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SAE J747 MAR86

Hydraulic Control Valve Test Procedure

SAE Recommended Practice
Reaffirmed March 1986

Submitted for Recognition as an American National Standard

This standard is indexed in the Standards Search Database

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RATIONALE:

This SAE Recommended Practice is currently under revision by Subcommittee 4, Hydraulic Fluid Power Systems and Components, of the Off-Road Machinery Technical Committee.

RELATIONSHIP OF SAE STANDARD TO ISO STANDARD:

Not applicable.

REFERENCE SECTION:

SAE J1116, Categories of Off-Road Self-Propelled Work Machines

APPLICATION:

This procedure describes laboratory tests for establishing operating characteristics of hydraulic directional control valves used on mobile industrial and construction equipment as referenced in SAE J1116. These characteristics are to be recorded on data sheets similar to those shown herein. Two sets of data are to be submitted--one at 122°F (50°C) and one at 194°F (90°C). A separate set of data sheets is to be submitted for the cylinder ports closest to, and farthest from the inlet and outlet ports of a multiple section valve.

The purpose of this procedure is to:

1. Establish conditions for directional control valve tests.
2. Outline a procedure for conduct of test.
3. Establish a method of presenting directional control valve test data.

The procedure covers the following determinations:

1. Pressure drop.
2. Leakage rate.
3. Operating effort.
4. Metering characteristics.
5. Relief valve characteristics.

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OFF-HIGHWAY MACHINERY PRACTICE

Submitted for recognition as an American National Standard

SAE J747

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Reaffirms J747 OCT80

HYDRAULIC CONTROL VALVE TEST PROCEDURE

1. SCOPE: This procedure describes laboratory tests for establishing operating characteristics of hydraulic directional control valves used on mobile industrial and construction equipment as referenced in SAE J1116. These characteristics are to be recorded on data sheets similar to those shown herein. Two sets of data are to be submitted--one at 122°F (50°C) and one at 194°F (90°C). A separate set of data sheets is to be submitted for the cylinder ports closest to, and farthest from the inlet and outlet ports of a multiple section valve.

2. THE PURPOSE OF THIS PROCEDURE IS TO:

   1. Establish conditions for directional control valve tests.

   2. Outline a procedure for conduct of test.

   3. Establish a method of presenting directional control valve test data.

   The procedure covers the following determinations:

   1. Pressure drop.

   2. Leakage rate.

   3. Operating effort.

   4. Metering characteristics.

   5. Relief valve characteristics.

3. MATERIALS AND APPARATUS: Hydraulic fluid shall be a mineral base oil designed for hydraulic service. Viscosity shall be within 105-125 SUS at 122°F and 48-50 SUS at 194°F (21-26 cst at 49-50°C and 6.6-7.4 cst at 90°C). Fluid temperature at the directional control valve shall be maintained at the prescribed level within +5°F (2.8°C). Pressure measurements shall be accurate within ±2.0%. Flow measurements shall be accurate within ±2.0%.

Precautions shall be taken to obtain static pressure readings unaffected by turbulence and velocity.

Back pressure shall be kept to a minimum.

The test circuit shall be provided with 25 μm absolute filtration.

4. GENERAL DEFINITIONS AND TEST CONDITIONS:

4.1 Pressure Drop: Difference in pressure between two connected ports of a control valve circuit as a result of flow. Shall be expressed in pounds per square inch (psi) or (Bar).

4.2 Leakage Rate: Amount of oil per unit time that passes through a valve circuit that is blocked. Shall be expressed in in^3/min or cm^3/min.

4.3 Operating Effort: Maximum force necessary to shift the valve control to its shifted positions from its hold or neutral position, and either the force exerted by the spool or required to move the spool from each shifted position back to neutral. Force shall be expressed in lb or N. Torque shall be expressed in in.-lb or N-M.

4.4 Metering Characteristic: Pressure or flow, versus control movement. Shall be expressed as pressure or flow, in percent of designated, versus control movement in percent of total control movement.

4.5 Fluid Temperature: The temprature of the oil as measured at the control valve. Tests should be conducted at fluid temperatures 122°F (50°C) and 195°F (90°C). The test unit must be at a stabilized temperature.

4.6 Port Identification: Cylinder port "A" is the work port nearest the spool end which attaches to the control linkage. Cylinder port "B" is opposite. The No. 1 circuit is the circuit located nearest the valve inlet port. "Designated flow" and "Designated pressure" as used in the test procedure, refer either to the rated flow and pressure for a valve, or a flow and pressure agreed upon between user and supplier.

5. TEST NO. 1 (PRESSURE DROP): Fig. 6 shows a recommended circuit for determining pressure drops.

5.1 Open Center Pressure Drop (open center valves only): With control valve in the neutral or hold position, and with pump delivery directed to tank through the valve, vary the inlet flow from zero to designated flow, in a suitable number of increments. Record the difference in pressure between the valve inlet and outlet.

5.2 Cylinder Port Pressure Drop:

5.2.1 Double Acting Valves: Connect cylinder "A" port to cylinder "B" port. Shift the valve control to direct flow from the valve inlet port to cylinder "A" port and from cylinder "B" port to tank. Vary the inlet flow from the pump from zero to designated flow in a suitable number of increments. Record the pressure difference between the inlet and cylinder "A" port and cylinder "B" port and the tank outlet. Repeat above test with the control shifted to direct flow from valve inlet port to the cylinder "B" port and flow from cylinder "A" port to tank.

5.2.2 Single Acting Valve: Connect the cylinder port directly to tank. With the valve shifted to direct flow from the valve inlet port to the cylinder port, record pressure difference between inlet and cylinder ports in a suitable number of increments of flow. The pressure loss from the cylinder port to the outlet port shall be determined in two manners when the valve is in the "lower" position.

a. Direct pump flow into the cylinder port and vary in a suitable number of increments, except double the designated flow.

Record the pressure difference.

b. Repeat (a) with fixed designated flow directed into the inlet port.

5.3 Valves having a float or regenerative position shall not require test for pressure losses in the float position, except by agreement between user and manufacturer.

6. TEST NO. 2 (LEAKAGE RATE): Fig. 6 shows a recommended circuit for determining leakage rate.

6.1 Open Center Valves:

6.1.1 Cylinder Port Leakage rate shall be applicable to valves in which the cylinder ports are blocked when the valve is on the holding or neutral position.

Apply designated pressure to each cylinder port in turn and record the leakage rate individually.

If circuit overload relief valve is incorporated, test at this time in accordance with Test No. 5.

7.2 Closed Center Valves:

7.2.1 Cylinder Port Leakage rate shall be applicable to valves in which the cylinder ports are blocked when the valve is on the holding or neutral position.

With the inlet and outlet ports open, apply designated pressure to each cylinder port in turn with the valve in the holding position and record the leakage rate individually.

7.2.2 Inlet Port to Outlet Port Leakage: With all cylinder ports open, apply designated pressure to the inlet port and measure and record leakage to the outlet port.

7.2.3 Inlet Port to Cylinder Port Leakage: Apply designated pressure to the inlet port and measure and record leakage to the individual cylinder ports.

8. TEST NO. 3 (OPERATING EFFORT): Fig. 6 shows a recommended circuit for determining operating effort. Tests shall be conducted with valve installed on base at manufacturers recommended mounting bolt torque.

8.1 No Load Condition: Operating effort under no load circuit conditions shall be measured with no flow or pressure at the valve. Measure the maximum axial force or torque necessary to shift the control from its hold position to each shifted position and record. Measure the minimum axial force or the torque either exerted by the control or required to move the control from each fully shifted position back to neutral and record.

8.2 Circuit Pressure Load Condition: A restricting valve shall be inserted in a line connecting the two cylinder ports.

Apply the designated flow to the inlet and with valve control shifted to direct pressure to either cylinder port. Close the restricting valve to a point where designated pressure is obtained at the inlet port. Measure the maximum axial force or torque necessary to shift the control from its hold position to each shifted position and record. Measure the minimum axial force or the torque either exerted by the control or required to move the control from each fully shifted position back to neutral and record.

8.3 Cylinder Pressure Load Condition: Apply designated pressure with available designated volume to each cylinder port in turn. Measure the maximum axial force or torque necessary to shift the control from its hold position to each shifted position and record. Measure the minimum axial force or the torque either exerted by the control or required to move the control from each shifted position back to neutral and record.

9. TEST NO. 4 (METERING CHARACTERISTICS): Fig. 7 shows a recommended circuit for conducting metering tests.

9.1 Pressure Rise: Open center pressure rise shall be measured by maintaining designated flow to the inlet port and actuating the control from a full shifted position to the opposite full shifted position in a suitable number of increments. Maintain full flow, record control movement and inlet pressure. Cylinder ports are plugged during this test. Repeat above test using 33% of designated flow to the inlet port.

9.2 Cylinder to Tank Metering: Cylinder to tank metering shall be measured by applying 75% of designated pressure with a maximum of designated flow at port "A". Shift the control in suitable increments, allowing flow to tank. Record control movement versus flow. Repeat above test using cylinder port "B".

9.3 Inlet to Cylinder Metering: Inlet to cylinder metering shall be measured with the pressure and flow conditions listed below. Adjust load relief valve to 75% of the designated pressure and set the main relief to designated pressure.

Apply designated flow to the valve inlet port. Shift the control in suitable increments, adjusting the load relief valve, if necessary, to maintain initial pressure. Record control movement and flow through the load relief valve.

10. TEST NO. 5 (RELIEF VALVE CHARACTERISTICS): Fig. 6 depicts a recommended circuit to conduct relief valve tests.

The main system relief valve tests shall be conducted by applying designated flow to the valve inlet and shifting one valve spool to direct flow to a cylinder port with no port relief valve. If all cylinder ports have port relief valves, shift the spool to direct the flow to the port with the highest relief setting.

The port relief valve tests shall be conducted by applying designated flow to the cylinder port with the valve spool in neutral or holding position.

10.1 Leakage:

10.1.1 Gradually apply pressure in suitable increments until flow equals approximately 5% of designated flow, and then decrease pressure in the same increments and record leakage at each increment.

10.2 Pressure Control:

10.2.1 Increase flow across valve from approximately 2% of designated flow to designated flow in suitable increments and then decrease flow in the same increments and record pressure at each increment.

10.3 Overshoot or Response:

10.3.1 Increase the pressure at the approximate rate of 100,000 psi/s until designated flow is reached. Record pressure against time on an oscilloscope or oscillograph. Determine overshoot and response time.

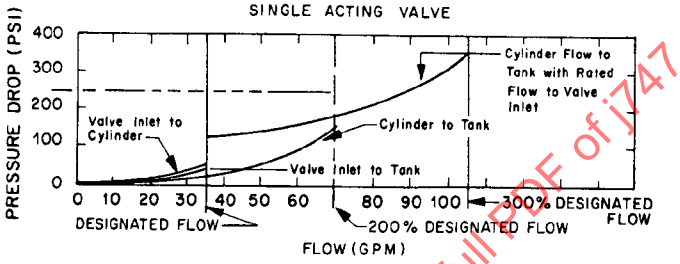
DIRECTIONAL CONTROL VALVE

PERFORMANCE DATA

MANUFACTURER: AJAX INC.
MODEL: YZ4-06 CIRCUIT TYPE: OPEN CENTER
SPOOL TYPE: SINGLE ACTING SPOOL 2 OF 2
DESIGNATED FLOW: 35 G.P.M. DESIGNATED PRESSURE: 1000 PSI
TEST FLUID: MINERAL BASE HYDRAULIC OIL
FLUID VISCOSITY: 105 SUS AT 120 °F VISCOSITY - INDEX: 102
TEST TEMPERATURE: 120 °F
MAXIMUM DESIGNATED TANK PORT PRESSURE: 200 P.S.I.

TEST NO. 1 PRESSURE DROP

SINGLE ACTING VALVE



DOUBLE ACTING VALVE

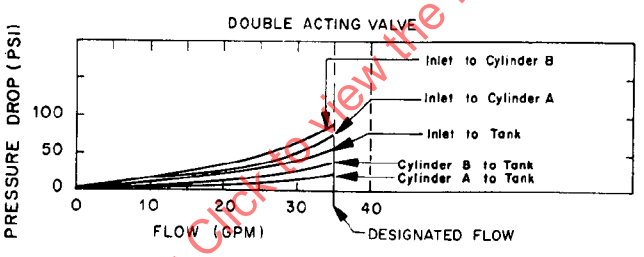


FIG. 1

TEST NO. 2 LEAKAGE RATE

PORT	CYLINDER PORT TO TANK	INLET PORT TO CYLINDER PORT	INLET PORT TO TANK *
A	____ IN^3/MIN	____ IN^3/MIN	____ IN^3/MIN
B	____ IN^3/MIN	____ IN^3/MIN	

* CLOSED CENTER VALVES ONLY

TEST NO. 3 OPERATING EFFORT

CONDITION	NO LOAD	CIRCUIT PRESSURE LOAD	CYLINDER PRESSURE LOAD
MAXIMUM ACTUATING FORCE OR TORQUE	____ LB	____ LB	____ LB
MINIMUM RETURN FORCE OR TORQUE	____ LB	____ LB	____ LB

FIG. 2