BM RT (FEMALE) - 6

BM LT (MALE) - 6

IMP FUNCTION 1 (2A)

IMP FUNCTION 1 (2B)

IMP FUNCTION 1 (Aux2/BM SW)

SOL8: MULTI

SOL9: MULTI

SOL10: PSO

SOL11: BYPASS

BYPASS

BOOM SWING

(7) CYLINDER GP - BOOM SWING
305 CR, 305.5 CR: 575-7040
304: 575-7026

WP B RT

WP A LT

CASE

BRK RELEASE

(16) MOTOR GP - SWING
305 CR, 305.5 CR: 583-1553
304: 575-7190

SW RT (1A)

SW LT (1B)

SOL4:SW RT

SOL5:SW LT

SOL6:BM UP

SOL7:BM UP

LLCV

BM HE(10A)

BM RE(10B)

SWING

BOOM

SOL1:TRL 2SPO

SOL2: SWG BK

SOL3: BM LLCV DN

CC

(25) VALVE GP CHECK (BACK PRESSURE)
600-9660

(24) VALVE AS - BALL (SHUT OFF) (1 WAY)
520-0065

(3) COOLER GP - HYDRAULIC OIL
581-8751

(15) FILTER GP - OIL (HYDRAULIC FILTER)
529-0120 (305 CR & 305.5 CR)
569-3955 (304)

(14) FILTER ELEMENT AS - OIL
529-0121 (305 CR & 305.5 CR)
575-2548 (304)

(2) CAP - PRESSURE (HYDRAULIC TANK)
4I-3745

(17) PUMP GP - MAIN HYDRAULIC
580-9197 (305 CR, 305.5 CR)
487-6215 (304)

AA

PVM

EP

M

(20) STRAINER AS - SUCTION
555-7002

(22) TANK AND FILTER GP - HYDRAULIC
583-5711 (305 CR & 305.5 CR)
583-5782 (304)

STICK

(10) CYLINDER GP - STICK
305 CR: 575-7038, 575-7037
305.5 CR: 575-7052
304: 575-7023

(29) VALVE GP - LOAD CONTROL (STICK)
582-5400

BM RT (FEMALE) - 10

BM LT (MALE) - 10

(23) VALVE AS - BALL
280-2652

THUMB (OPT STD FLOW)

(11) CYLINDER GP - THUMB
305 CR: 520-6109
304: 520-6100

(8) CYLINDER GP - BUCKET
305 CR: 606-4242, 614-3363
305.5 CR: 575-7054
304: 575-7025

BUCKET

(9) CYLINDER GP - COUPLER
305.5 CR, 305 CR: 485-5288
304: 485-5287
NOTE E

COUPLER

SV1

SV2

(31) VALVE GP - SOLENOID AND MANIFOLD (QUICK COUPLER)
586-3548

BOOM

(6) CYLINDER GP - BOOM
305.5 CR: 575-7051 (STD)
305 CR: 575-7036, 575-7035
304: 575-7021

(28) VALVE GP - LOAD CONTROL (BOOM)
582-5399

LINE PATTERNS

	Pressure Line
	Pilot / Load Sensing Pressure
	Drain / Return Lines
	Air Line
	Component Group

CALLOUTS

	Taps (Pressure, Sampling, Sensor - by letter)
	Connectors (By letter)

Callout Number (Machine Location Num) (Component Location Num) — (52) VALVE GP - CONTROL 138-1234 — Component Name / Part Number

HYDRAULIC CIRCUIT COLOR DESCRIPTIONS

- PILOT CONTROL CIRCUIT
- MAIN PUMP CIRCUIT
- BLADE LIFT CYLINDER CIRCUIT
- TRAVEL MOTOR CONTROL CIRCUIT (RIGHT)
- ANGLE BLADE EXTENDER CIRCUIT
- TRAVEL MOTOR BRAKE CIRCUIT
- SUPPLY LINE
- STICK CYLINDER CIRCUIT
- THUMB CYLINDER CIRCUIT
- SWING MOTOR CONTROL CIRCUIT
- SWING MOTOR BRAKE CIRCUIT
- SWING BRAKE CONTROL CIRCUIT
- TRAVEL SPEED CONTROL CIRCUIT
- BUCKET CYLINDER CIRCUIT
- TRAVEL MOTOR CONTROL CIRCUIT (LEFT)
- BOOM CYLINDER CIRCUIT

⚠ WARNING

Do not operate or work on this product unless you have read and understood the instruction and warnings in the Operation and Maintenance Manual and the relevant service literature. Failure to follow the instructions or heed the warnings could result in injury or death. Proper care is your responsibility.

NOTE E: ONLY HYDRAULIC DUAL LOCK COUPLER IS SHOWN

NOTE F: ALPHA TRAVEL SPOOLS AND SWIVEL PORT LABELS CHANGE

NOTE G: BLADE HE RV ONLY FIT TO 10 BANK ANGLE BLADE VALVE

THIS SCHEMATIC IS FOR THE 304, 305 CR, 305 SR, AND 305.5 CR MINI HYDRAULIC EXCAVATOR HYDRAULIC SYSTEM

VOLUME 1 of 2: 304, 305 CR, 305.5 CR SCHEMATIC

MEDIA NUMBER: M0130191-02

SCHEMATIC PART NUMBER: 533-4251, CHANGE: 10, VERSION: -

Components are shown installed on a fully operable machine with the key and engine off.
Refer to the appropriate Service Manual for Troubleshooting, Specifications and Systems Operations.
Refer to the Parts Manual using a specific serial number prefix in SIS before ordering parts from this schematic.

M0130191-02 VOL 2 of 2
42 Page, (Dimensions: 56 inches x 35 inches)

2 SPD
(60) DRIVE GP - FINAL (RIGHT)
575-7189
NOTE F
(59) DRIVE GP - FINAL (LEFT)
575-7189
NOTE F
WP-A
WP-B
WP-B
WP-A
2 SPD
BLADE
(54) CYLINDER GP - BLADE
575-7041
(68) SWIVEL GP
616-2561 (8 PORT BLADE)
583-1555 (10 PORT)
NOTE F
TVL RT FWD (5A)
TVL RT REV (5B)
TVL LT FWD (4A)
TVL LT REV (4B)
BLADE HE (3A)
BLADE RE (3B)
IMP FUNCTION 1 (2A)
IMP FUNCTION 1 (2B)
POB
(56) CYLINDER GP - BOOM SWING
575-7058
WP B RT
WP A LT
SW RT (1A)
SW LT (1B)
(63) MOTOR GP - SWING
583-1553
BRK RELEASE
(64) PUMP GP - MAIN HYDRAULIC
580-9197
EP
M
AA
BB
CC
SOS
(75) VALVE GP - MAIN CONTROL
580-4136 (BANK 9)
(66) SENSOR GP - PRESSURE (EJECTOR) (PUMP)
344-7391
SOL20:TVL RT FWD
SOL21:TVL RT REV
SOL22:AUX1 SUPPLY B
SOL23:AUX1 RETURN A
TVL RT
AUX 1
SOL16:TVL LT FWD
SOL17:TVL LT REV
SOL18: STK RE
SOL19:STK HE
TVL LT
STICK
SOL12:BL DN HE
SOL13:BL UP RE
SOL14: BKT RE
SOL15: BKT HE
BLADE
BUCKET
SOL8: IMP FUNCTION 1
SOL9: IMP FUNCTION 1
IMP FUNCTION 1 (BSW, POB, 2PC BM)
SOL10: PSO
SOL11: BYPASS
BYPASS
SOL4:SW RT
SOL5:SW LT
SOL6:BM UP
SOL7:BM UP
SWING
BOOM
LLCV
SOL1:TRL 2SPD
SOL2: SWG BK
SOL3: BM LLCV
STK HE (7A)
STK RE (7B)
BKT HE (8A)
BKT RE (8B)
BM HE(10A)
BM RE(10B)
(71) VALVE GP CHECK (BACK PRESSURE)
600-9660
(53) COOLER GP - HYDRAULIC OIL
581-8751
(62) FILTER GP - OIL (HYDRAULIC FILTER)
529-0120
(61) FILTER ELEMENT AS - OIL
529-0121
(67) STRAINER AS - SUCTION
555-7062
(69) TANK AND FILTER GP - HYDRAULIC
584-6480
(65) SENSOR GP PRESSURE (EJECTOR) (CALIBRATION)
344-7391
(51) ACCUMULATOR HYDRAULIC (UNCHARGED)
397-6929
(72) VALVE GP - CHECK (COOLER BYPASS)
602-0421
(70) VALVE AS - BALL (SHUT OFF) (1 WAY)
520-0065
(58) CYLINDER GP STICK
575-7055
(74) VALVE GP - LOAD CONTROL (STICK)
582-5400
(57) CYLINDER GP BUCKET
614-3363
(55) CYLINDER GP BOOM
575-7050
(73) VALVE GP LOAD CONTROL (BOOM)
613-4475
(52) CAP - PRESSURE (HYDRAULIC TANK)
4I-3745
BM RT - 10
BM LT - 10

LINE PATTERNS	
	Pressure Line
	Pilot / Load Sensing Pressure
	Drain / Return Lines
	Air Line
	Component Group

CALLOUTS	
	Tags (Pressure, Sampling, Sensor - by letter)
	Connectors (By letter)

Callout Number (Machine Location Number) Component Location Digits — (52) VALVE GP - CONTROL — Component Name
138-1234 — Part Number

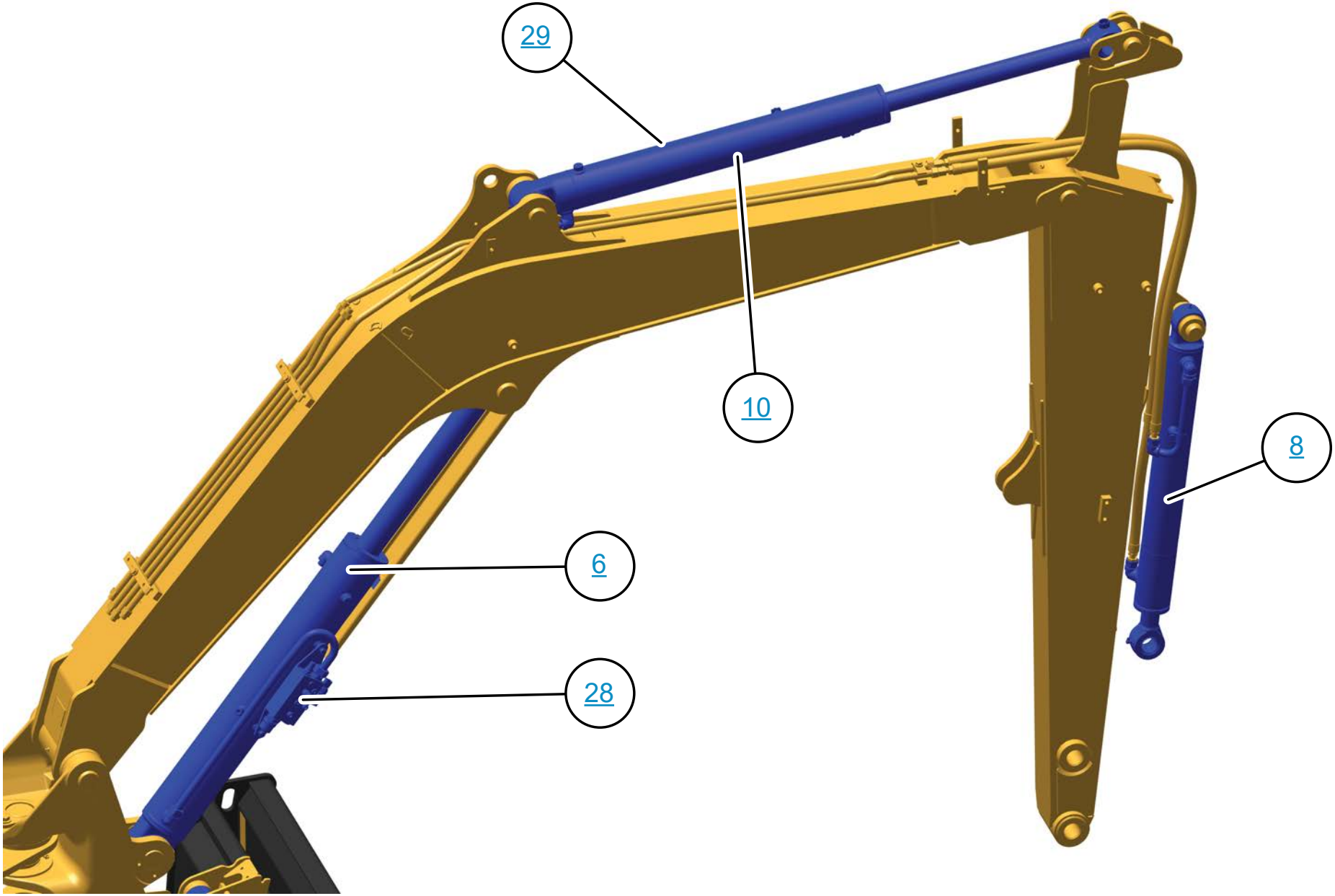
HYDRAULIC CIRCUIT COLOR DESCRIPTIONS
PILOT CONTROL CIRCUIT
MAIN PUMP OUTPUT
BLADE LIFT CYLINDER CIRCUIT
TRAVEL SPOOL CONTROL CIRCUIT (RIGHT)
TRAVEL SPOOL CONTROL CIRCUIT (LEFT)
STICK CYLINDER CIRCUIT
TRAME CYLINDER CIRCUIT
SWING MOTOR CONTROL CIRCUIT
DRAIN / RETURN LINE
SWING BRAKE CONTROL CIRCUIT
BOOM CONTROL SPOOL CIRCUIT
BUCKET CYLINDER CIRCUIT
TRAVEL MOTOR CONTROL CIRCUIT (LEFT)
BOOM CYLINDER CIRCUIT

NOTE F: ALPHA TRAVEL SPOOLS AND SWIVEL PORT LABELS CHANGE

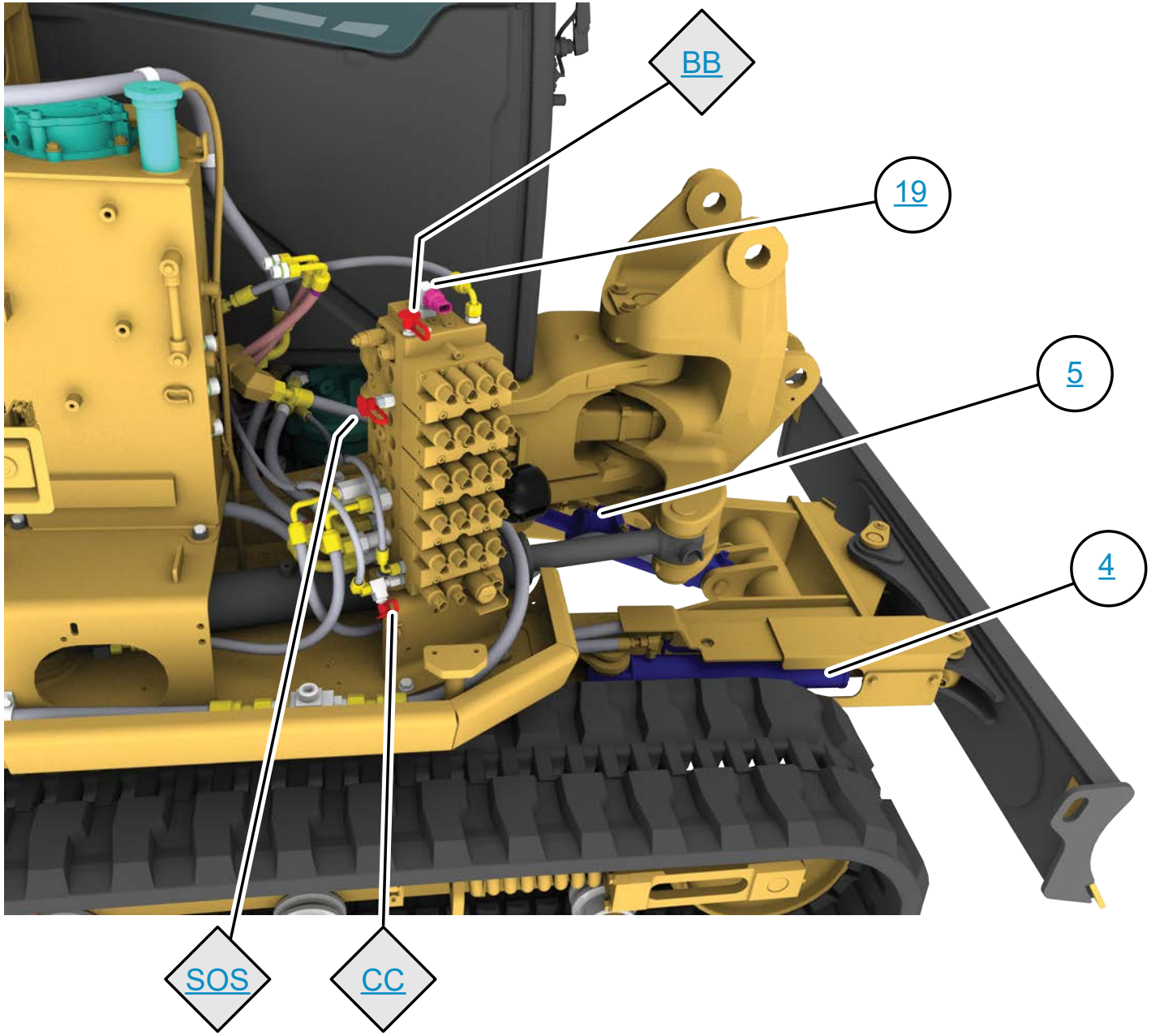
WARNING
Do not operate or work on this product unless you have read and understand the instructions and warnings in the relevant Operation and Maintenance Manuals and relevant service literature. Failure to follow the instructions or heed the warnings could result in injury or death. Proper care is your responsibility.

THIS SCHEMATIC IS FOR THE 304, 305 CR, 305 SR, AND 305.5 CR MINI HYDRAULIC EXCAVATOR HYDRAULIC SYSTEM
VOLUME 2 of 2: 305 SR SCHEMATIC
MEDIA NUMBER: M0130191-02
SCHEMATIC PART NUMBER: 533-4251, CHANGE: 10, VERSION: -
Components are shown installed on a fully operable machine with the key and engine off.
Refer to the appropriate Service Manual for Troubleshooting, Specifications and Systems Operations.
Refer to the Parts Manual using a specific serial number prefix in SIS before ordering parts from this schematic.

BOOM, STICK, AND BUCKET CYLINDER VIEW

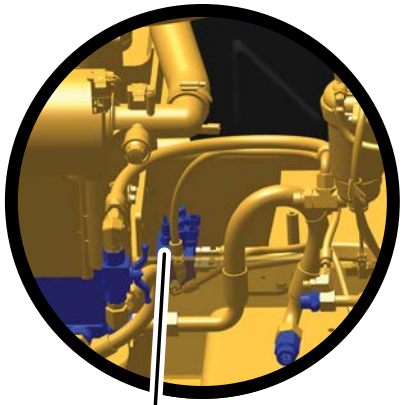


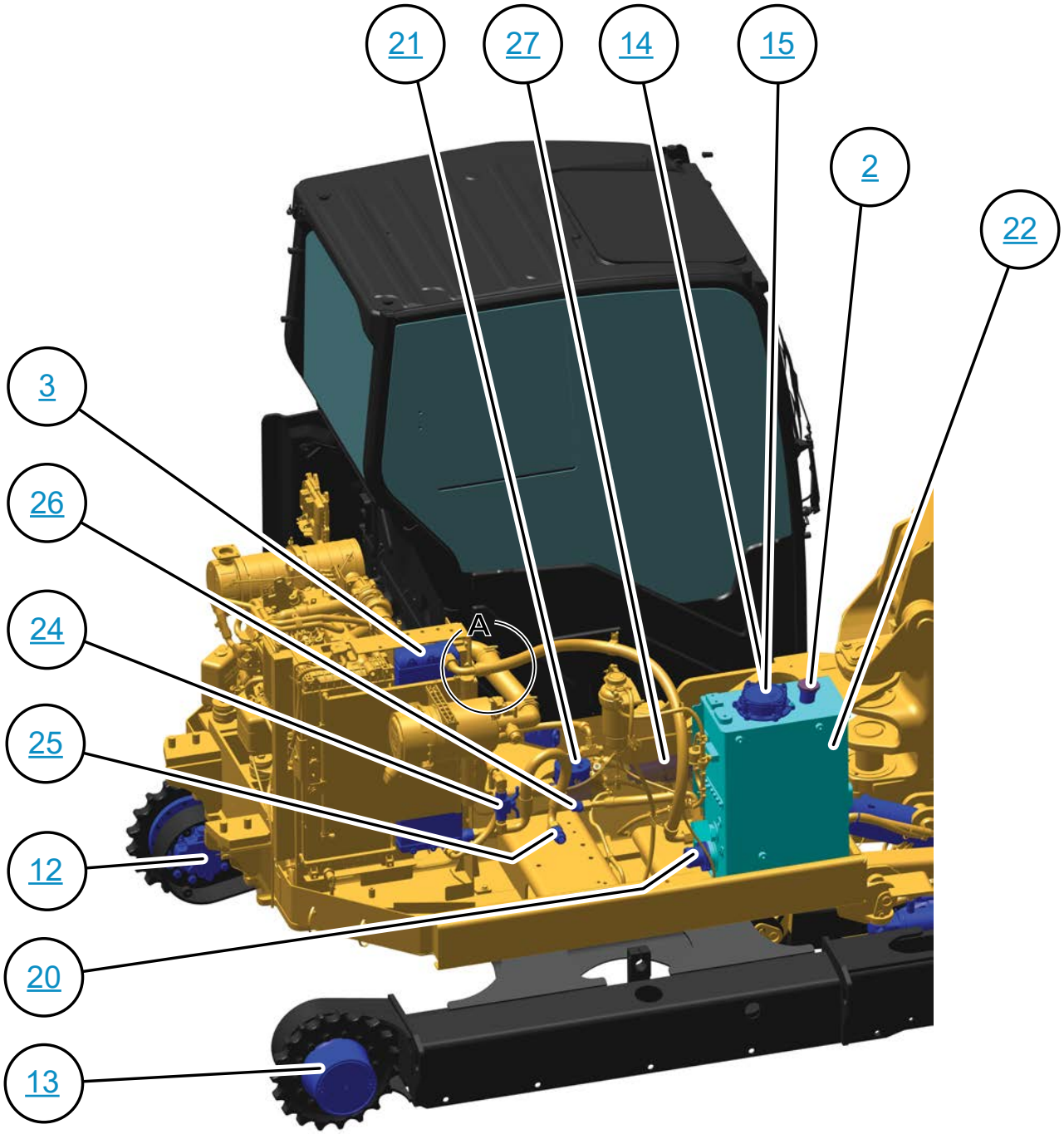
MACHINE FRONT - RH VIEW



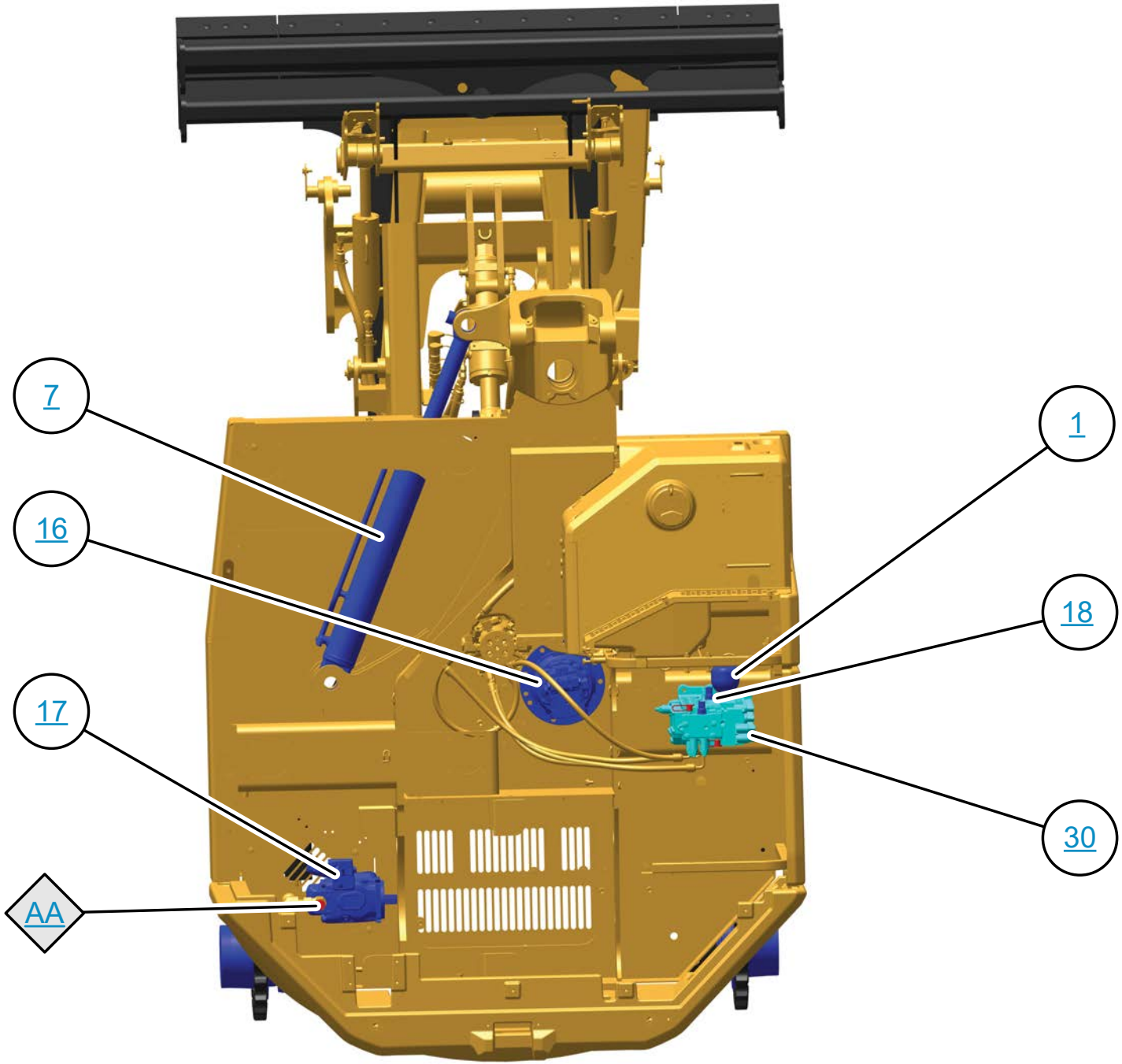
MACHINE REAR - RH VIEW

VIEW OF AREA “A”
(ROTATED FOR CLARITY)

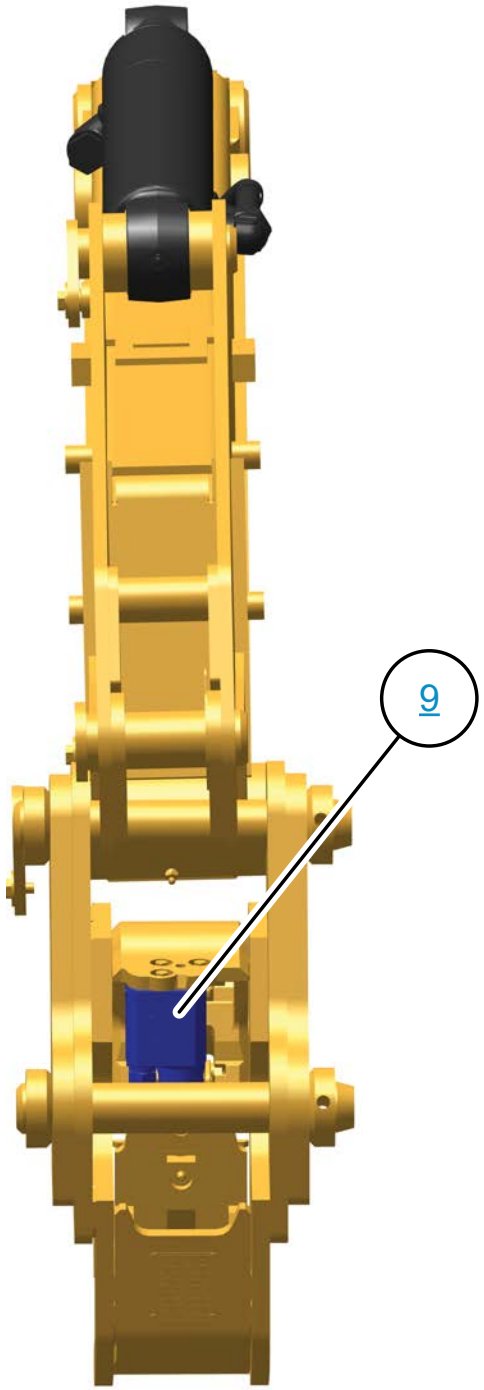




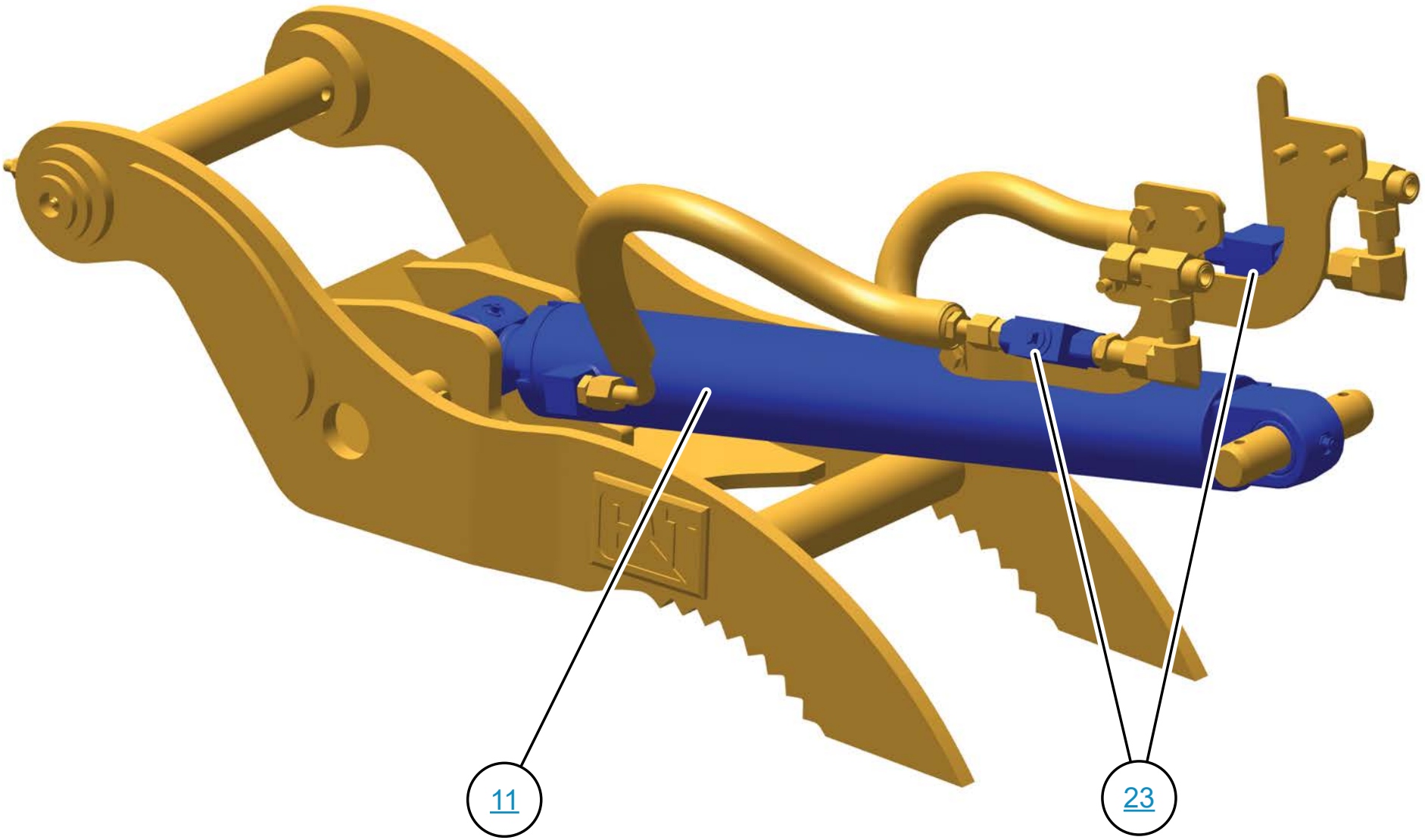
MACHINE TOP VIEW



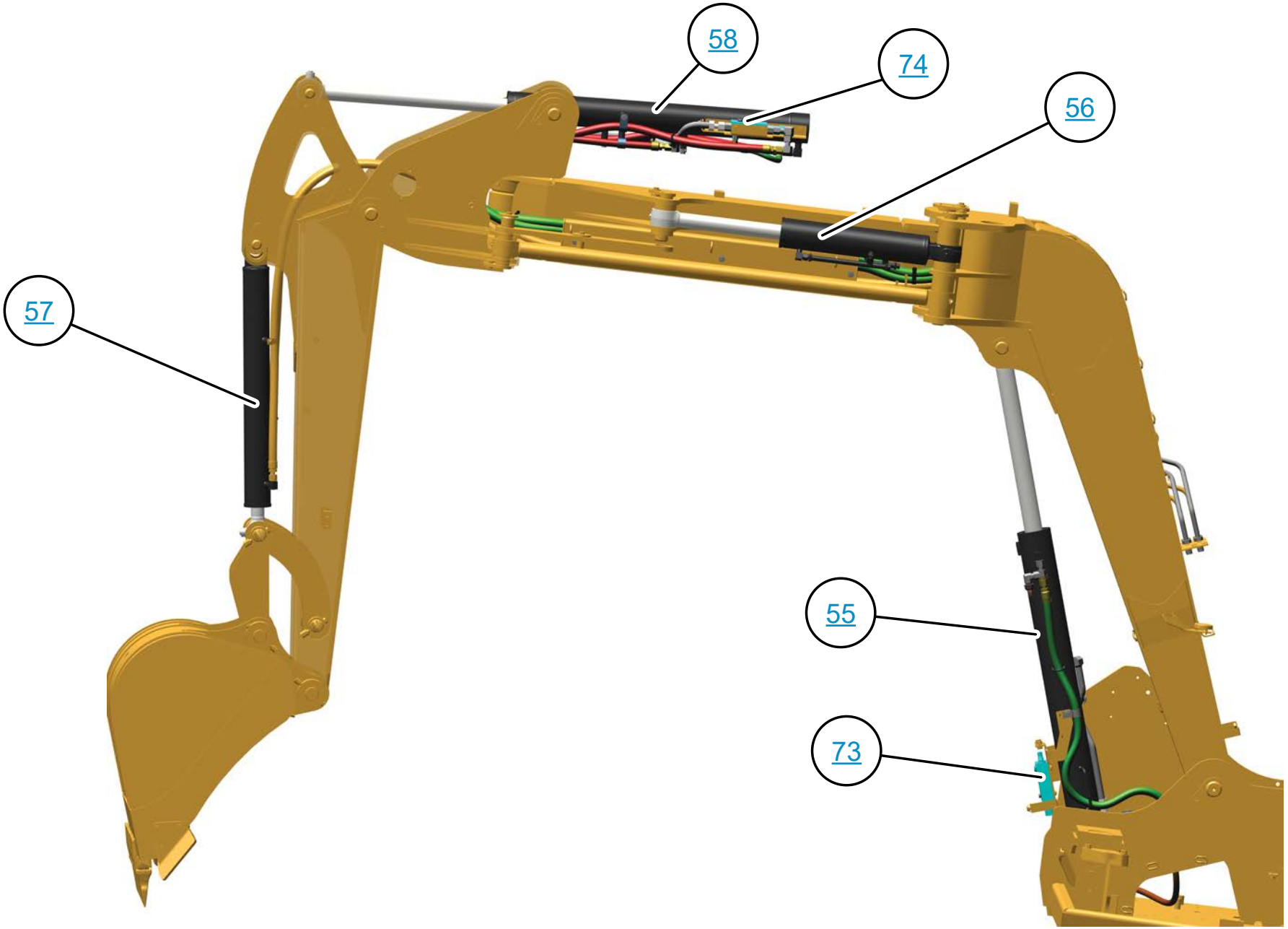
QUICK COUPLER



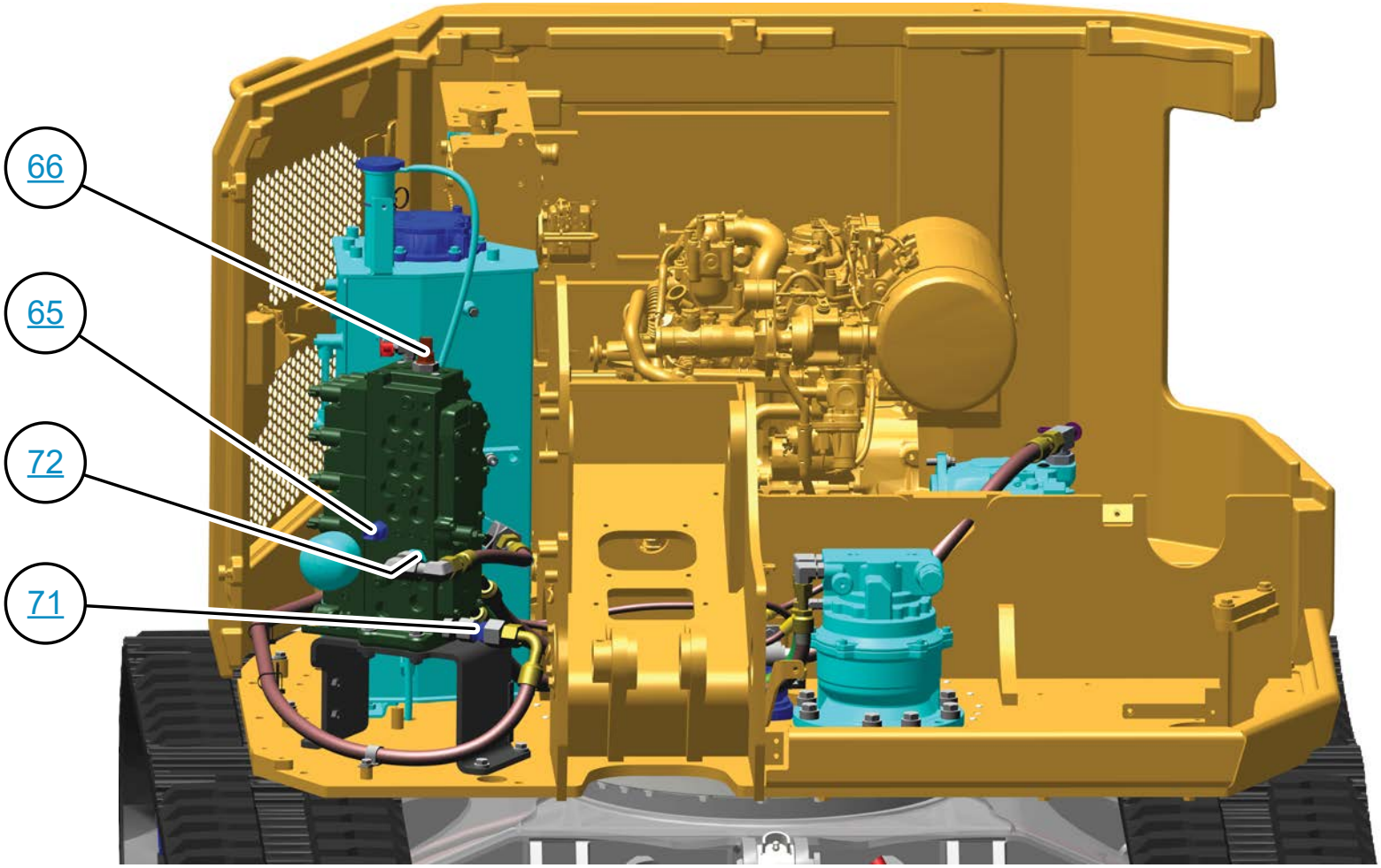
THUMB CYLINDER



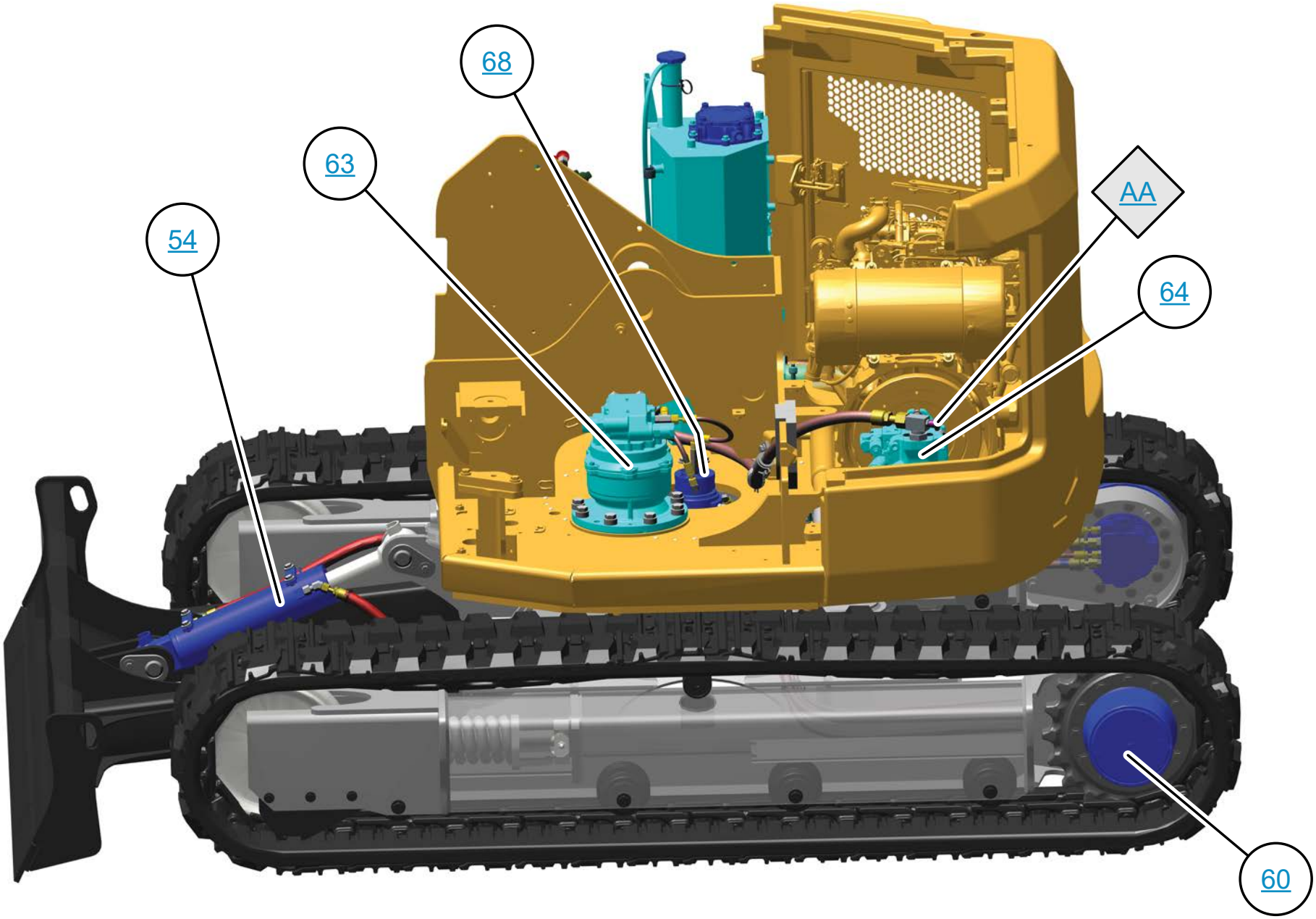
BOOM, STICK, AND BUCKET CYLINDER VIEW



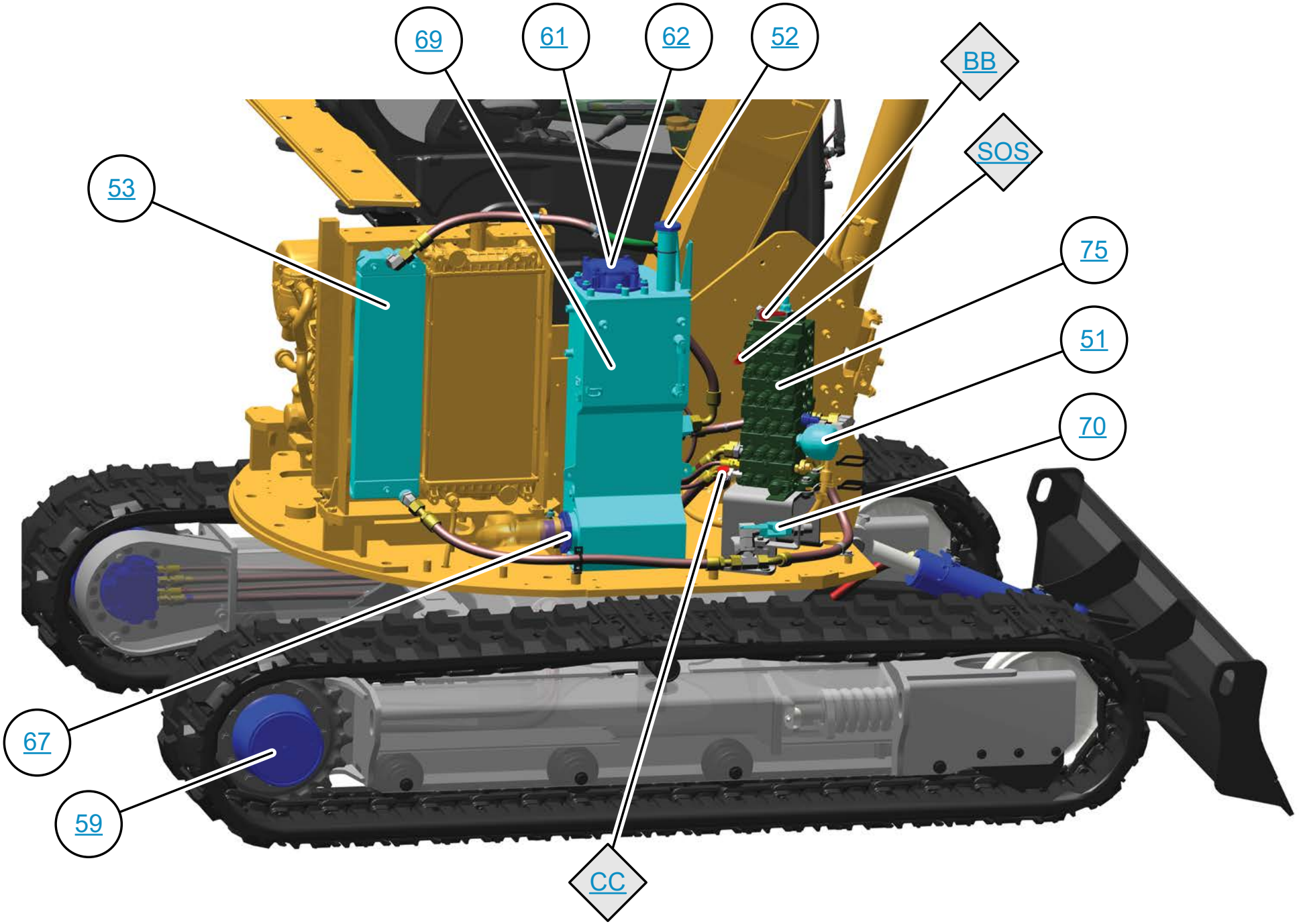
MACHINE - FRONT VIEW



MACHINE - LEFT SIDE VIEW



MACHINE - RIGHT SIDE VIEW



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General Information for Lubricants

When you are operating the machine in temperatures below −20 °C (−4 °F), refer to Operation and Maintenance Manual, SEBU5898 , "Cold-Weather Recommendations for All Caterpillar Machines". This publication is available from your Cat® dealer.

Refer to the "Lubricant Information" section in the latest revision of the Operation and Maintenance Manual, SEBU6250 , "Caterpillar Machine Fluids Recommendations" for a list of Cat® engine oils and for detailed information.

The footnotes are a key part of the tables. Read all footnotes that pertain to the machine compartment in question.

Selecting the Viscosity

To select the proper oil for each machine compartment, refer to the "Lubricant Viscosity for Ambient Temperature" table. Use the oil type and oil viscosity for the specific compartment at the proper ambient temperature.

The proper oil viscosity grade is determined by the minimum ambient temperature (the air in the immediate vicinity of the machine). Measure the temperature when the machine is started and while the machine is operated. To determine the proper oil viscosity grade, refer to the "Min" column in the table. This information reflects the coldest ambient temperature condition for starting a cold machine and for operating a cold machine. Refer to the "Max" column in the table for operating the machine at the highest temperature that is anticipated. Unless specified otherwise in the "Lubricant Viscosities for Ambient Temperatures" tables, use the highest oil viscosity that is allowed for the ambient temperature.

Machines that are operated continuously should use oils that have the higher oil viscosity in the final drives and in the differentials. The oils that have the higher oil viscosity will maintain the highest possible oil film thickness. Refer to "General Information for Lubricants" article, "Lubricant Viscosities" tables, and any associated footnotes. Consult your Cat® dealer if additional information is needed.

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NOTICE

Not following the recommendations found in this manual can lead to reduced performance and compartment failure.

Engine Oil

Cat® oils have been developed and tested to provide the full performance and life that has been designed and built into Cat® engines.

Cat® DEO-ULS or oils that meet the Cat ECF-3 specification, API CJ-4, and the newer API CK-4, are required for use in the applications listed below. Cat® DEO-ULS and oils meeting Cat® ECF-3 specification, API CJ-4, the newer API CK-4, and ACEA E9 oil categories have been developed with limited sulfated ash, phosphorus, and sulfur. These chemical limits are designed to maintain the expected aftertreatment devices life, performance, and service interval. If oils meeting the Cat® ECF-3 specification, API CJ-4, the newer API CK-4 specifications are not available, oils meeting ACEA E9 may be used. ACEA E9 oils meet the chemical limits designed to maintain aftertreatment device life. ACEA E9 oils are validated using some but not all ECF-3 and API CJ-4 standard engine performance tests. Consult your oil supplier when considering use of an oil that is not Cat® ECF-3, API CJ-4, or the newer API CK-4 qualified.

Failure to meet the listed requirements will damage aftertreatment-equipped engines and can negatively impact the performance of the aftertreatment devices. The Diesel Particulate Filter (DPF) if equipped, will plug sooner and require more frequent DPF ash service intervals.

Typical aftertreatment systems may include the following:

- Diesel Particulate Filters (DPF)
- Diesel Oxidation Catalysts (DOC)
- Selective Catalytic Reduction (SCR)

- Lean NOx Traps (LNT)

Other systems may apply.

Oils that are per API CI-4 or prior categories are not allowed. These oils have high ash and are not appropriate for use in engines with aftertreatment devices.

Table 1

Lubricant Viscosities for Ambient Temperatures						
Compartment or System	**Oil Type and Performance Requirements**	**Oil Viscosities**	**°C**		**°F**	
			Min	**Max**	**Min**	**Max**
Engine Crankcase for all Machines	**Cat DEO-ULS Cold Weather**	SAE 0W-40	−40	40	−40	104
	Cat DEO-ULS SYN	SAE 5W-40	−30	50	−22	122
	Cat DEO-ULS	SAE 10W-30	−18	40	0	104
		SAE 15W-40	−10	50	14	122
Pump Coupling (If Equipped)	**Cat DEO-ULS**	SAE 10W-30	−18	40	0	104

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Hydraulic Systems

Refer to the "Lubricant Information" section in the latest revision of the Operation and Maintenance Manual, SEBU6250 , "Caterpillar Machine Fluids Recommendations" for detailed information.

The following are the preferred oils for use in most Cat ® machine hydraulic systems:

- Cat® HYDO Advanced 10 SAE 10W
- Cat® HYDO Advanced 20 SAE 20W

- Cat® HYDO Advanced 30 SAE 30
- Cat® BIO HYDO Advanced, Multigrade

Itis recommended to follow the maintenance interval schedule for oil filter changes and for oil sampling that is stated in the Operation and Maintenance Manual for your particular machine. Consult your Cat® dealer for details. When switching to Cat® HYDO Advanced fluids, cross contamination with the previous oil should be kept to less than 10%.

Second choice oils are listed below.

- Cat® MTO
- Cat® DEO
- Cat® DEO-ULS
- Cat® TDTO
- Cat® TDTO Cold Weather
- Cat® TDTO-TMS
- Cat® DEO-ULS Cold Weather

Note: Oil drain intervals of the oils listed above are less than those of Cat® HYDO Advanced oils. An exception is Cat® TDTO Cold-Weather oil which allows 6000 hours or higher oil drain interval. Scheduled Oil Sampling (S·O·S) services oil analysis is required when the oils listed above are used in Cat® hydraulic system components and hydrostatic transmissions.

Table 2

Lubricant Viscosities for Ambient Temperatures						
Compartment or System	**Oil Type and Performance Requirements**	**Oil Viscosities**	**°C**		**°F**	
			Min	**Max**	**Min**	**Max**

Lubricant Viscosities for Ambient Temperatures						
Compartment or System	**Oil Type and Performance Requirements**	**Oil Viscosities**	**°C**		**°F**	
			Min	**Max**	**Min**	**Max**
Hydraulic System	**CatHYDO Advanced 10** Cat TDTO	SAE 10W	−20	40	−4	104
	CatHYDO Advanced 20 Cat TDTO	SAE 20W	–5	45	23	113
	Cat HYDO Advanced 30 Cat TDTO	SAE 30	10	50	50	122
	Cat BIO HYDO Advanced	"ISO 46" Multi-Grade	−30	50	−22	122
	Cat MTO Cat DEO-ULS Cat DEO	SAE 10W-30	−20	40	−4	104
	Cat DEO-ULS Cat DEO	SAE 15W-40	−15	50	5	122
	Cat TDTO-TMS	Multi-Grade	−15	50	5	122
	Cat DEO-ULS SYN	SAE 5W-40	−25	40	−13	104
	Cat DEO-ULS Cold Weather	SAE 0W-40	−40	40	−40	104
	Cat TDTO Cold Weather	SAE 0W-20	−40	40	−40	104

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For applications requiring the use of fire-resistant hydraulic fluids, Cat® recommends the use of EcoSafe FR-46. This product is a fully synthetic, non-aqueous hydraulic fluid. Water based and glycol-based hydraulic products are not recommended for use in Cat® machine hydraulic systems. EcoSafe FR-46 is an ISO 46 multi-grade product. For more information refer to the product information provided by the manufacturer of EcoSafe hydraulic oil. Refer to your Cat® dealer for availability.

Other Fluid Applications

Table 3

Excavators, Front Shovels, Mass Excavators, Demolition Excavators, and Track Material Handlers Lubricant Viscosities for Ambient Temperatures						
Compartment or System	**Oil Type and Performance Requirements**	**Oil Viscosity Grade**	**° C**		**° F**	
			Min	**Max**	**Min**	**Max**
Final Drives and Swing Drives for Small, Medium, and Large Mini Excavators along with 305.5 Excavator (GZ5 (1-3099)) and 307 Excavator (ZGC (1-Up)), and machines with the operating weight ranging between 5 Tonne to 10 Tonne.	**Cat TDTO Cold Weather**	SAE 0W-20	-40	0	- 40	32
	Cat TDTO	SAE 10W	-30	0	- 22	32
		SAE 30[1]	-30	35	- 22	95
		SAE 50	-15	50	5	122
	Cat TDTO-TMS	Multi-Grade	-25	25	- 13	77
Final Drives and Swing Drives for Mini-Excavators between (1 Tonne to 2 Tonne)	**Cat GO (Gear Oil) Cat SYNTHETIC GO commercial API GL-5 gear oil**	SAE 75W-90	−30	40	−22	104
		SAE 75W-140	-30	45	-22	113
		SAE 80W-90	−20	40	−4	104
		SAE 85W-90	−20	40	−4	104

Excavators, Front Shovels, Mass Excavators, Demolition Excavators, and Track Material Handlers Lubricant Viscosities for Ambient Temperatures						
Compartment or System	**Oil Type and Performance Requirements**	**Oil Viscosity Grade**	**° C**		**° F**	
			Min	**Max**	**Min**	**Max**
		SAE 85W-140	−10	50	14	122
		SAE 90	0	40	32	104
Final Drives and Swing Drives for 305.5 Excavator(GZ5 (3100-Up)) and 307 Excavator (WZ2 (1-Up))	**Cat GO (Gear Oil) Cat SYNTHETIC GO commercial API GL-5 gear oil**	SAE 80W-90 (2)	−20	40	−4	104
		SAE 85W-90	−20	40	−4	104
Track Roller Frame Recoil Spring and Pivot Shaft Bearings	**Cat TDTO Cold Weather**	SAE 0W-20	-40	0	- 40	32
	Cat TDTO	SAE 10W	-30	0	- 22	32
		SAE 30(3)	-20	25	- 4	77
		SAE 50	0	50	32	122
	Cat TDTO-TMS	Multi-Grade	−25	25	−13	77
Track Idlers and Track Rollers	**Cat DEO-ULS CatDEO**	SAE 15W-40(3)	-10	50	14	122
	Cat DEO Cold Weather	SAE 0W-40	−40	40	−40	104
	Cat DEO-ULS SYN	SAE 5W-40	−35	40	−31	104

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Excavators, Front Shovels, Mass Excavators, Demolition Excavators, and Track Material Handlers Lubricant Viscosities for Ambient Temperatures						
Compartment or System	**Oil Type and Performance Requirements**	**Oil Viscosity Grade**	**° C**		**° F**	
			Min	**Max**	**Min**	**Max**
	Cat FDAO SYN	Multi-Grade	-30	50	-22	122

(1) Factory fill oil for standard configuration machines.

(2) Factory fill oil for standard configuration machines.

(3) Factory fill oil for standard configuration machines.

Special Lubricants

Grease

To use a non-Cat® grease, the supplier must certify that the lubricant is compatible with Cat® grease.

Each pin joint should be flushed with the new grease. Ensure that all old grease is removed. Failure to meet this requirement may lead to failure of a pin joint.

Table 4

Recommended Grease						
Compartment or System	**Grease Type**	**National Lubricating Grease Institute (NLGI) Grade**	**°C**		**°F**	
			Min	**Max**	**Min**	**Max**
External Lubrication Points	**Cat Prime Application Grease**	NLGI Grade 2	−20	140	−4	284

Recommended Grease						
Compartment or System	Grease Type	National Lubricating Grease Institute (NLGI) Grade	°C		°F	
			Min	Max	Min	Max
	Cat Extreme Application Grease	NLGI Grade 1	−20	140	−4	284
		NLGI Grade 2	−15	140	+5	284
	Cat Extreme Application Grease-Artic	NLGI Grade 0.5	-50	130	-58	266
	Cat Extreme Application Grease-Desert	NLGI Grade 2	−10	140	+14	284
	Cat Utility Grease	NLGI Grade 2	−20	140	−4	284
	Cat Ball Bearing Grease	NLGI Grade 2	−20	160	−4	320

Diesel Fuel Recommendations

Diesel fuel must meet Cat® specification for distillate fuel and the latest versions of "ASTM D975" or "EN 590" to ensure optimum engine performance. Refer to Operation and Maintenance Manual, SEBU6250 , "Caterpillar Machine Fluids Recommendations" for the latest fuel information and for Cat® fuel specification.

The preferred fuels are distillate fuels. These fuels are commonly called diesel fuel, furnace oil, gas oil, or kerosene. These fuels must meet the Caterpillar Specification for Distillate Diesel Fuel for Off-Highway Diesel Engines. Diesel Fuels that meet the Cat® specification will help provide maximum engine service life and performance.

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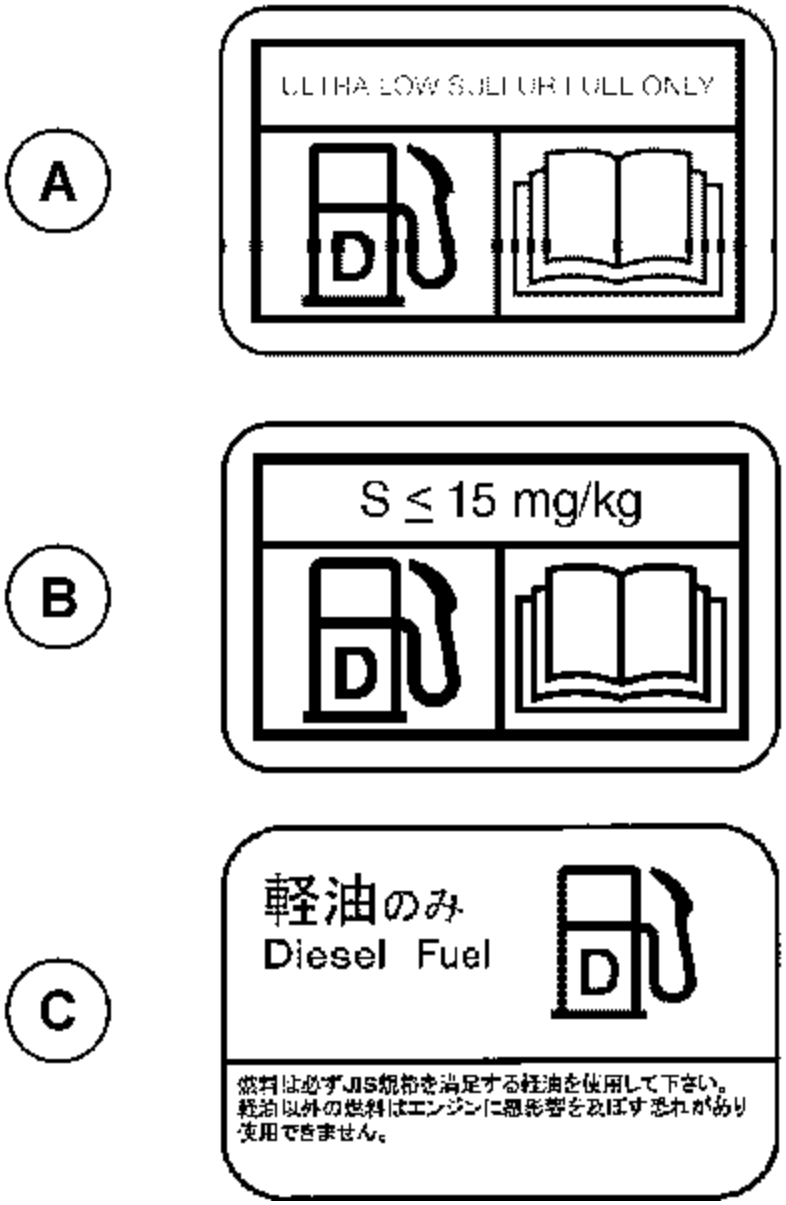

Illustration 1 g03218956

(A) North America film

(B) Europe, Africa, Middle East film

(C) Japan film

NOTICE

Ultra Low Sulfur Diesel (ULSD) fuel 0.0015 percent (≤15 ppm (mg/kg)) sulfur is required by regulation for use in engines certified to nonroad Tier 4 standards (U.S. EPA Tier 4 certified) and that are equipped with exhaust aftertreatment systems.

European/China ULSD 0.0010 percent (≤10ppm (mg/kg)) sulfur fuel is required by regulation for use in nonroad engines type-approved to EU Stage V / China Nonroad Stage IV. Additionally, the Cetane number should not be less than 45, and the bio-diesel content should not be greater than 20% volume/volume.

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Misfueling with fuels of high sulfur level can have the following negative effects:

- **Shorten the time interval between aftertreatment device service intervals (cause the need for more frequent service intervals).**
- **Adversely impact the performance and life of aftertreatment devices (cause loss of performance).**
- **Reduce regeneration intervals of aftertreatment devices.**
- Reduce engine efficiency and durability.
- Increase the wear.
- Increase the corrosion.
- Increase the deposits.
- Lower fuel economy.

- Shorten the time period between oil drain intervals (more frequent oil drain intervals).
- Increase overall operating costs.

Failures that result from the use of improper fuels are not Cat® factory defects. Therefore the cost of repairs would not be covered under a Cat® warranty.

Caterpillar does not require the use of ULSD in off road and machine applications that are not Tier 4/Stage IIIB certified engines. ULSD is not required in engines that are not equipped with after treatment devices.

Follow operating instructions and fuel tank inlet labels, if available, to ensure that the correct fuels are used.

Refer to Operation and Maintenance Manual, SEBU6250 , "Caterpillar Machine Fluids Recommendations" for more details about fuels and lubricants.

Fuel Additives

Cat® Diesel Fuel Conditioner and Cat® Fuel System Cleaner are available for use when needed. These products are applicable to diesel and biodiesel fuels. Consult your Cat® dealer for availability.

Biodiesel Fuel Recommendations

NOTICE

Never use raw vegetable or plant-based oils in place of esterified biodiesel.

The use of oils that are not esterified can lead to engine damage, up to and including engine failure.

Biodiesel is a fuel that can be made from various renewable resources that include vegetable oils, animal fat, and waste cooking oil. These oils and fats are chemically processed (esterified), and filtered to remove water and contaminants.

For biodiesel storage requirements, consult your fuel supplier.

Note: In some regions, biodiesel blends are known as Fatty Acid Methyl Ester (FAME).

Use biodiesel blends that meet national, regional, and local standards.

For more information on biodiesel standards, and to reduce the risks associated with biodiesel usage, refer to Operation and Maintenance Manual, SEBU6250 , "Caterpillar Machine Fluids Recommendations".

Biodiesel Blend Limits

NOTICE

The use of biofuel blends above the acceptable limit can lead to higher engine downtime.

Biodiesel blend levels up to B20 are acceptable to use in this product.

The use of higher biodiesel blend levels are acceptable in regions where mandated. Consult your Cat® dealer.

Note: The energy density of biodiesel blends above B20 are noticeably lower than diesel fuel.

Note: For engines equipped with emission aftertreatment devices, biodiesel blends must be blended with U.S. Ultra Low Sulfur Diesel, or European Sulfur Free Diesel.

Coolant Information

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The information provided in this "Coolant Recommendation" section should be used with the "Lubricants Information" provided in the latest revision of Operation and Maintenance Manual, SEBU6250 , "Caterpillar Machine Fluids Recommendations".

The following two types of coolants may be used in Cat® diesel engines:

Preferred

- Cat® ELC (Extended Life Coolant)

Acceptable

- Cat® DEAC (Diesel Engine Antifreeze/Coolant)

NOTICE

Never use water alone as a coolant. Water alone is corrosive at engine operating temperatures. In addition, water alone does not provide adequate protection against boiling or freezing.

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WARNING

Personal injury or death can result from grease under pressure.

Grease coming out of the relief valve under pressure can penetrate the body causing injury or death.

Do not watch the relief valve to see if grease is escaping. Watch the track or track adjustment cylinder to see if the track is being loosened.

Loosen the relief valve one turn only.

If track does not loosen, close the relief valve and contact your Caterpillar dealer.

NOTICE

Keeping the track properly adjusted will increase the service life of the track and drive components.

Note: The track tension must be adjusted according to the current operating conditions. Keep the track as slack as possible if the soil is heavy.

Measuring Track Tension

1. Swing the upper structure so that the upper structure is perpendicular to the tracks.
2. Lower the bucket to the ground.
3. Raise the blade fully.
4. Apply gradual downward pressure with the boom until the track is lifted off the ground.
5. Block the machine by using the appropriate blocks and lower the frame onto the blocks.

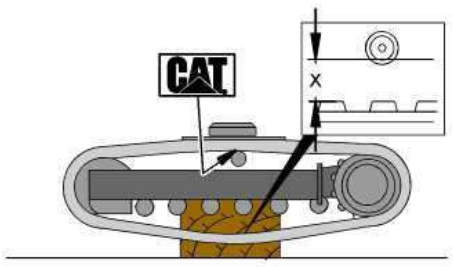

Illustration 1 g06338944

Example of the machine on blocks.

6. Operate the track until the "CAT" symbol that is on the track is above the track carrier roller.
7. Measure the sag in the track.
   a. **Rubber Track**

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Measure the distance between the track and the wear surface of the track roller. Dimension (X) should be 10 to 15 mm (0.39 to 0.59 inch). Adjust the tension on the track until dimension (X) is reached.

b. **Steel Track**

With the steel track not contacting the ground and link pin directly over the top of the carrier roller, measure the sag at the bottom from the wear surface of the track link to the wear surface of the closest track roller. This dimension should be 25 to 35 mm (0.98 to 1.38 inch). Adjust the tension on the track until dimension is reached.

8. Tighten the tension of the track. Refer to Operation and Maintenance Manual, "Track Adjustment - Adjust" for the correct procedure.

9. Repeat Step 1 through Step 8 for the other track.

Adjusting Track Tension

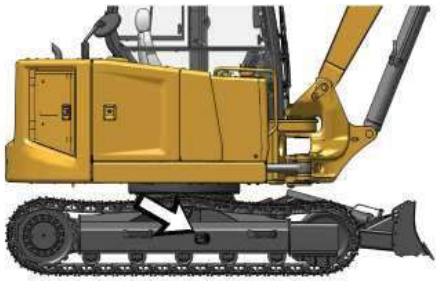

Illustration 2 g06338940

The track adjuster is on the track frame.

Tightening the Track

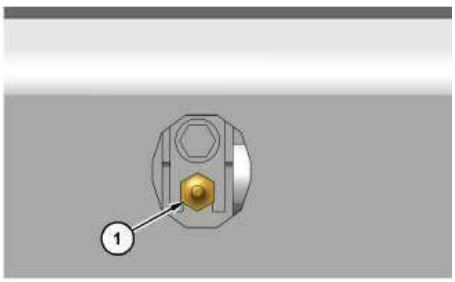

Illustration 3 g06442994

(1) Grease valve

Wipe the fitting before you add grease.

1. Add grease through grease valve (1) until the correct track tension is reached.

2. Operate the machine back and forth to equalize the pressure.

3. Check the amount of sag. Adjust the track, as needed.

Loosening the Track

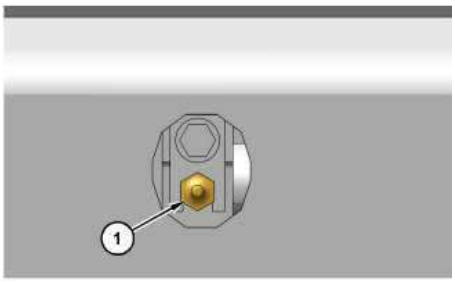

Illustration 4 g06442994

(1) Grease valve

1. Loosen valve (1) carefully until the track begins to loosen. One turn should be the maximum.
2. Tighten grease valve (1) to 34 ± 5 N·m (25 ± 4 lb ft) when the desired track tension is reached.
3. Operate the machine back and forth to equalize the pressure.
4. Check the amount of sag. Adjust the track, as needed.

If the correct adjustment cannot be achieved, consult your Cat dealer.

Storage of Rubber Belt Tracks (If Equipped)

If a rubber track needs to be stored for an extended time, store the rubber track in a well ventilated area that is not exposed to direct sunlight. The tracks should be operated monthly while the tracks are in storage. If the rubber track is not stored on a machine, do not roll the track in a small radius.

Break in Period for the Rubber Track (If Equipped)

A rubber track that has been replaced requires a break-in period of 200 service hours. Adjust the track in 50-hour intervals during the break-in period.

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Track adjusting systems use either grease or oil under high pressure to keep the track under tension.

Grease or oil under high pressure coming out of the relief valve can penetrate the body causing injury or death. Do not watch the relief valve to see if grease or oil is escaping. Watch the track or track adjustment cylinder to see if the track is being loosened.

The pins and bushings in a dry track pin joint can become very hot. It is possible to burn the fingers if there is more than brief contact with these components.

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Mini Hydraulic Excavator
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Introduction

Rubber tracks are used for various applications under a wide variety of operating conditions. During the service life of a rubber track, various types of damage may occur. Some applications do not affect continued usage of the rubber tracks. Some applications can damage the rubber tracks and the rubber tracks will require replacement.

This Special Instruction also shows the construction of rubber tracks, different types of track damage and likely causes of damage. This Special Instruction also shows operating practices to extend the service life of rubber tracks to help reduce premature failure.

For further information on rubber track application and wear, refer to Special Instruction, REHS1300 , "Evaluating the Condition of Rubber Tracks".

Structure of a Typical Rubber Track

A typical rubber track consists of steel and fabric cords or the rubber track consists of bands with a molded rubber outer casing. The outer casing also contains embedded metal components that form the engagement for the final drive system. The outer casing will give stiffness to the track across the width.

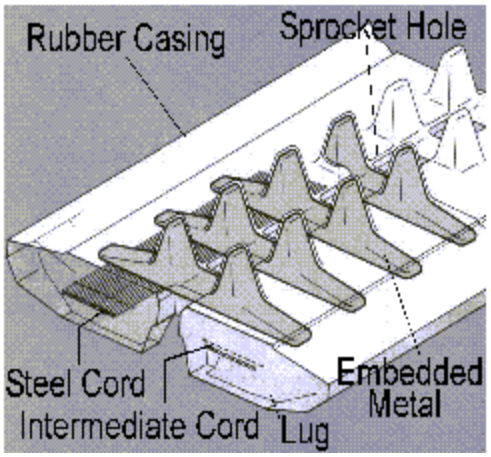

Illustration 1 g01794234

General Factors that Affect the Track Wear

Application

The amount of torque and horsepower that is required by any application will affect the wear rate of the tracks. For example, abnormal amounts of dozing operations will increase wear on embedded metals and drive sprockets.

Materials and Ground Conditions

The ground condition during machine operation will affect the wear of the rubber tracks. The wear affects both the lug side and the opposite side of the rubber tracks. Abrasive materials or corrosive materials will cause wear to the lug side during turning and traveling but can also become clogged in the undercarriage. Corrosive materials will increase the wear rate of embedded metals and drive components.

Harsh conditions such as rocky ground or demolition sites will have a great effect on the life of rubber tracks. Harsh ground conditions will cause wear to the lug side of the track and results in cuts and tears to the edges and lugs of the tracks.

Light ground conditions such as soft dirt, grass, or finished landscape areas will cause least damage and lowest wear rates.

Terrain

The contour and the grade of the ground is referred to as the terrain. Most of the wear on the undercarriage components are caused by rugged terrain and steeper grades. Large amounts of side hill driving or driving across a grade will increase the wear to certain areas of the embedded metals. Side hill driving or driving across a grade will also create a side loading on the idler wheels.

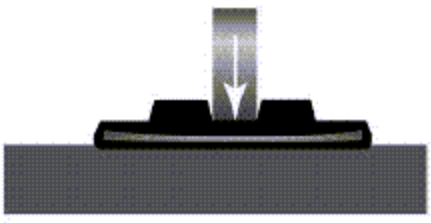

Illustration 2 g01794402

Roller forces on flat ground

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On a flat surface, the machine weight is spread through the track roller to the full ground contact area of the track. Minimal machine weight is applied to the sides of the embedded metals.

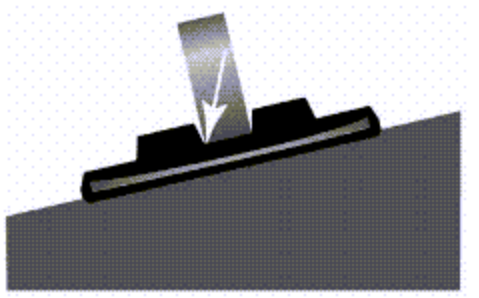

Illustration 3 g01794404

Roller forces on Side slope

On side slopes, the machine weight shifts so the roller wheels and drive components increase contact pressure to the guiding surface of the embedded metals. Excessive wear to the edge of the guide lugs on embedded metals is attributed to operating on slopes. Excessive wear to the edge of the guide lugs is normal.

Operating Technique

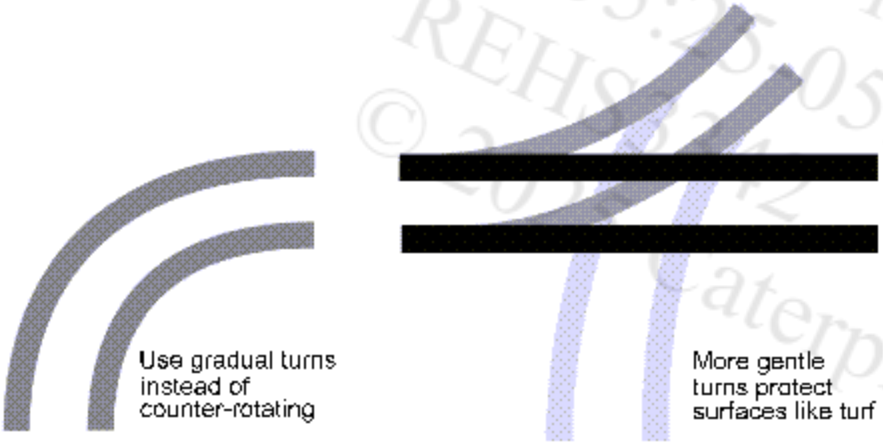

Illustration 4 g01794479

Turning technique to reduce track wear

The operating method of the machine causes the greatest effect on the life of the rubber tracks. Aggressive operation will increase the rate of wear and overall operating costs of the machine. For example, making quick turns by turning gradually can cause increased track wear versus turning counterrotating.

Undercarriage Maintenance

Regular checking of the track tension and proper adjustment of track tension maximizes the service life of the track. Maintaining the track tension also maximizes the machine performance. Tracks that are too tight can reduce the service life and machine performance. Loose tracks that will also reduce service life and machine performance. Low track tension can also cause derailment of the track.

Cleanliness of the machine undercarriage is also critical. Removing debris and attached dirt and foreign material from the rollers, idler wheels, and track sprockets avoids unnecessary wear and damage to drive components.

Summary

- The track tension should be checked. The tension should be adjusted if needed. Refer to the machine Operation and Maintenance Manual.
- The rubber track life is greatly affected by the terrain. In adverse conditions, careful driving and lower speeds reduce wear.
- Extra care should be taken in order to avoid environments that are contaminated by salt or oil to ensure maximum life.
- To avoid bonding or corrosion failures, tracks should be repaired when damage has occurred.
- Before installing a new track, check the condition of the driving system. Replacement of the sprocket or idler wheel may be required.
- Keep the driving system clean of mud, stones, and other foreign substances.

Types of Damage

Cut Steel Cords

Replacement is required.

Causes of Damage

Over tension of the rubber tracks can cause tension in excess of the necessary strength to break the embedded steel cords. Over tensioning under normal operation can occur in the following circumstances.

- When the rubber track is de-tracking, the idler or the sprocket rides on the projections of the embedded metal.

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- When the rubber track is de-tracked, projections of the rubber tracks get stuck between the frame, the idler, or the drive wheel of the undercarriage.
- The rubber track can be clogged or blocked with foreign obstacles.

In addition, when moisture gets through a cut on the lug side of the rubber track surface, the embedded steel cords will corrode. The deterioration of the design strength may lead to broken steel cords.

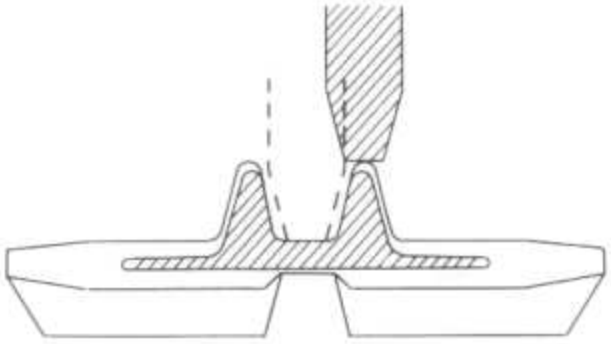

Illustration 5 g01794645

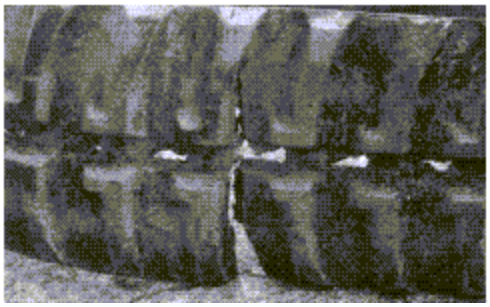

Illustration 6 g01794657

Prevention

The following precautions should be taken in order to minimize the risk of this damage.

- Occasional checking of track tension in line with the requirements of the Operation and Maintenance Manual
- Avoid quick turns in uneven ground conditions. Avoid quick turns in rocky ground conditions also.

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- Avoid stones and other articles that may clog or block the track.
- Avoid driving over sharp objects. If avoiding sharp objects is not possible, making turns when driving over sharp objects should always be avoided.

Abrasion of Embedded Metal

Replacement is required when the width of the embedded metals becomes 67 percent or less of the original width.

Causes of Damage

In proportion to the track service life, embedded metals are gradually worn down. Abrasion of embedded metals is inevitable due to the contact between idler wheels and drive sprockets during operation. This type of track damage can be found due to operating environment and normal wear. The following circumstances can sometimes accelerate this wear.

- Sprocket design does not correspond with the design of the embedded metals.
- Rubber tracks are driven with an extra ordinary heavy load. Steep gradients or towing operations would be examples.
- Rubber tracks are used in sandy environments as well as other abrasive environments.

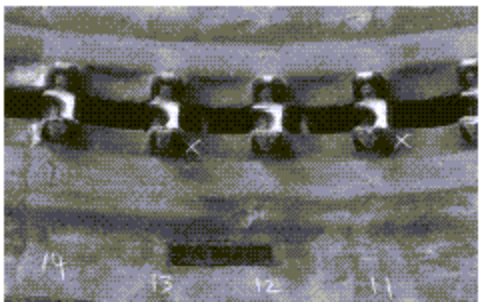

Illustration 7 g01794894

Excessive abrasion of embedded metals

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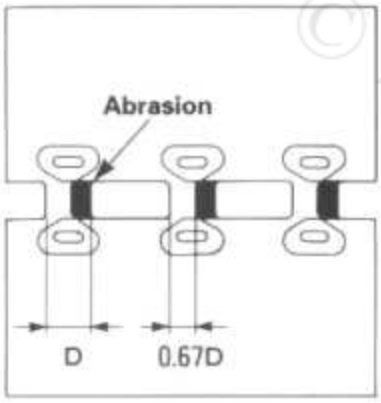

Illustration 8 g01794895

Abrasion measurement

Prevention

If rubber tracks are used under normal operating conditions excessive or abnormal abrasion is unlikely to occur. The wear rate of the embedded metals should be checked regularly. The checks should occur regularly if machines perform dozing operations and towing operations. If the machine is operating in an abrasive material environment, these checks should be performed more often.

Separation of Embedded Metals Due to External Forces

Even partial separation of embedded metals requires replacement of the complete track.

Causes of Damage

Embedded metals are adhered between the steel cords and the rubber body of the track. The following cases generate external forces that are greater than the adhesion strength. This causes separation of the embedded metals.

- Continual riding of the idler roller on the projections of embedded metals may cause the metals to be peeled off the main body of the track.
- When rubber tracks derail, the track can become stuck between the guide frame and the undercarriage frame.
- Abnormally worn down sprockets may pull embedded metals out of the track body.

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Illustration 9 g01795034

Separation of embedded metals cause damage.

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Prevention

The following precautions should be taken in order to minimize the risk of damage to the track.

- Occasional checking of track tension in line with the requirements of the Operation and Maintenance Manual
- Avoid quick turns in uneven ground conditions. Also avoid quick turns in rocky ground conditions.
- Avoid stones and other articles that may clog or block the track.
- Avoid driving over sharp objects. If avoiding sharp objects is impossible, making turns when driving over sharp objects should always be avoided.

If abnormal abrasion of drive sprockets is observed, the sprocket should be replaced immediately.

Separation of Embedded Metals Due to Corrosion

Even partial separation of embedded metals requires replacement of the complete track.

Causes of Damage

Embedded metals are adhered to the rubber body of the track. The following operating conditions cause embedded metals to corrode causing deterioration of the adhesion, and results in separation of the embedded metals from the rubber body.

- Excessively corrosive environment such as sea salt
- Strong acidic or strong alkaline environments that are stronger than normal
- Grounds with compost or fertilizer

The track rollers gradually wear down the rubber surface of the track. The wear will eventually expose the embedded metals and the embedded metals will corrode. The corrosion results in the

separation of the embedded metals from the rubber body of the track.

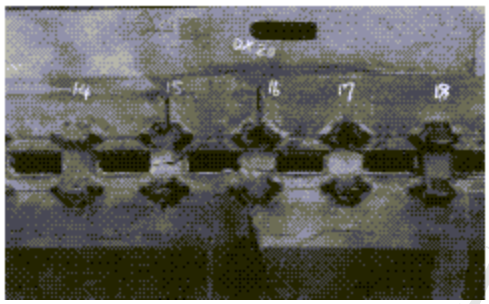

Illustration 10 g01796013

Damage that has been caused by corrosion

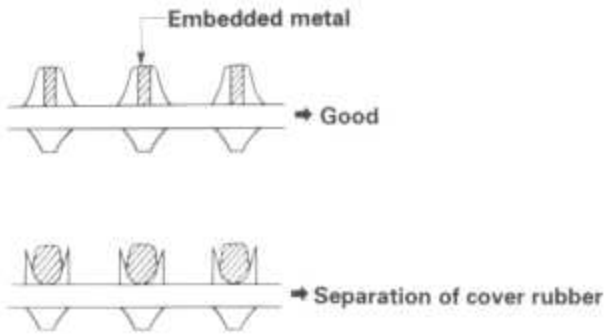

Illustration 11 g01796014

Separation of rubber cover from embedded metals

Prevention

If rubber tracks are used under the above conditions, then the rubber tracks should be washed with plenty of water. Dry the track after use. When the rubber cover is separated from the embedded metals and the metals become loose in the rubber body of the track, replacement of the track should be considered.

Cuts on the Lug Side of the Rubber Track Body

When a cut on the lug side of the rubber track reaches the embedded steel cords in the track, the track should be repaired immediately. The repair is done to prevent failure of the steel cords through corrosion.

Cause of Damage

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When rubber tracks drive over projections or sharp stones, then the concentrated forces that are applied will cause cuts on the lug side rubber surface. Turning on projections or sharp stones will increase the chance of cuts to the track. If the cut runs through the embedded steel cords, then failure due to corrosion may result.

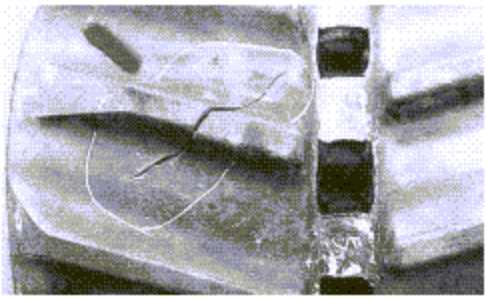

Illustration 12 g01796054

Cuts in the lug side of the track body

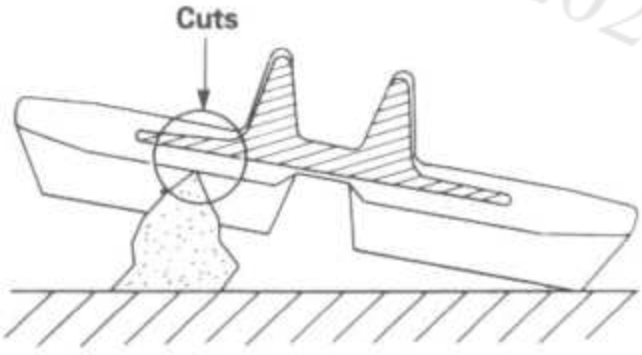

Illustration 13 g01796056

Track damage from a sharp object

Prevention

Machine operators should drive with attention to the surface conditions especially in the terrain's of the following types.

- Construction sites
- Demolition sites
- Rocky paths
- Concrete ridges

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- Plowed fields

When the operator is working on terrain types that were mentioned above, the operator should avoid high-speed drive. Also, any sharp turns should be avoided and also should not perform excessive loading.

Cracks on the Lug Side of the Rubber Track Body Due to Fatigue

Small cracks can appear around the root of the track lugs as a result of operation fatigue. When the cracks are deep enough to expose the steel cords, complete track replacement.

Cause of Damage

Small cracks may appear at the root of the track lug due to stresses applied to the rubber during operation. The fatigue that is caused by the rolling of the track around the idler wheel and drive sprocket causes cracks. Fatigue happens especially on the lug side rubber surface. Rubber tracks are more likely to suffer from ozone cracks when the tracks are operated at low temperatures. Ozone cracks also occur in harsh environments such as salt water or sand.

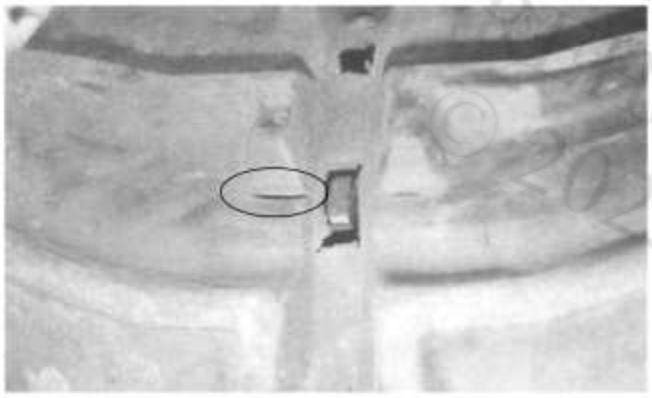

Illustration 14 g01796113

Fatigue cracking

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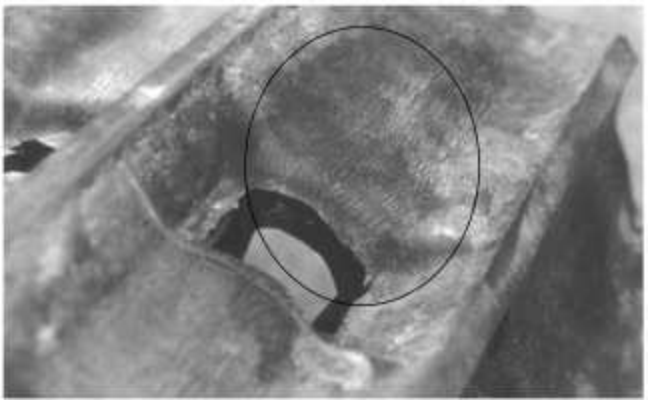

Illustration 15 g01796114

Ozone cracking

Prevention

Rubber tracks are manufactured by using special material compounds to prevent fatigue cracks. However, surface damage on the lug side rubber increases the chances of cracking. In order to avoid cuts on the lug side rubber surface of the tracks, operators should be careful driving.

To minimize the occurrence of ozone cracks, attention should be paid to the following maintenance instructions.

- Avoid exposing stored tracks to direct sunlight.
- Avoid exposing stored tracks to direct rain and snow.
- The tracks should be used at least once a month.

Lug Abrasion

As service time increases, the lug side of the track is abraded. Lug side abrasion is normal component wear and component replacement is not required.

Causes of Damage

Lug abrasion is inevitable and does not affect the use of the track. As lug height decreases, traction performance will deteriorate. It is recommended to replace the track when lug height becomes less than 5 mm (0.20 inch).

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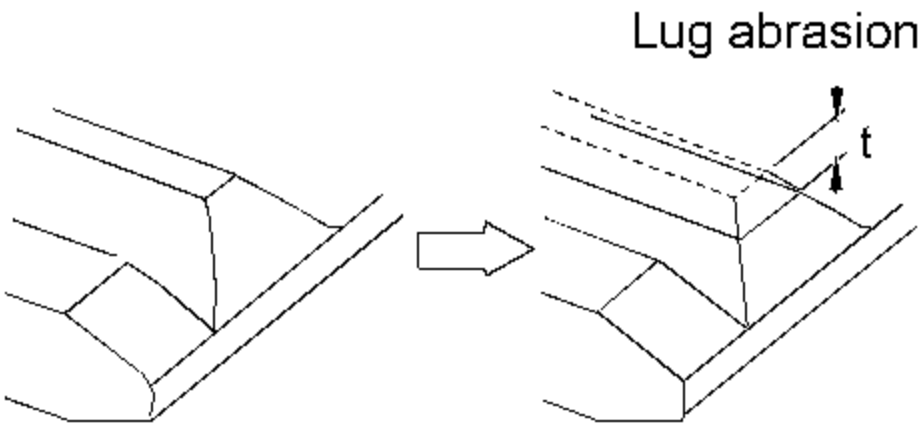

Illustration 16 g01796514

Lug abrasion

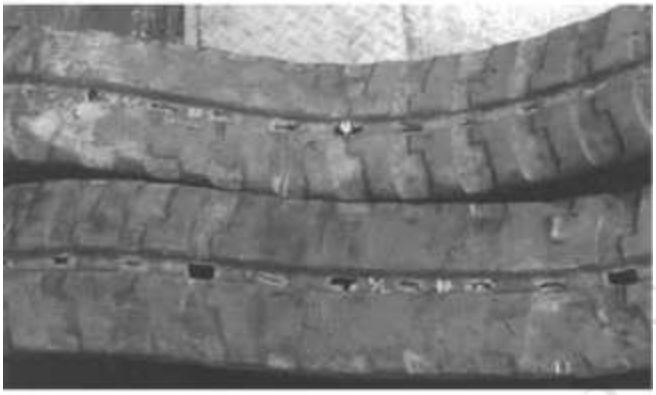

Illustration 17 g01796535

Example of worn track

Prevention

In order to protect the track from abnormal or premature lug wear, the following operating conditions should be avoided.

- Making quick and repeated turns on concrete, asphalt, and other hard surfaces such as roads and pavements
- Repeated driving up and down steep grades where track slippage occurs.
- Making frequent turns on rocky or highly uneven surfaces.

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Cracks and Cuts on Lug Side Rubber

Sometimes cuts on the lug side rubber surface occur at the edges of the embedded metals. Replacement is not required unless the cuts on the lug side rubber are discovered all around the edges of the embedded metals. Cuts all around the edges could result in complete failure.

Causes of Damage

When rubber tracks drive over sharp projections, areas of high stress form on the lug side rubber surface, especially at the edges of the embedded metals causing cracks and cuts.

Illustration 18 g01796674

Example of cuts in lug side rubber

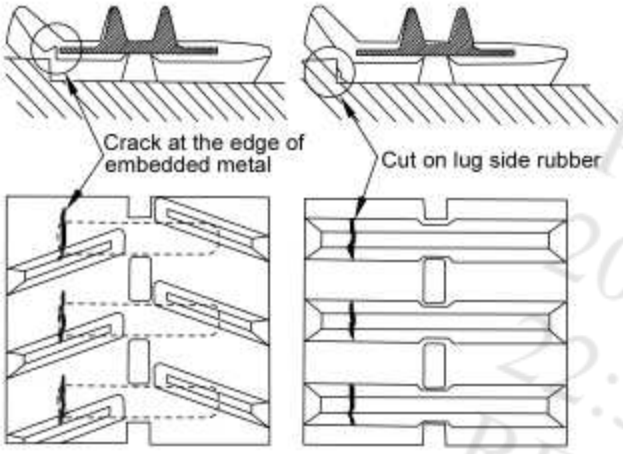

Illustration 19 g01796676

Operating conditions resulting in cuts and cracks

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Prevention

To avoid intense stress applied to the lug root where the metals are embedded, machine operators should avoid driving over curbs, ridges, and corners of road-stones or blocks.

Abrasion of Track Roller Rubber Surface

The rubber surface on which the track rollers and drive sprocket run is gradually abraded. This results in the exposure of the embedded metals. Replacement of the track is not necessary unless more than half of the embedded metals are exposed.

Causes of Damage

The abrasion of the track roller side rubber surface occurs under normal operation, but can be accelerated under certain operating conditions. The level of abrasion will increase when rubber tracks are operated in sandy or gravel conditions, also in ground conditions where dirt can become stuck to the track rollers and drive components. After extended periods of abrasion it is more likely for the track to fail through corrosion of steel cords, due to water ingress around the embedded metals.

Illustration 20 g01797653

Example of abrasion of rubber side track rubber

Prevention

After operation in sandy or gravel conditions or ground conditions where dirt may become stuck to the track rollers and drive components, operators should wash down the machine to remove these materials.

Cuts and Tears on Track Edges

The edges of the rubber track do not have special reinforcements. Under certain operating conditions the edge of the track may be cut or torn. In such cases the track does not need replaced.

Causes of Damage

The damage is caused by objects in the field or by interference with the machine.

In the case of damage by objects on the ground:

- The edges of rubber tracks are often deformed by bumpy ground conditions, stones, and other objects. Bumpy ground conditions cause high stress areas on the edges of the track, resulting in damage. When machines drive over concrete ridges, curbs, or large rocks, then this type of damage easily occurs.

In the case of damage by interference with the machine:

- If a machine operates with derailed rubber tracks, the track may be caught on the undercarriage of the machine or the drive components resulting in damage.
- When a machine travels along severe side slopes, the rubber tracks may be deformed to the point where the tracks come into contact with the structure of the undercarriage resulting in damage.

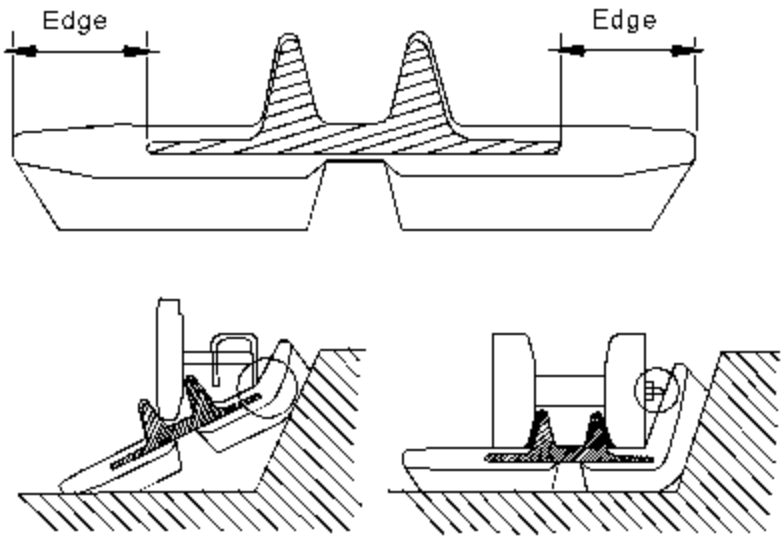

Illustration 21 g01797814

Edge section of rubber track

Examples of applications where damage can occur

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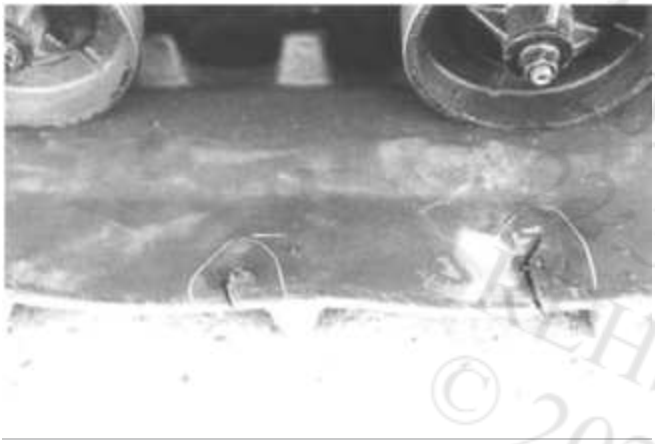

Illustration 22 g01797817

Example of cutting on track edge

Prevention

When traveling the operator should be careful not to drive over any projections on the ground. The operator should also prevent rubber tracks from coming into contact with concrete walls, ditches, and ridges. If rubber tracks are derailed, the machine should be stopped immediately to realign the track.

Additional Examples of Track Wear and Damage

Illustration 23 g01798234

Lug abrasion 1

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Illustration 24 g01800760

Lug abrasion 2

Illustration 25 g01798253

Lug side cuts 1

Illustration 26 g01800813

Lug side cuts 2

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Illustration 27 g01798254

Cuts and tears on track edges 1

Illustration 28 g01801093

Cuts and tears on track edges 2

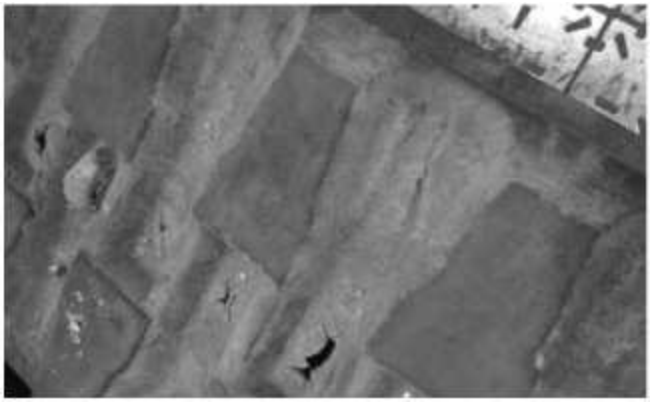

Illustration 29 g01798256

Lug side cracks 1

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Illustration 30 g01801133

Lug side cracks 2

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