UNIT 2

Intermediate Hydraulics-- 950G Wheel Loader

Unit Objectives:

Upon completion of this unit, the student will be able to:

1. Identify all components in the 950G Wheel Loader electro-hydraulic implement system and command control steering system.
2. State the function of all components in the 950G Wheel Loader electro-hydraulic implement system and command control steering system.
3. Trace the oil flow through various schematics of both the 950G Wheel Loader electro-hydraulic implement system and command control steering system.
4. Using the procedures in the Service Manual, test and adjust the 950G Wheel Loader electro-hydraulic implement system and command control steering system.

Introduction

This unit covers the components nomenclature, functions, locations, systems operation, and testing and adjusting procedures for the Electro-Hydraulic Implement System and the Command Control Steering System.

The Electro-Hydraulic Implement System is a replacement for the Pilot Operated Hydraulic System and the Command Control Steering System is a replacement for the Conventional Steering System. Both systems are available on the Caterpillar G-Series Medium Wheel Loaders.

The information in this unit covers the 950G, 962G, 966G, 972G and 980G Wheel Loaders. However, specifications may not be the same. When performing the testing and adjusting procedures, use the Service Manual for the machine being tested.

Lesson 1: Electro-Hydraulic Implement System

950G Wheel Loader

- **Electro-Hydraulic Implement System**
- **Command Control Steering System**

Introduction

On machines equipped with the electro-hydraulic implement system, the operator's lever is attached to the appropriate lever position sender. When the operator moves the lever, the lever position sender sends a pulse width modulation (PWM) signal to the Electronic Control Module (ECM). The ECM analyzes the input signal and sends a proportional signal to energize the appropriate pilot valve solenoid. The pilot valve solenoid opens the pilot valve which sends pilot oil to move the implement control valve spool. The implement control valve spool directs the main pump oil to move the implement.

Objectives

Upon completion of this lesson, the student will be able to:

1. Identify components of the 950G Wheel Loader electro-hydraulic implement system.
2. State the function of the 950G Wheel Loader electro-hydraulic implement system in all positions (tilt back, lower, float etc...).
3. Trace the oil flow through the 950G Wheel Loader electro-hydraulic implement system in all positions (tilt back, lower, float etc.)
4. Perform the testing and adjusting procedures as stated in the 950G and 962G Wheel Loaders Electro-Hydraulic System, Testing and Adjusting Module (Form No. RENR2146).

Fig. 2.1.1

When discussing the hydraulic system operation, both sectional view and graphic symbol schematics will be used. The system will be explained by tracing oil flow from the tank, through the system and back to the tank.

ELECTRO-HYDRAULIC IMPLEMENT SYSTEM COMPONENTS

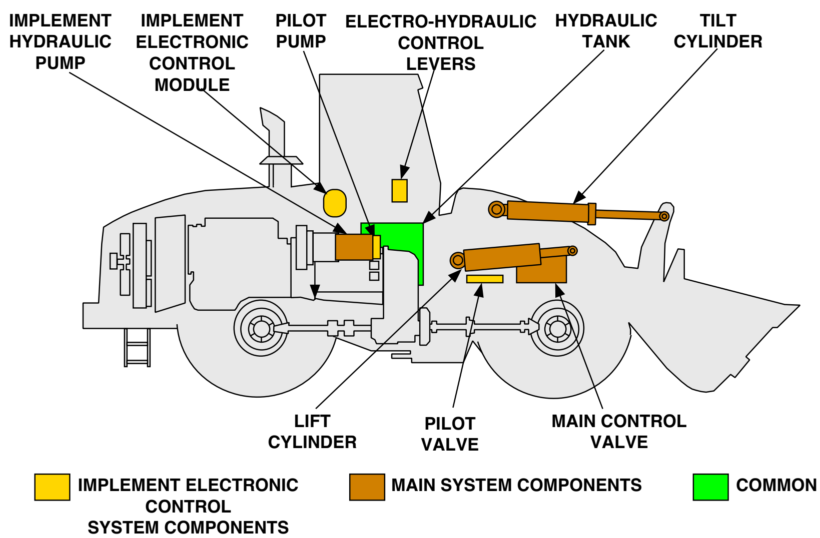

Fig. 2.1.2

ELECTRO-HYDRAULIC IMPLEMENT SYSTEM

Figure 2.1.2 shows the major components of the electro-hydraulic implement system.

The implement hydraulic system is composed of the following systems:

Implement Electronic Control System: Pilot valve (oil manifold), pilot and brake pump, implement electronic control module, the control levers, and the implement lockout switch.

Main Hydraulic System: Main control valve, auxiliary cylinders (if equipped), tilt cylinder, lift cylinders, main relief valve and the implement pump.

Ride Control System: Tilt cylinder, lift cylinders, ride control diverter valve, and the ride control accumulator.

Kickout System: Pilot valve (oil manifold), lift position sensor, bucket positioner switch, implement control levers, and the implement Electronic Control Module (ECM).

Fan Drive System: Oil cooler bypass valve, hydraulic oil cooler, hydraulic oil filter, fan drive pump, and the fan drive motor.

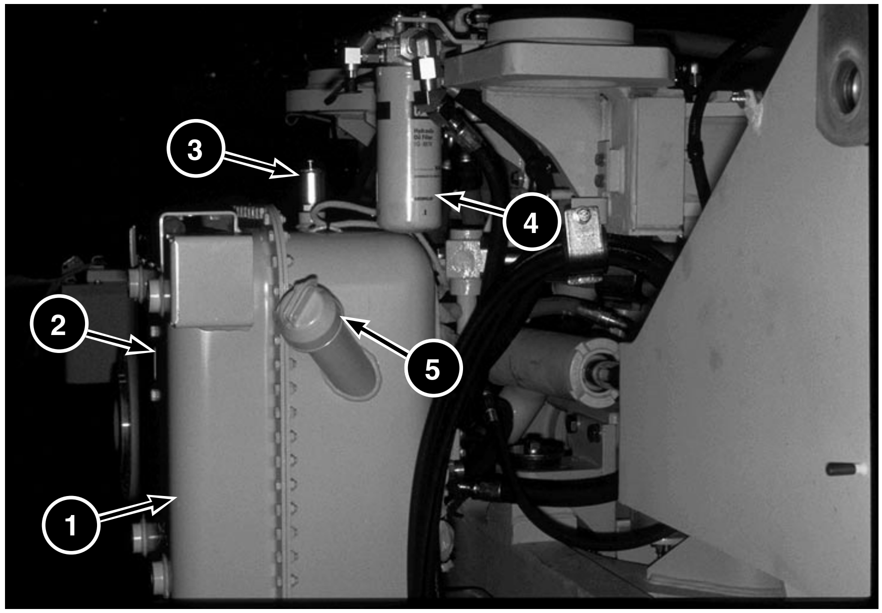

Fig. 2.1.3

Common Hydraulic System Components

The hydraulic tank (1) is located on the right side of the machine. A sight glass (2) indicates the level of the hydraulic oil in the tank.

The tank has a vent valve (3) that protects the tank from excessive pressure and/or vacuum and an ecology-type drain valve (not shown) for changing the oil.

The hydraulic oil filter (4) is located above the tank. The hydraulic oil filter is in the return line for the fan drive system.

Also shown is the fill cap (5).

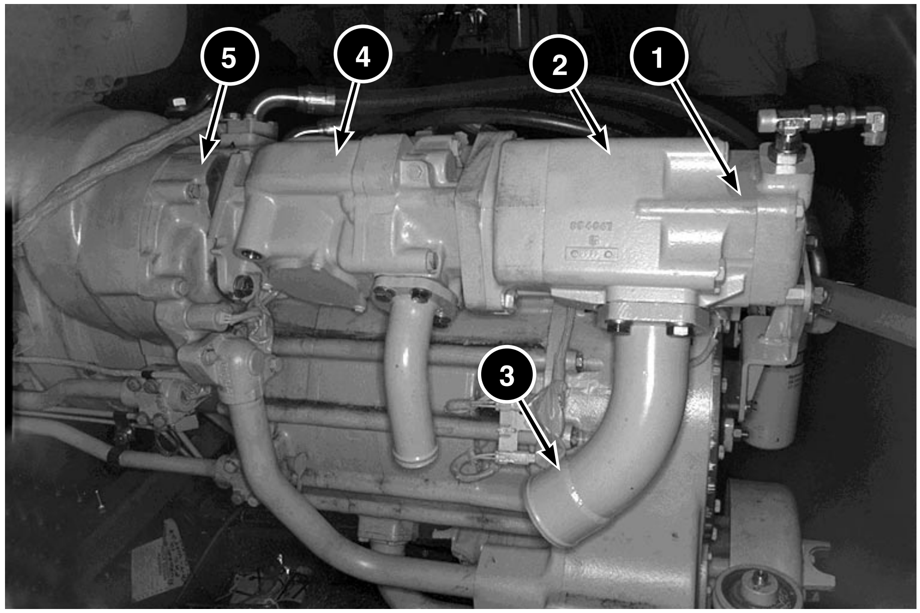

Fig. 2.1.4

Implement Electronic Control System

The pilot and brake pump (1) is the rear section of a two-section vane pump located below the cab of the machine. The implement pump (2) is the front section of the pump group. Oil from the tank flows through the common inlet tube (3) to both pump sections. The pump sections have separate outlets (not visible in this view).

Also shown are the steering pump (4) and the transmission pump (5). All the pumps are mounted in line and are attached to the torque converter.

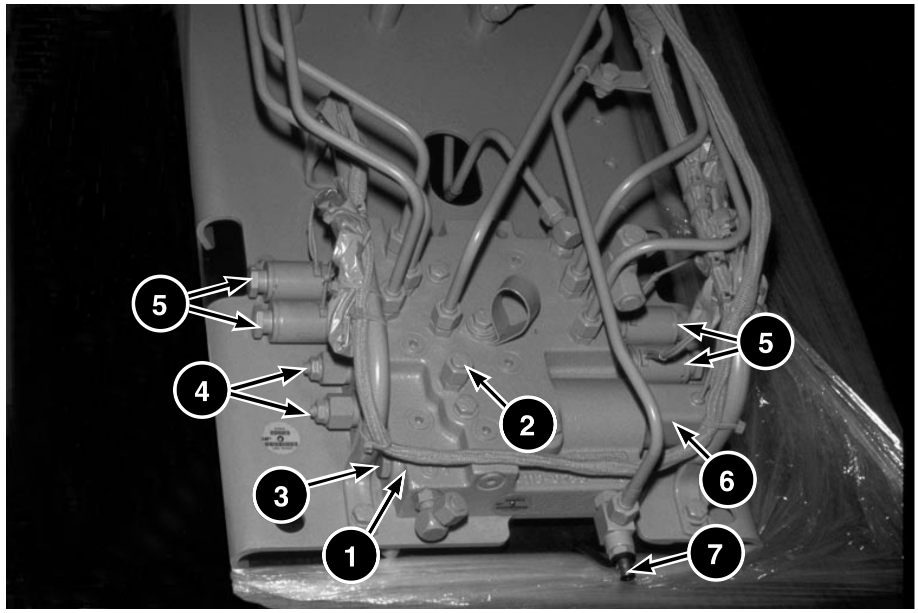

Fig. 2.1.5

The pilot valve (1) is located between the lift arms behind the implement control valve on the front frame of the machine. Oil from the pump enters the pilot valve through the supply port (2). The pilot manifold contains nine valves: the shuttle valve (3), the pressure reducing valves (4), the four proportional solenoid valves (5) for the implement functions, and the pilot on/off solenoid valve (6).

Also shown is the ride control pressure tap (7).

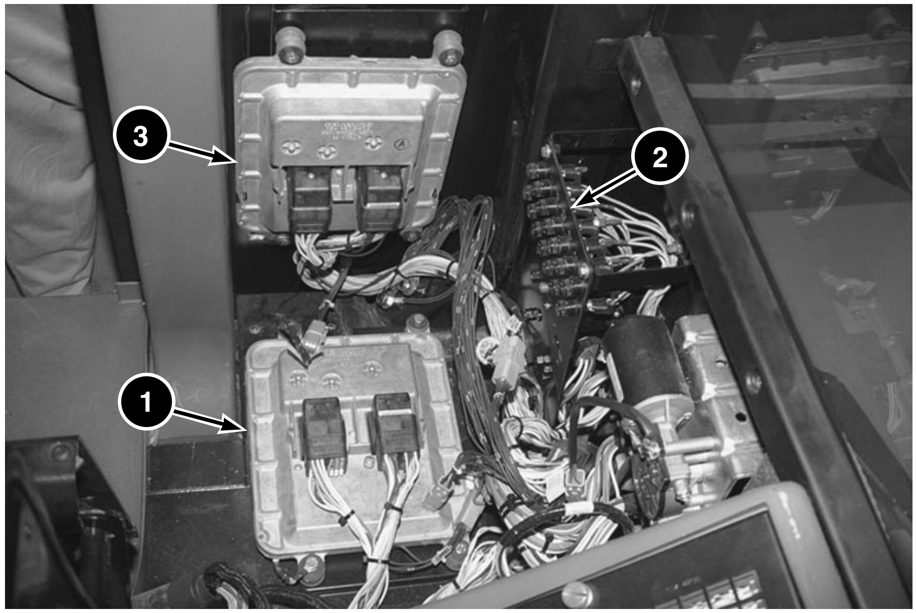

Fig. 2.1.6

The implement Electronic Control Module (ECM) is located at the right rear of the cab. The ECM (1) is accessed by removing the floor panel.

The diagnostic connector for electronic service tool use is located on the fuse panel (2).

Also shown is the transmission ECM (3).

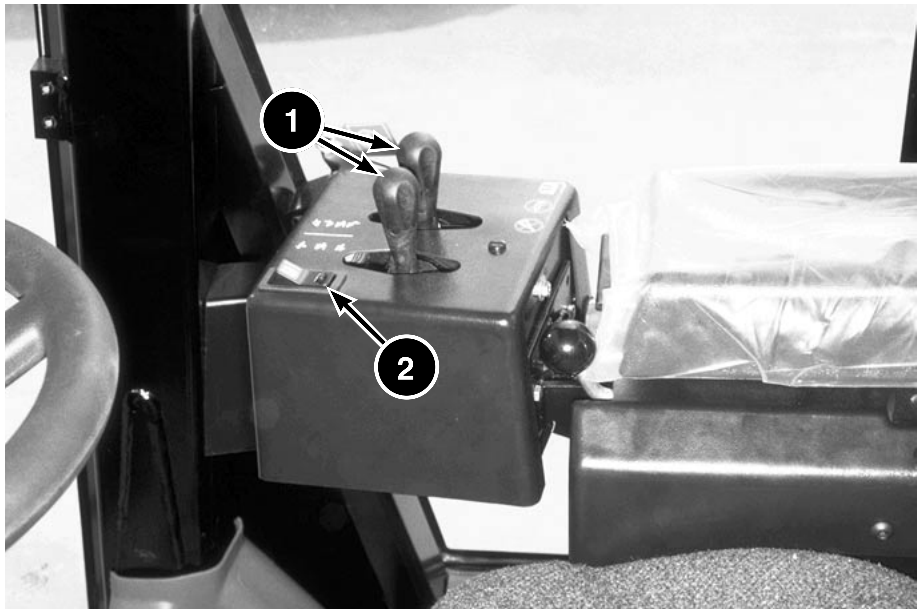

Fig. 2.1.7

Main Hydraulic System

The implement control levers (1) are located at the front of the right armrest on the operator's seat. The control levers move with the seat for operator comfort. The control levers move the lever position sensors which send a Pulse Width Modulated (PWM) signal to the implement ECM. The implement ECM sends a modulated signal to the corresponding proportional solenoid valve on the pilot valve. The signal regulates the amount of pilot oil flow through the proportional solenoid valve. The pilot oil flows to the main control valve spool, which directs main implement pump oil to the cylinder to move the implement.

The implement lockout switch (2) is located forward and to the left of the tilt control lever. If the implement lockout switch is in the OFF position, the pilot on/off solenoid valve will not move to the ON position when the control levers are moved. No oil will flow from the pilot valve to the main control valve, and the implements will not move.

NOTE: The key start switch and the implement lockout switch must be in the ON position to move any implements with the implement control levers.

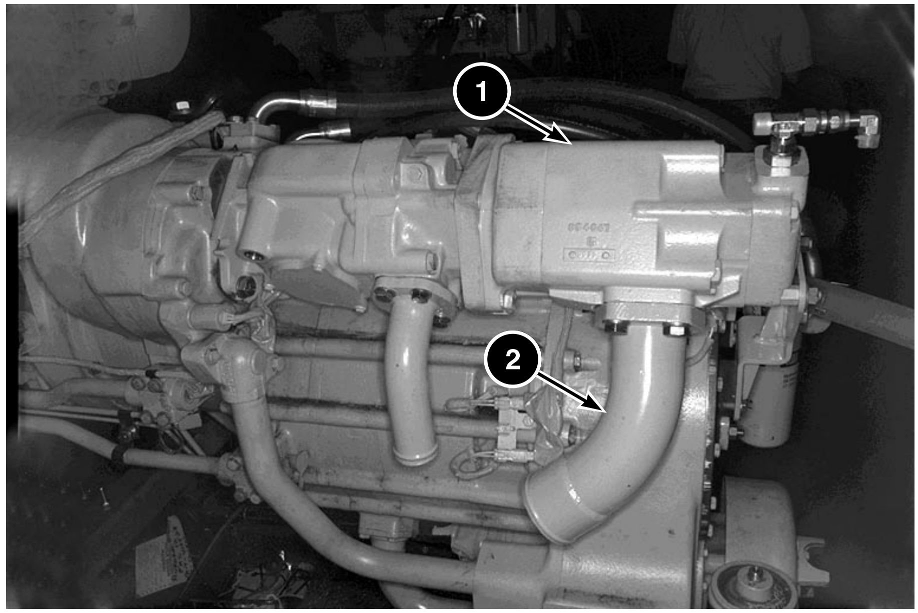

Fig. 2.1.8

The main implement pump (1) is located below the cab on the right side of the machine. The pump is mounted in line with the steering and transmission pumps. The pumps are driven by a gear in the torque converter housing.

The implement pump and the pilot and brake pump form a two-section vane pump group using one common inlet (2) from the hydraulic tank. The pump sections rotate on a common shaft.

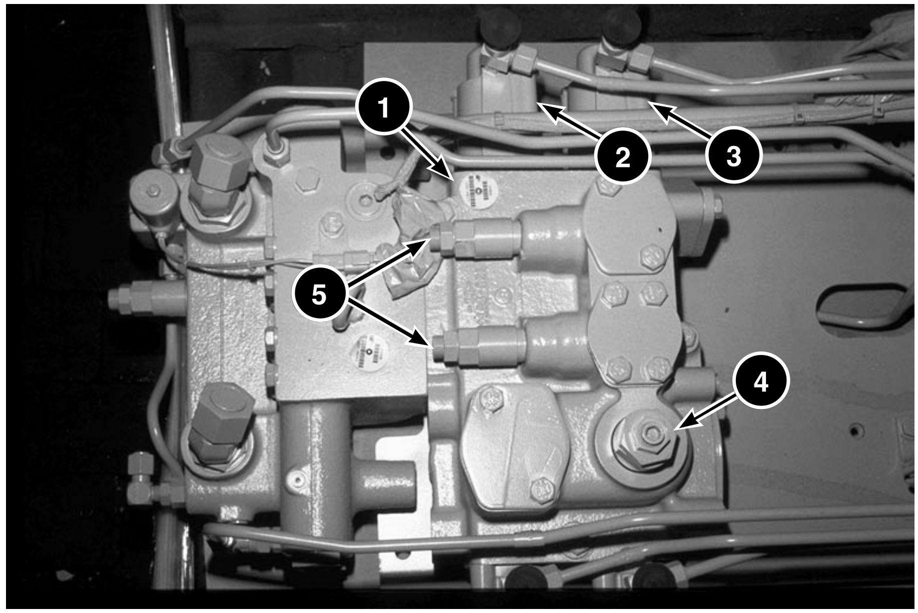

Fig. 2.1.9

The main control valve (1) is located between the lift arms on the front of the machine. The valve houses the lift valve spool (2), the tilt valve spool (3), the main system relief valve (4), and the tilt line relief valves (5).

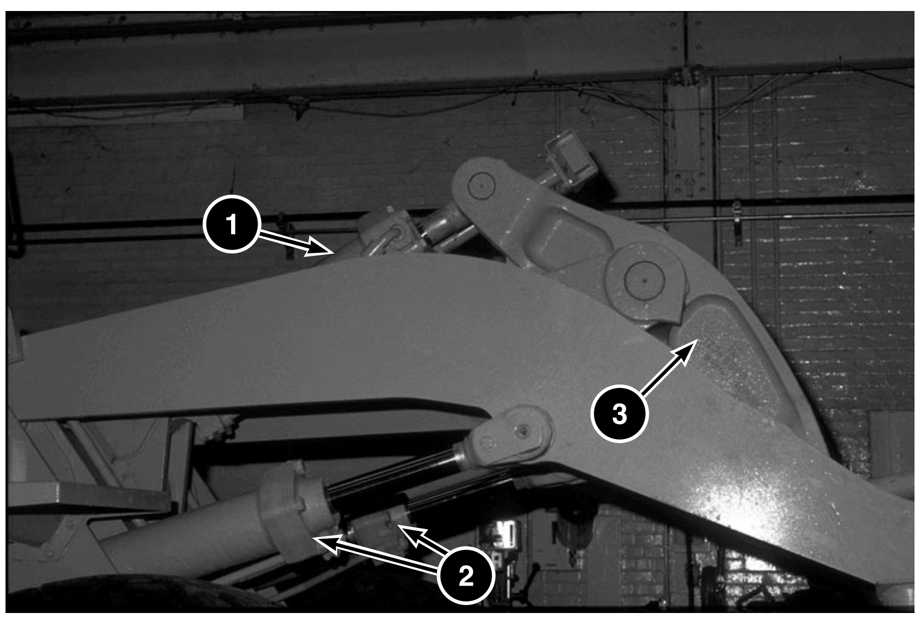

Fig. 2.1.10

When an implement is activated, oil from the implement control valve is directed to the tilt cylinder (1) and/or the lift cylinders (2).

Like most Caterpillar Wheel Loaders, the 950G/962G Wheel Loaders are equipped with a Z-Bar linkage (3).

Fig. 2.1.11

Ride Control System

The ride control system consists of the tilt cylinder, lift cylinders, ride control accumulator and the ride control diverter valve. Only the components not previously shown will be discussed in this section of the presentation.

The optional ride control system dampens the bucket forces which produce a pitching motion as the machine travels over rough terrain.

The ride control accumulator (arrow) is located in front of the articulation joint on the right side of the front frame. The accumulator contains a precharge of nitrogen gas. Oil from the lift cylinders pushes a piston in the accumulator against the nitrogen gas which absorbs the forces rather than transferring the forces to the machine. The system provides a dampening effect while traveling over rough terrain.

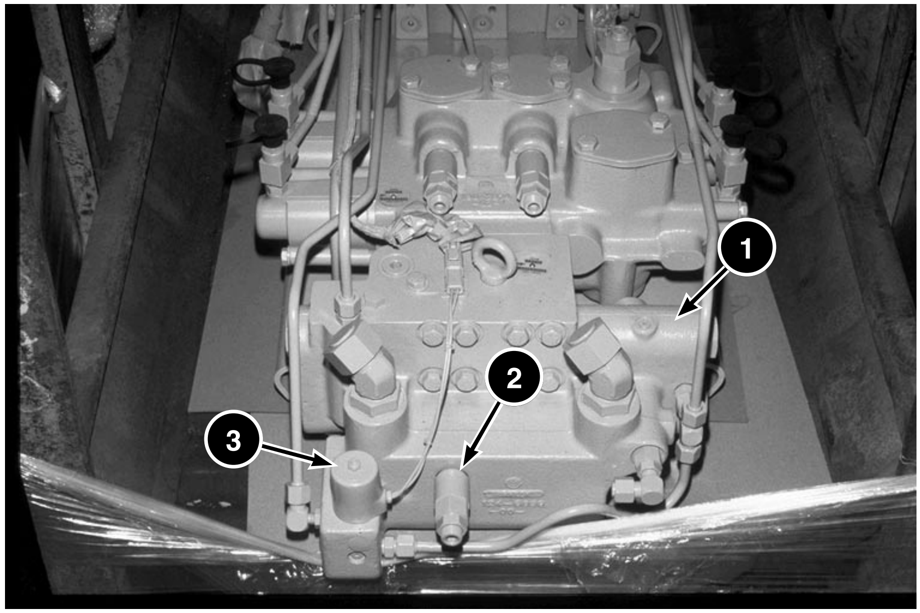

Fig. 2.1.12

The ride control diverter valve (1) is located at the front end of the main control valve. The ride control diverter valve controls oil flow to the ride control accumulator. Located on the ride control diverter valve are the ride control relief valve (2) and the ride control on/off solenoid valve (3).

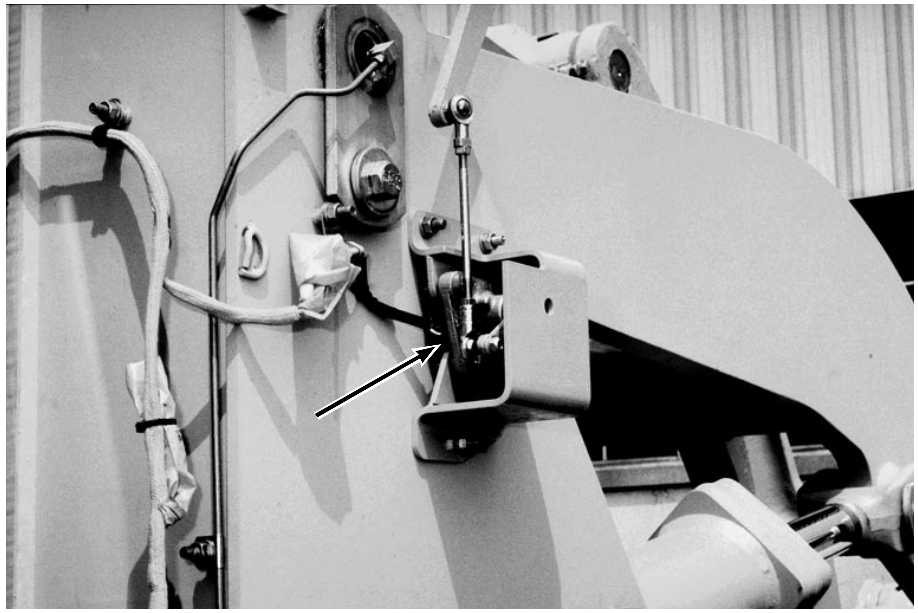

Fig. 2.1.13

Kickout System

The kickout system consists of the lift position sensor (arrow), the bucket positioner switch, the lift kickout switch, the implement ECM and the control lever detent coils. Only the components not previously shown will be discussed in this section of the presentation.

The lift position sensor is located on the right side of the loader frame in front of the cab.

When the operator moves the lift control lever to the FULL RAISE position, the detent coil holds the lever in the detent position. As the bucket raises, the lift position sensor sends a pulse width modulated signal to the implement ECM. The signal tells the ECM the position of the lift arm.

When the lift arm reaches the preset kickout height, the implement ECM stops the flow of current to the lift control lever detent coil. The control lever returns to the HOLD position, and the implement stops moving.

The operation is the same for the LOWER kickout.

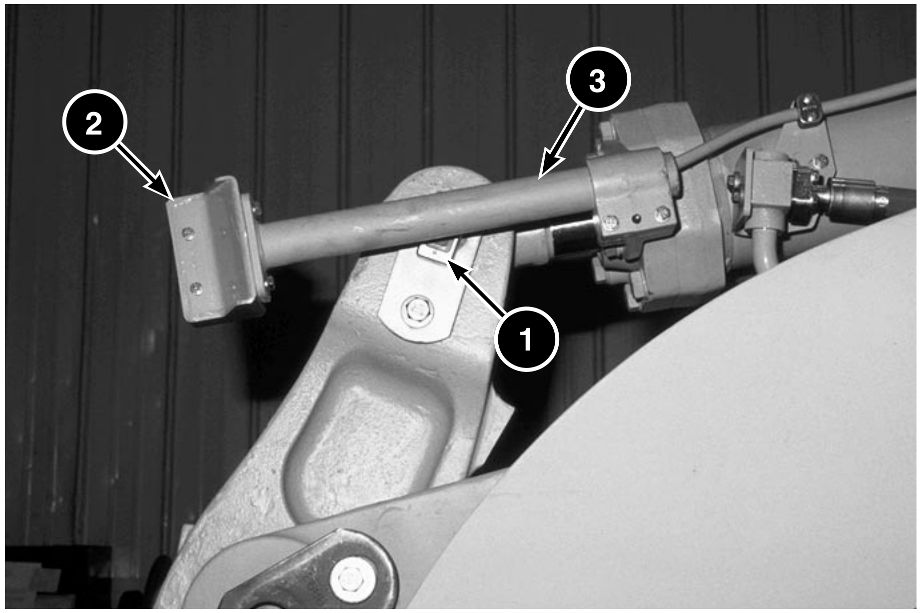

Fig. 2.1.14

The bucket positioner consists of two components: a magnet (1) mounted on the pin that connects the Z-Bar linkage to the rod end of the tilt cylinder and a bucket positioner switch (2) mounted on the end of the tube (3) extending from the tilt cylinder.

When the operator moves the tilt control lever to the TILT BACK position, the detent coil for the tilt control lever holds the lever in the detent position.

As the bucket tilts back, the magnet assembly moves toward the bucket positioner switch. The switch opens and the implement ECM stops the flow of current to the lever detent coil. The lever returns to the HOLD position, and the bucket stops moving.

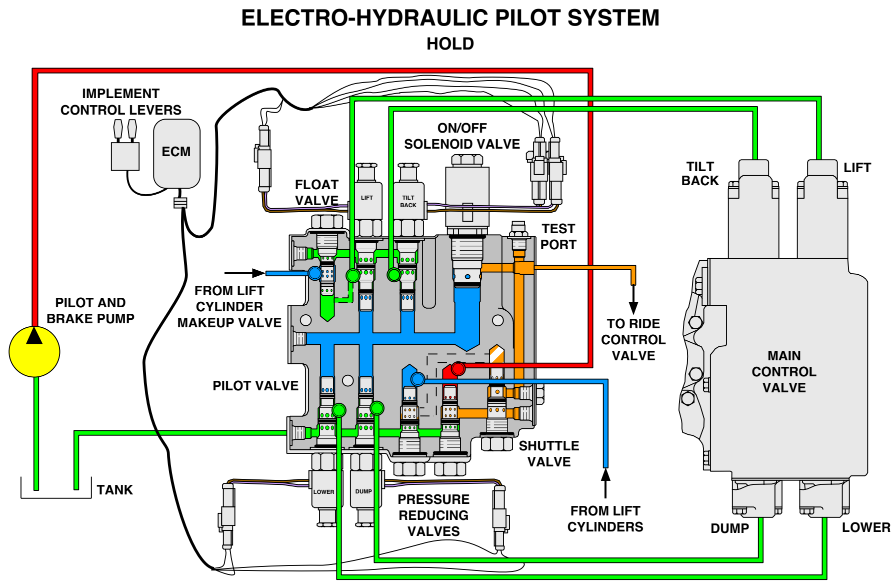

Fig. 2.1.15

ELECTRO-HYDRAULIC SYSTEM OPERATION

Implement Pilot System

Figure 2.1.15 shows the implement pilot system electro-hydraulic pilot valve (oil manifold) in the HOLD position.

The pilot system is a closed-center design. The pilot pump pulls oil from the tank and sends pilot oil to the electro-hydraulic control valve. Pilot pump oil enters the electro-hydraulic control valve and flows through the pump oil pressure reducing valve.

When the engine is at high idle and the oil is at normal operating temperature, the pump oil pressure reducing valve reduces the pilot pump pressure to 3450 ± 200 kPa (500 ± 30 psi).

The pilot pump oil moves the shuttle valve. The shuttle valve blocks the lower pressure oil from the lift cylinder pressure reducing valve. The lift cylinder pressure reducing valve reduces oil pressure from the lift cylinders to approximately 2070 ± 200 kPa (300 ± 30 psi). Pilot pump oil flows past the shuttle valve to the on/off solenoid valve. When the on/off solenoid is DE-ENERGIZED (implement lockout switch in the LOCKED position), pilot oil is blocked at the on/off solenoid valve. When the on/off solenoid is ENERGIZED by the ECM (implement lockout switch in the UNLOCKED position and a lever is moved), pilot oil flows past the on/off solenoid valve to the proportional solenoid valves.

In the HOLD position, pilot oil is blocked at the on/off solenoid valve until the pilot control levers signal the ECM to energize the on/off solenoid and one or more proportional solenoids.

NOTE: The color codes used for hydraulic oil throughout this presentation are:

Red	**- System or high pressure**
Red and White Stripes	**- Reduced pressure**
Orange	**- Pilot pressure**
Orange Stripe	**- Lower pilot pressure**
Blue	**- Blocked oil**
Green	**- Tank or return oil**

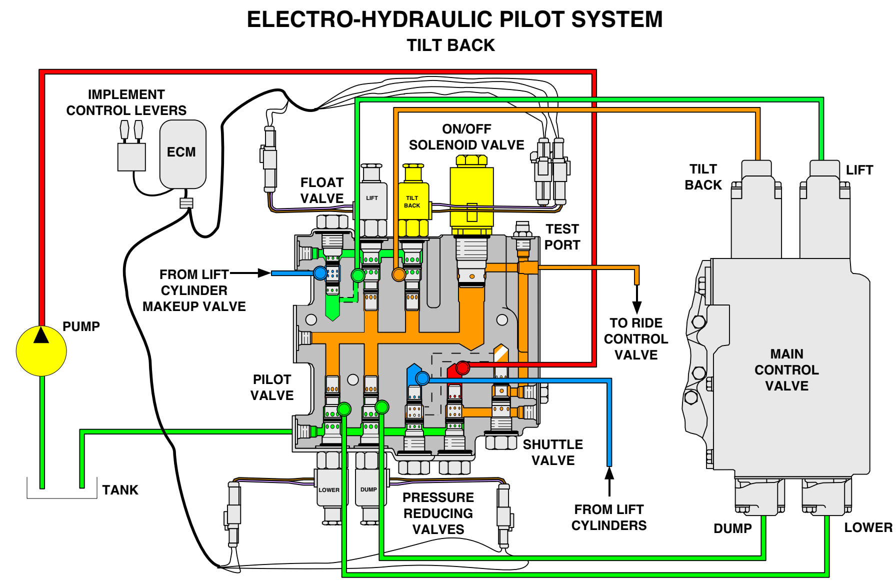

Fig. 2.1.16

Figure 2.1.16 shows the implement pilot system electro-hydraulic control valve in the TILT BACK position.

When the tilt control lever is moved to the TILT BACK position, the tilt lever position sensor sends an electrical signal input to the implement Electronic Control Module. The implement ECM analyzes the input signal and sends an electrical output to energize the on/off solenoid valve and the tilt back solenoid valve. The tilt back solenoid valve controls the flow of pilot oil to the main control valve tilt spool. The implement ECM electrical output is proportional to the input signal from the tilt lever position sensor. The tilt back solenoid valve output pressure is proportional to the implement ECM output signal. The main control valve tilt spool movement is proportional to the pressure from the tilt back solenoid valve.

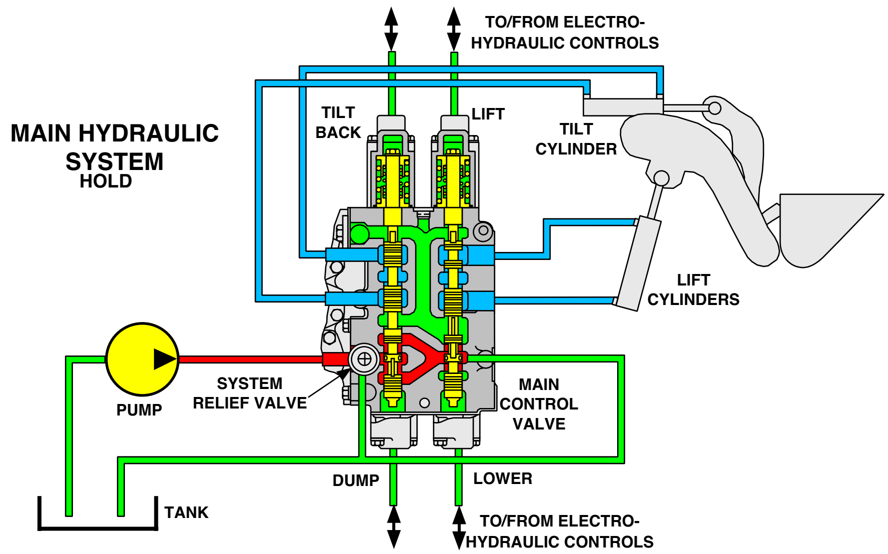

Fig. 2.1.17

Main Hydraulic System

Figure 2.1.17 shows a sectional view of the main hydraulic system with the control levers in the HOLD position.

The pump draws oil from the hydraulic tank and sends supply oil to the main implement control valve. Supply oil entering the control valve flows past the system relief valve. The system relief valve constantly senses system pressure and opens to the tank when the pressure reaches the maximum setting of the valve. When no oil flow is sent from the electro-hydraulic pilot valve (not shown), the main control valve spools are in the HOLD position. Supply oil flows through the main control valve and returns to the tank.

When the operator moves a pilot control lever, a PWM signal is sent to the implement ECM. The implement ECM sends a signal current to the electro-hydraulic pilot valve. The electro-hydraulic pilot valve sends pilot oil to move the respective spool in the main implement control valve. The main implement control valve spool directs supply oil to the respective cylinder.

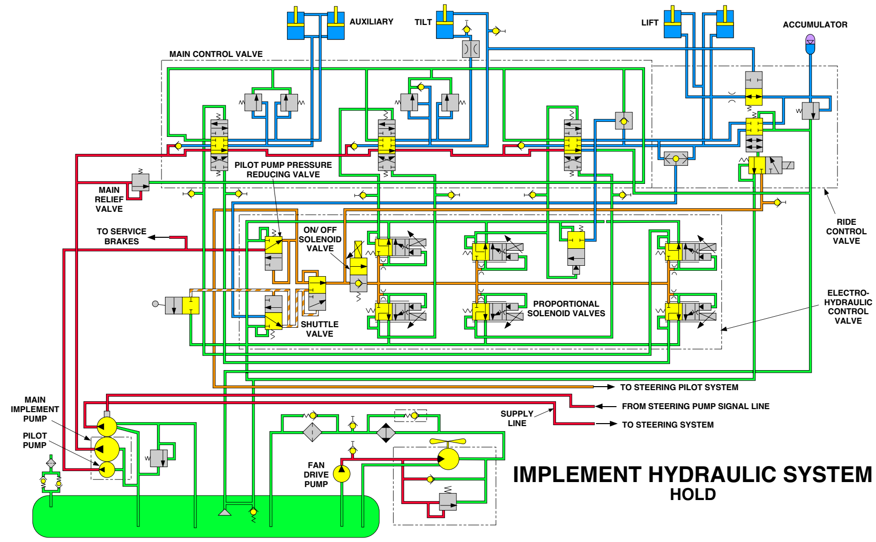

Fig. 2.1.18

Implement Hydraulic Schematics

Figure 2.1.18 shows the oil flow in the electro-hydraulic pilot system and the main hydraulic system when the engine is running and the proportional solenoid valves are in the HOLD position.

In the pilot system, the pilot pump pulls oil from the tank and sends oil flow to the electro-hydraulic control valve. Pilot pump oil enters the electro-hydraulic control valve and flows through the pilot pump pressure reducing valve. The pressure reducing valve reduces the pilot pump pressure to 3450 ± 200 kPa (500 ± 30 psi). The pilot pump oil moves the shuttle valve. The shuttle valve blocks the lower pressure oil from the lift cylinder pressure reducing valve. Pilot pump oil flows through the shuttle valve to the on/off solenoid valve.

When the on/off solenoid is ENERGIZED by the ECM (implement lockout switch in the UNLOCKED position and a lever is moved), pilot oil flows past the on/off solenoid valve to the proportional solenoid valves.

When the on/off solenoid is DE-ENERGIZED (implement lockout switch in the LOCKED position), pilot oil is blocked at the on/off solenoid valve.

In the main hydraulic system, the implement pump pulls oil from the tank and sends oil flow to the main control valve. When the control spools are in the HOLD position, oil flows past the main relief valve and through the open-center control spools to the tank. The system relief valve constantly senses system pressure and opens to the tank when the pressure reaches the maximum setting of the relief valve.

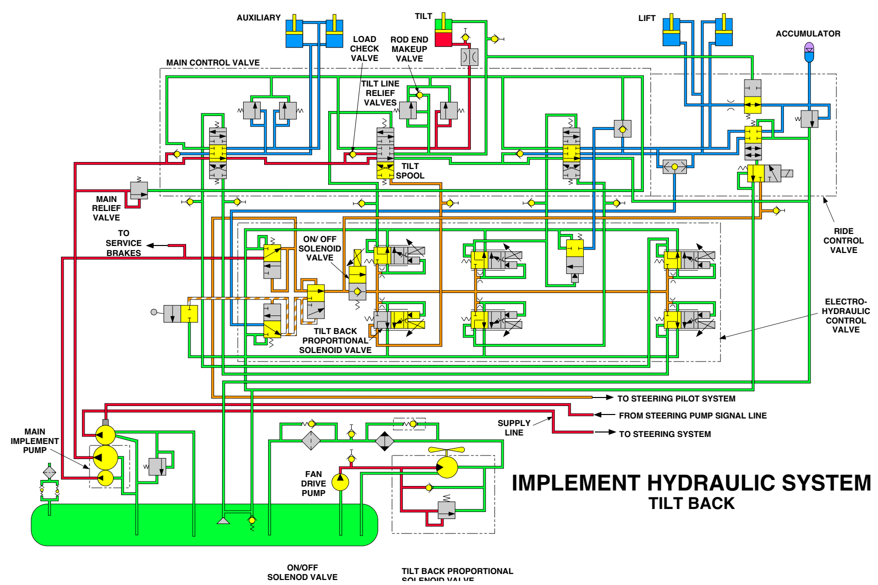

Fig. 2.1.19

When the tilt control lever is moved to the TILT BACK position, as shown in Figure 2.1.19, the tilt lever position sensor sends an electrical signal input to the implement ECM. The ECM analyzes the input signal and sends an electrical output to energize the on/off solenoid valve and the tilt back proportional solenoid valve on the electro-hydraulic control valve. The electro-hydraulic control valve sends pilot oil to move the tilt spool in the main control valve. The tilt spool moves against the centering springs. Tilt spool movement closes the implement pump oil passage to the tank and opens the passages to the tilt cylinder.

Implement pump oil flows through the load check valve and tilt spool to the head end of the tilt cylinder. Oil from the rod end of the tilt cylinder flows back through the tilt control spool to the tank.

The load check valve blocks oil flow from the cylinder to prevent the bucket from drifting when the operator moves the tilt control lever from the HOLD to the TILT BACK position.

The rod end makeup valve permits oil to flow directly from the return circuit or the tank to the rod end of the tilt cylinder when the rod end pressure decreases to approximately 14 kPa (2 psi) less than the tank oil pressure. The makeup oil prevents cavitation in the cylinder and lines.

When the tilt control spool is in the HOLD position, the tilt line relief valves protect the tilt circuit from pressure caused by external forces. The line relief valves are usually set at a higher pressure than the main relief valve. However, the tilt cylinder rod end line relief valve is set at a lower pressure than the main relief valve.

When the lift arms are raised and the bucket is in the DUMP position, the lift arms cannot reach their maximum height until the lift linkage extends the tilt cylinder rod. The rod end line relief valve must open to allow the tilt cylinder rod to extend. Therefore, the rod end relief valve is set at a lower pressure than the main relief valve.

If the rod end line relief valve was set at a higher pressure, the main relief valve would open before the tilt cylinder rod extends. Therefore, the lift arms could not reach their maximum height.

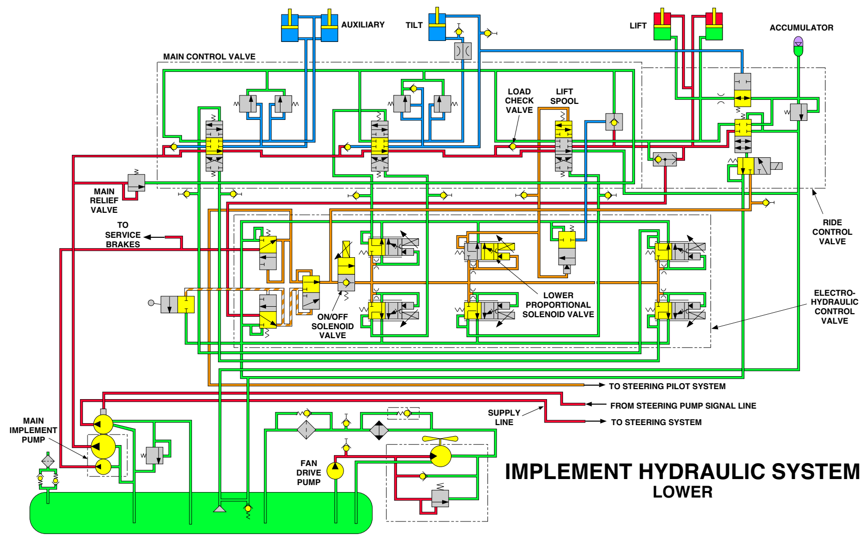

Fig. 2.1.20

Figure 2.1.20 shows the hydraulic flow during the LOWER operation.

When the lift control lever is moved to the LOWER position, the lift lever position sensor sends a PWM signal input to the implement ECM. The implement ECM analyzes the input signal and sends a PWM output signal to energize the on/off solenoid valve and the lower proportional solenoid valve on the electro-hydraulic control valve. The implement ECM output signal is proportional to the input signal from the lift lever position sensor.

The electro-hydraulic control valve sends pilot oil to move the lift spool in the main control valve. The lift spool moves against the centering springs. The lift spool movement blocks the flow of implement pump oil to the tank and opens a passage to the rod end of the lift cylinders. Implement pump oil flows through the load check valve and lift spool to the rod end of the lift cylinders. The lift spool also opens a passage for oil from the head end of the lift cylinders to return to the tank.

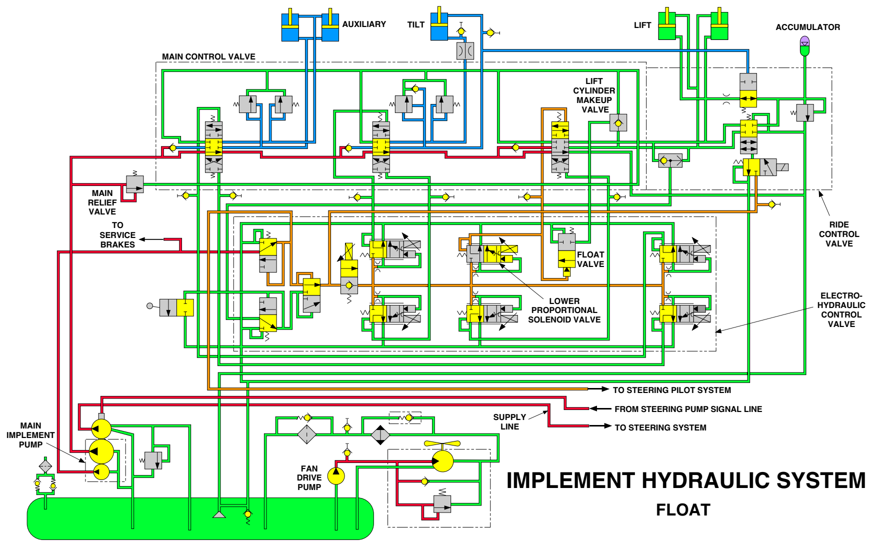

Fig. 2.1.21

Figure 2.1.21 shows the hydraulic flow when the control lever is moved to the FLOAT position. When the lift control lever is in the FLOAT position, the lift control spool is in the same position as when the lift control lever is in the LOWER position.

When the lift control lever is in the FLOAT position, the ECM increases the electrical output to the lower proportional solenoid valve on the electro-hydraulic pilot valve. The lower proportional solenoid valve increases the pilot oil pressure to the control spool. The increase in pilot oil pressure is also sensed at the float valve. The increased pilot oil pressure overcomes the float valve spring and moves the float valve to the open position. Oil behind the lift cylinder makeup valve flows through the float valve to the tank.

The small orifices in the makeup valve cause a restriction to the implement pump oil when filling the cavity behind the makeup valve. With oil flowing from behind the makeup valve faster than oil flows in, the pressure difference between the oil around the makeup valve and the oil behind the makeup valve becomes high enough to lift the makeup valve off its seat. The oil from the implement pump flows past the makeup valve to the tank. Both ends of the lift cylinder are open to tank allowing the bucket to float along the ground (follow the contour of the ground).

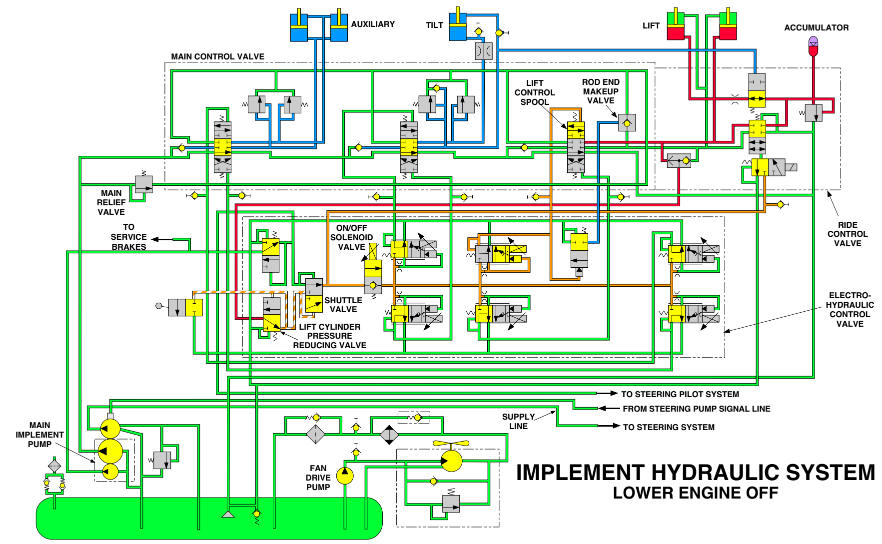

Fig. 2.1.22

In Figure 2.1.22 the bucket is being LOWERED with the ENGINE OFF. The weight of the implement creates a high pressure in the head end of the lift cylinders. The high pressure oil flows through the hose to the lift cylinder pressure reducing valve. The lift cylinder pressure reducing valve reduces the oil pressure from the lift cylinder to approximately 2070 kPa (300 psi). With the engine off and no pressure on the pilot pump side of the shuttle valve, the lift cylinder oil shifts and flows past the shuttle valve to the on/off solenoid valve. When the on/off solenoid is de-energized, lift cylinder oil is blocked at the on/off solenoid valve. When the on/off solenoid is energized (key on, implement lockout switch unlocked, as shown) and the lift control lever in the LOWER position, lift cylinder oil flows through the on/off solenoid valve to the proportional solenoid valves.

With the lift control lever in the LOWER position, lift cylinder oil is sent to move the lift control spool. The lift control spool directs oil in the head end of the lift cylinders to the tank.

Tank oil flows through the rod end makeup valve into the rod end of the lift cylinders and prevents cylinder cavitation.

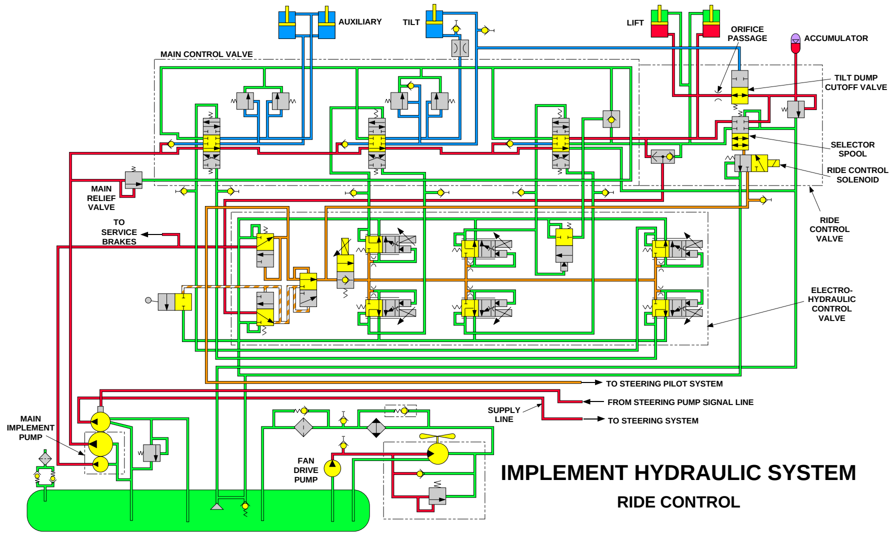

Fig. 2.1.23

Figure 2.1.23 shows the hydraulic flow when the ride control solenoid valve is ENERGIZED. The ride control solenoid valve is controlled by the transmission ECM.

The ride control switch (not shown) allows the operator to select between the ride control ON, ride control OFF and ride control AUTO positions.

When the ride control switch is in the ON position, the transmission ECM will continually ENERGIZE the ride control solenoid.

When the ride control switch is in the AUTO position, the transmission ECM will ENERGIZE the ride control solenoid when the machine ground speed is above 9.7 km/h (6 mph) and will DE-ENERGIZE the ride control solenoid when the ground speed is below 8.8 km/h (5.5 mph).

When the ride control solenoid valve is ENERGIZED, pilot pressure shifts the selector spool to connect the head end of the lift cylinders with the accumulator. A floating piston in the accumulator separates the oil from the nitrogen gas. Since nitrogen gas is compressible, the gas serves as a spring. Any downward force on the lift arms is transferred through the oil at the head end of the lift cylinders to the accumulator. The force in the oil is transmitted to the accumulator piston, which compresses the nitrogen gas. Compressing the nitrogen gas absorbs the pressure spike and the oil displacement caused by the downward force on the lift arms. This operation results in less ground induced shocks on structures and components, reduced tire flexing and a greater payload retention.

When the ride control solenoid valve is DE-ENERGIZED, the orifice passage in the control valve allows the pressure in the head end of the lift cylinders and the pressure in the accumulator to equalize. When the tilt cylinder rod end is pressurized to dump the load from the bucket, the tilt dump cutoff valve in the ride control valve blocks the accumulator to lift cylinders head end. This prevents the lift cylinders from being pushed rapidly upward by accumulator pressure as the load is dumped from the bucket with the switch in the ON position.

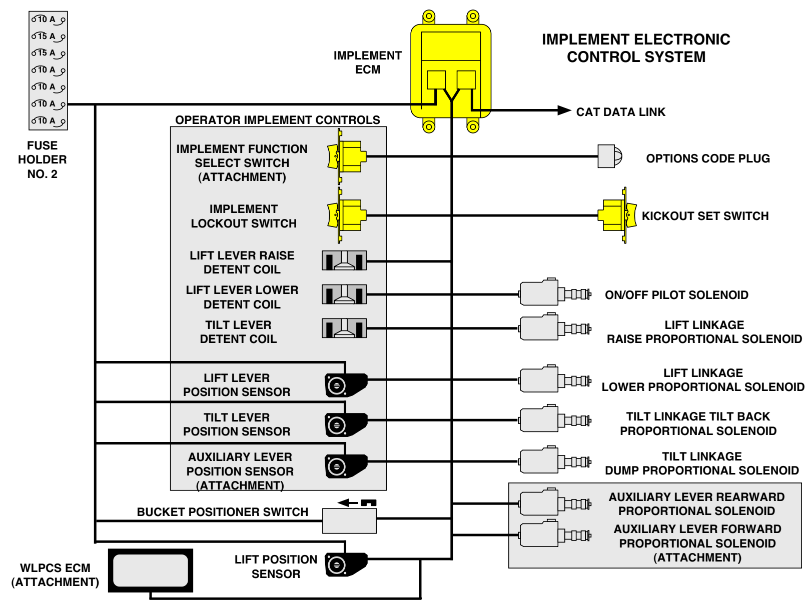

Fig. 2.1.24

IMPLEMENT ELECTRONIC CONTROL SYSTEM

Figure 2.1.24 shows a block diagram of the Implement Electronic Control System.

The implement ECM receives input signals from the various sensors and switches. The ECM processes the input signals, makes decisions and provides a corresponding output signal to the proportional solenoid valves, detent coils, and auxiliary attachments (if equipped). The ECM also communicates with other electronic control systems through the CAT Data Link.

The Electronic Implement Control System consists of the following components:

Lift lever position sensor: Signals the ECM the position of the lift control lever.

Tilt lever position sensor: Signals the ECM the position of the tilt control lever.

Auxiliary lever position sensor: Signals the ECM the position of the auxiliary control lever.

Lift position sensor: Signals the ECM the position of the lift arms.

Bucket positioner switch: Signals the ECM the position of the bucket.

Implement lockout switch: Signals the ECM that the operator wants the control levers disabled.

Kickout set switch: Used to set the kickout positions.

Implement function select switch: Provides a third hydraulic function to be controlled when a machine is equipped with a two-axis joystick.

Options code plug: Signals the ECM what implement options are installed on the machine.

Pilot on/off solenoid valve: Used to disable and enable the pilot hydraulic system.

Tilt linkage dump proportional solenoid valve: Directs pilot oil to the main control valve.

Tilt linkage tilt back proportional solenoid valve: Directs pilot oil to the main control valve.

Lift linkage raise proportional solenoid valve: Directs pilot oil to the main control valve.

Lift linkage lower proportional solenoid valve: Directs pilot oil to the main control valve.

Auxiliary lever rearward proportional solenoid valve: Directs pilot oil to the main control valve.

Auxiliary lever forward proportional solenoid valve: Directs pilot oil to the main control valve.

Lift lever raise detent coil: Holds the raise/lower lever in the raise position.

Lift lever lower detent coil: Holds the raise/lower lever in the lower position.

Tilt lever detent coil: Holds the tilt/dump lever in the tilt back position.

CAT Data Link: Communication path to and from other electronic control modules.

Wheel loader payload control system: Signals the operator various payload information.

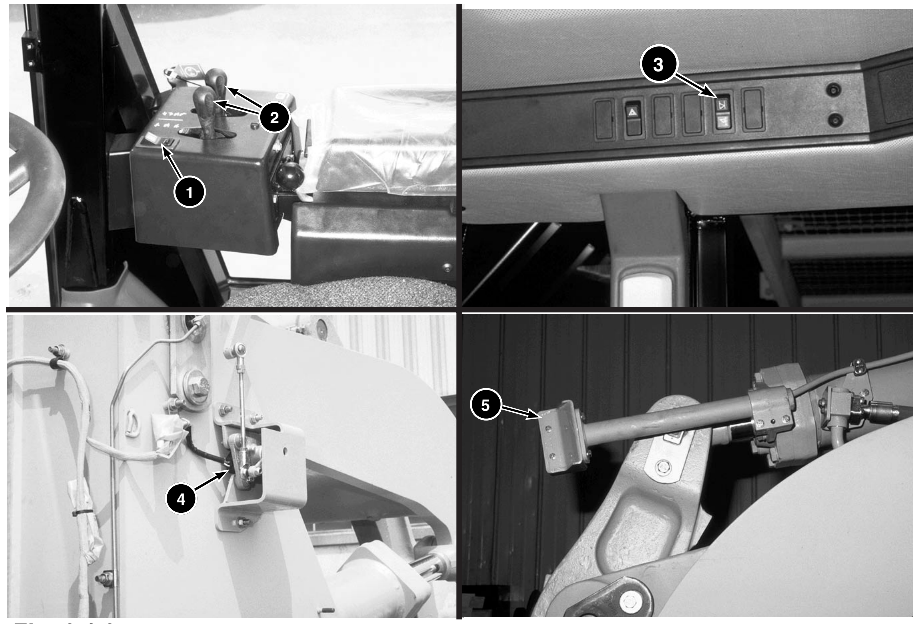

Fig. 2.1.25

Implement Electronic Control System Components

The implement ECM receives input signals from the implement lockout switch (1), the lever position sensors located on each side of the pilot control levers (2) below the cover, the lift kickout set switch (3), the lift arm position sensor (4), and the bucket position switch (5).

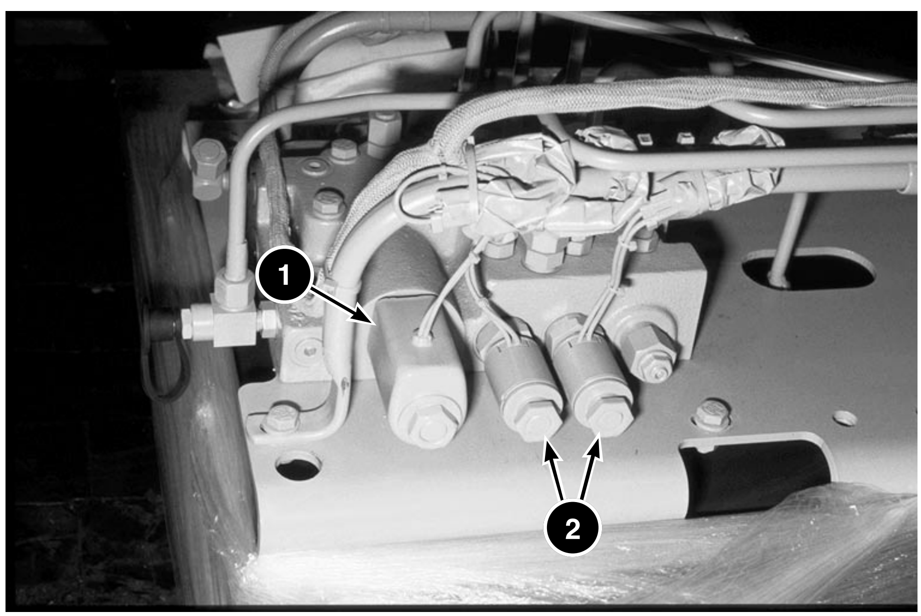

Fig. 2.1.26

The implement ECM energizes the pilot on/off solenoid (1) and the proportional solenoid valves (2). Only two proportional solenoid valves are visible in this view. The other two valves are located on the opposite side of the pilot valve.

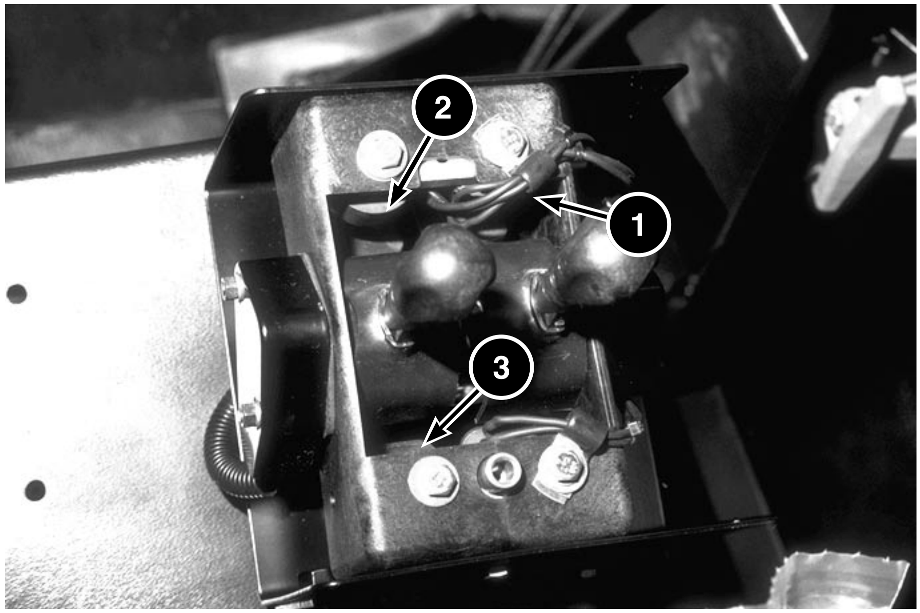

Fig. 2.1.27

The implement ECM energizes and de-energizes the tilt lever detent coil (1), the lift lever raise detent coil (2) and the lift lever lower detent coil (3) as needed to perform the implement kickout functions.

The implement ECM also sends information over the CAT Data Link.

Fig. 2.1.28

Kickout Set Switch

The lift kickout set switch (arrow) is a momentary push button switch used to set the lift raise and lift lower kickout positions.

To set the raise kickout position, raise the lift arms above the midway point to the desired position, and release the control lever. PRESS the lift kickout switch. The implement ECM records the lift arm position sensor PWM signal. The implement ECM DE-ENERGIZES the lift lever raise detent coil each time the lift arm position sensor PWM signal is equal to or above the recorded signal.

To set the lower kickout position, lower the lift arms below the midway point to the desired position, and release the control lever. PRESS the lift kickout switch. The implement ECM records the lift arm position sensor PWM signal. The implement ECM uses the recorded PWM signal to determine when to DE-ENERGIZE the lift lever lower detent coil.

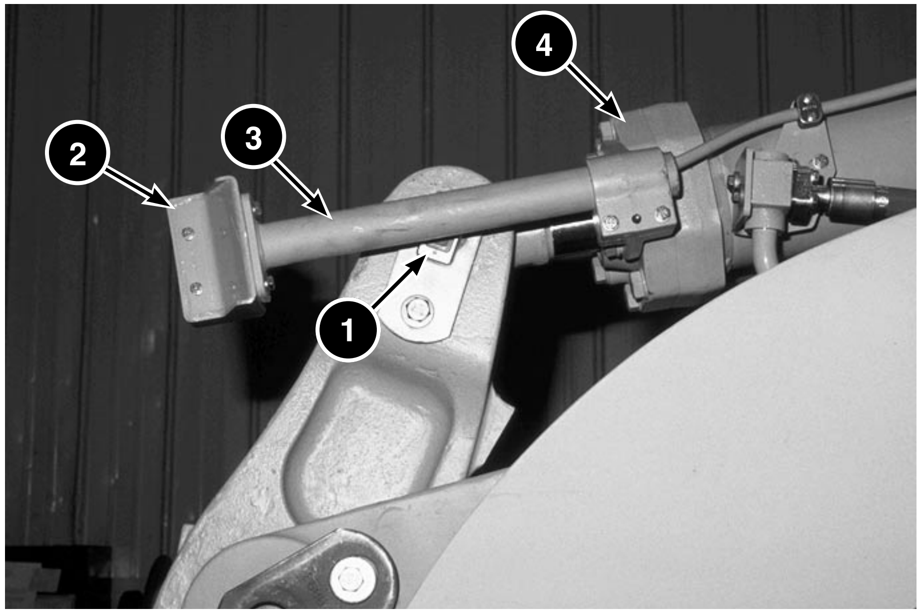

Fig. 2.1.29

Bucket Positioner

The bucket positioner consists of two components: a magnet (1) mounted on the pin that connects the Z-Bar linkage to the rod end of the tilt cylinder and a bucket positioner switch (2) mounted on the end of the tube (3) extending from the tilt cylinder (4).

Adjustment for the bucket kickout is made by aligning the magnet assembly with the solid state switch on the end of the tube assembly with the bucket positioned in the desired return to dig position. Always refer to the appropriate service literature before any adjustments are made.

Each time the magnet and switch align, the switch sends a signal to the implement ECM to de-energize the tilt lever detent coil.

Fig. 2.1.30

ELECTRONIC CONTROL SYSTEM DIAGNOSTICS

The implement ECM is capable of detecting most electrical faults associated with the implement electronic control system. When a fault is detected, the fault is stored in the implement ECM memory. Diagnostic information is shown on the Caterpillar Monitoring System Message Center Module display (arrow) when using the operator's switch (not shown) and the Diagnostic Scrolling Mode or the 9U6665 or 4C8195 Service Tool to enter the Service Mode (Mode 3).

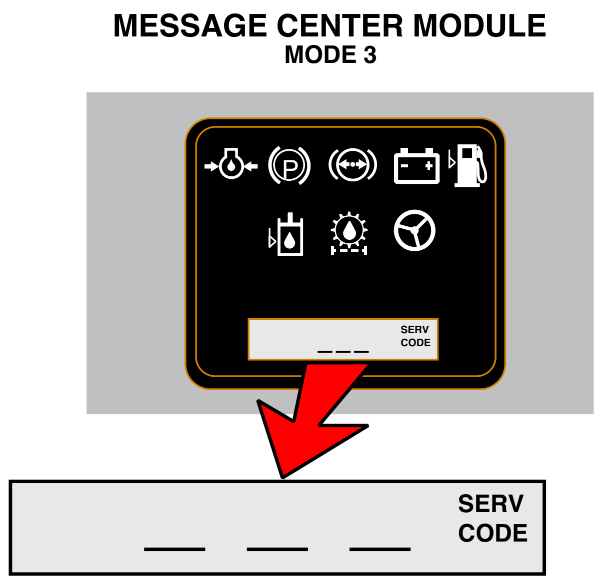

Fig. 2.1.31

Figure 2.1.31 shows the Caterpillar Monitoring System Message Center Module display in the Service Mode (Mode 3). When no fault is detected, the display shows three continuous dashes (- - -).

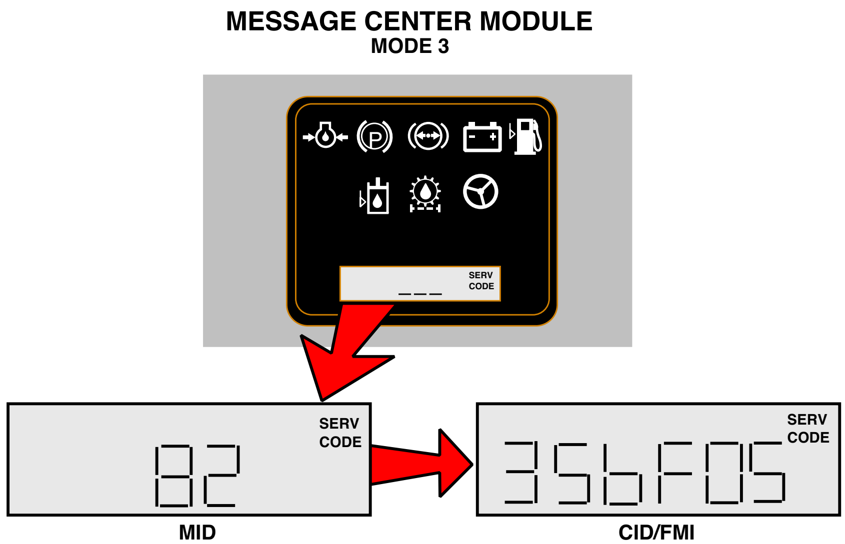

Fig. 2.1.32

When the Caterpillar Monitoring System is in the Service Mode (Figure 2.1.32), the Message Center shows the fault code.

The fault code consists of the Module Identifier (MID) followed by the Component Identifier (CID) and Failure Mode Identifier (FMI).

The MID tells which electronic control module diagnosed the fault. An MID of 082 means the fault was diagnosed in the implement electronic control system. MID's are listed on the machine electrical schematic in the Service Manual.

The CID tells which component is faulty. CID 356 means the fault was diagnosed in the bucket dump solenoid circuit.

The FMI tells the type of failure. FMI F05 means the failure is "current below normal" or "open circuit."

When the SERV CODE indicator is ON, the fault is PRESENT in the machine. When the SERV CODE indicator is OFF, the fault is NOT PRESENT in the machine.

Fig. 2.1.33

CONCLUSION

This concludes the presentation on the 950G/962G Wheel Loaders Electro-Hydraulic Implement System.

Always check the Service Manual for the latest service information and specifications when servicing, testing and adjusting, and/or making repairs.

NOTES

Lab 2.1.1: Implement Hydraulic System Component Identification

Shop Lab Exercise

Procedure:

You will identify Implement Hydraulic System components by matching the lettered or numbered tags on the components with the names on the worksheets.

After locating the components on the machine, you will locate the component on the hydraulic system schematic and record the schematic item number for each component.

Materials Needed

Lab 2.1.1 Worksheet

Pen or pencil

950G Wheel Loader

Mechanic's tool box with hand tools

Service Manual module "950G and 962G Wheel Loaders Electro-Hydraulic System, Testing and Adjusting Module" (Form No. RENR2146)

950G Wheel Loader Hydraulic System Schematic (Form No. SENR1391).

Lab 2.1.1: Implement Hydraulic System Component Identification Worksheet

Directions: Use this worksheet during the slide presentation to take notes on the function and location of each component. During the lab exercise, write the letter or number attached to the component next to the correct name. After locating the components on the machine, locate and record the hydraulic schematic item number for each component.

______ **Brake/pilot pump**

Location: ____

Function: ____

Item Number: ____________________

______ **Implement pilot control levers**

Location: ____

Function: ____

Item Number: ____________________

______ **Pilot valve**

Location: ____

Function: ____

Item Number: ____________________

______ **Implement hydraulic pump**

Location: _ ____

Function: ____

Item Number: ____________________

Lab 2.1.1: Implement Hydraulic System Component Identification Worksheet (continued)

______ **Main control valve**

Location: _ ____

Function: ____

Item Number: ____________________

______ **Main relief valve**

Location: _ ____

Function: ____

Item Number: ____________________

______ **Lift cylinders**

Location: _ ____

Function: ____

Item Number: ____________________

______ **Tilt cylinders**

Location: _ ____

Function: ____

Item Number: ____________________

Lab 2.1.1: Implement Hydraulic System Component Identification Worksheet (continued)

______ **Hydraulic tank**

Location: _ ____

Function: ____

Item Number: ________________________________

______ **Ride control accumulator**

Location: _ ____

Function: ____

Item Number: ________________________________

Lab 2.1.2: Implement Hydraulic System Tests

Shop Lab Exercise

This lab measures your ability to perform the implement hydraulic system tests.

Procedure

Following the procedures in the 950G and 962G Wheel Loaders Electro-Hydraulic System, Testing and Adjusting Module (Form No. RENR2146), perform the following tasks:

1. Lift and Tilt Cylinder Drift Tests
2. Lift and Tilt Cylinder Speed Tests
3. ilot System Pressure Test Engine OFF with Raised Bucket
4. Pilot System Pressure Test Engine ON
5. Main Relief Valve Test and Adjust
6. Line Relief Valves Test and Adjust
7. Charge Ride Control Accumulator Test and Charge
8. Ride Control Diverter Valve Test

Record all test results on "Lab 2.1.2: Implement Hydraulic System Tests Worksheets"

⚠ WARNING

To avoid possible personal injury, follow all warnings listed in the 950G Wheel Loader, 962G Wheel Loader and IT62G Integrated Toolcarrier Hydraulic System, Testing and Adjusting Module (Form No. SENR1390)

Lab 2.1.2: Implement Hydraulic System Tests (comtinued)

Materials Needed

The materials listed is the amount needed per machine used.

Lab 2.1.2 Worksheets

950G Wheel Loader

950G and 962G Wheel Loaders Electro-Hydraulic System, Testing and Adjusting Module (Form No. RENR2146)

1 - 8T-5320 Hydraulic test group

2 - 8S-7630 Stand or equivalent

2 - 8S-8048 Saddle

2 - 8S-7641 Tube

2 - 8S-7615 Pin

1 - 7S-5437 Nitrogen Charging Group

1 - 4C-4892 ORFS Fitting Group

1 - 9U-7400 Multitach

1 - Straight edge ruler 152 mm (6 in.)

1 - Stop watch

1 - Felt tip pen or marker

1 - Mechanic's tool box with hand tools

Lab 2.1.2: Implement Hydraulic System Tests Worksheet

TILT CYLINDERS DRIFT			
	Maximum Drift	Oil Temperature	Time In Minutes
Specifications			
Cylinders Drift			

LIFT CYLINDERS DRIFT			
	Maximum Drift	Oil Temperature	Time In Minutes
Specifications			
Cylinders Drift			

PILOT AND MAIN SYSTEM PRESSURE TEST			
	Pilot Relief Pressure	Main Relief Pressure	Rod End Relief Pressure
Specifications			
Machine Pressure			

TILT CYLINDER				
Oil Temp ____°F	1st Test	2nd Test	3rd Test	Average
Cycle Time				
Specification				

Is the average cycle time within machine specification? ___Yes ___No

LIFT CYLINDERS				
Oil Temp ____°F	1st Test	2nd Test	3rd Test	Average
Cycle Time				
Specification				

Is the average cycle time within machine specification? ___Yes ___No

NOTES

Lab 2.1.3: Implement Hydraulic System Tests Worksheet

Directions: Following the procedures in the 950G Wheel Loader Operation and Maintenance Manual (Form No. SEBU7018) and the Caterpillar Monitoring System Service Manual (Form No. SENR1394), perform the following tests:

1. Using the operator's switch, scroll and list all modes on the Caterpillar Monitoring System.

   a. ______________________________
   b. ______________________________
   c. ______________________________
   d. ______________________________
   e. ______________________________
   f. ______________________________
   g. ______________________________

2. Using the 9U6665 CMS Service Tool, access and list all modes on the Caterpillar Monitoring System.

   a. ______________________________
   b. ______________________________
   c. ______________________________
   d. ______________________________
   e. ______________________________
   f. ______________________________
   g. ______________________________
   h. ______________________________
   i. ______________________________
   j. ______________________________

Lab 2.1.3: Implement Hydraulic System Tests Worksheet (continued)

3. Identify and record problems.

MID	CID	FMI	Description	Service Code
____	____	____	________________________________	Yes ____ No _____
____	____	____	________________________________	Yes ____ No _____
____	____	____	________________________________	Yes ____ No _____
____	____	____	________________________________	Yes ____ No _____
____	____	____	________________________________	Yes ____ No _____
____	____	____	________________________________	Yes ____ No _____
____	____	____	________________________________	Yes ____ No _____

4. Clear memory.

5. Record problems that did not clear.

MID	CID	FMI	Description	Service Code
____	____	____	________________________________	Yes ____ No _____
____	____	____	________________________________	Yes ____ No _____
____	____	____	________________________________	Yes ____ No _____
____	____	____	________________________________	Yes ____ No _____
____	____	____	________________________________	Yes ____ No _____
____	____	____	________________________________	Yes ____ No _____

5. Why did problems not clear?

____

____

____

____

____