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SAE INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

SURFACE VEHICLE RECOMMENDED PRACTICE

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Superseding J214 OCT80

Submitted for recognition as an American National Standard

HYDRAULIC CYLINDER TEST PROCEDURE

***Foreword*—**This Reaffirmed Document has been changed only to reflect the new SAE Technical Standards Board format.

***1. Scope*—**This test procedure describes tests for determining characteristics of hydraulic cylinders as used on construction and industrial mobile machinery as referenced in SAE J1116. In this code, metric equivalents are established according to SAE J916. These characteristics are to be recorded on data sheets similar to the ones shown herein. Two sets of data sheets are to be submitted for each cylinder, one set at 120 °F (49 °C) and one at 180 °F (82 °C).

1.1 Purpose—This test procedure establishes conditions for cylinder tests, outlines a procedure for tests, and describes a method of presenting cylinder test data.

1.1.1 The procedure specifies methods for determining leakage rate, packing drag, proof pressure capacity, and endurance capacity.

2. References

2.1 Applicable Publications—The following publications form a part of the specification to the extent specified herein. Unless otherwise indicated the latest revision of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J916—Rules for SAE Use of SI (Metric) Units
SAE J1116—Categories of Off-Road Self-Propelled Work Machines

3. Material And Apparatus

3.1 Test Fluid—Test fluid shall preferably be a mineral base oil designed for hydraulic service. Fluid viscosity shall be within the limits of 95–115 SUS (438.9–531.3 cs) at 120 °F (49 °C) and 50–54 SUS (231–249.5 cs) at 180 °F (82 °C).

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

3.2 Pressure Measurements—Pressure measurements shall be accurate within ±2.0%.

3.3 Flow Measurement—Flow measurement shall be accurate within ±2.0%.

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3.4 **Temperature Measurement and Control—**Fluid temperature shall be measured at the entrance to the cylinder by means of a thermometer or thermocouple. If a means of measuring temperature of fluid under pressure is not available, or if temperature change from reservoir to cylinder inlet is kept to a minimum, reservoir temperature is acceptable. Fluid temperature shall be maintained at the prescribed level through the test within ±5 °F (±2.8 °C).

3.5 The test setup shall not impose side loads upon either the cylinder under test or the slave cylinder.

4. General Definitions And Test Conditions

4.1 **Internal leakage—**shall be measured in inches (millimetres) per minute of shaft movement at a specified pressure.

4.2 **Fluid temperature—**shall be 120 °F and 180 °F (49 °C and 82 °C) for standard tests and the test cylinder shall be stroked prior to test runs to eliminate air from the circuit and to allow the cylinder components to heat up to the test temperature.

4.3 **Designated pressure—**of a cylinder shall be considered as the maximum pressure at which the manufacturer recommends continuous duty.

4.4 **Proof pressure—**is to be defined as the maximum pressure which can be applied that will not cause any permanent set or deformation. Normally, this is never less than 200% designated pressure.

4.5 **Packing drag—**shall be defined as the amount of pressure necessary to move the piston with all external (either mechanical or hydraulic) forces removed or in balance.

4.6 **Rod end—**is the cylinder end closure which covers the differential area between the bore and the piston rod.

4.7 **Cap end—**is the cylinder end closure which completely covers the bore area.

4.8 **Rod leakage—**is defined as the oil that leaks by the rod packing. This leakage is associated with rod movement and is measured in cubic inches (or litres) per number of cycles.

5. Test 1 - Internal Leakage

5.1 Figure 1 shows a recommended circuit for determining internal leakage.

5.2 Position the piston of the cylinder under test at the approximate midpoint of the cylinder.

5.3 Fill both sides of the cylinder under test with hydraulic fluid and close the zero leakage valve to the cap end of this cylinder. Vent the rod end to atmosphere.

5.4 Pressurize cap end of slave cylinder to attain 5% of the designated pressure at the cap end of the cylinder under test.

5.5 Maintain this pressure on the cap end for a period of 15 min.

5.6 Measure the total movement of the rod at 3 min intervals and record.

5.7 Repeat the above test by applying pressure to the rod end of the slave cylinder to attain 5% of the designated pressure at the rod end of the test cylinder and closing the zero leakage valve to the rod end rather than the cap end under test. Vent the cap end to atmosphere.

5.8 Repeat steps 5.2–5.7 at 50 and 100% of designated pressure.

6. Test 2 - Packing Drag

6.1 Disconnect the slave cylinder from the cylinder under test and position the piston at the midpoint of the cylinder under test.

6.2 Fill both sides of the cylinder with hydraulic fluid and vent the cap end to atmosphere.

6.3 Apply increasing pressure to the rod end of the cylinder under test.

6.4 Record on data sheet the minimum pressure at which the piston moves and also the pressure required to keep it moving.

6.5 Repeat the above test for the reverse direction by applying pressure to the cap end and venting the rod end.

7. Test 3 - Proof Pressure

7.1 Position the piston of the cylinder under test at the approximate midpoint of the cylinder and secure the rod to the test fixture.

7.2 Connect the hydraulic supply to one end of the cylinder. Vent the opposite end to atmosphere.

7.3 Apply the proof pressure for a period of 30 s.

7.4 Examine for structural failure evidenced by external loss of fluid through any portion of the cylinder except a vented port.

7.5 Relieve the hydraulic pressure and disconnect the hydraulic supply.

7.6 Connect the hydraulic supply to the opposite end of the cylinder.

7.7 Repeat steps 7.2–7.5.

8. Test 4 - Endurance

8.1 When endurance testing is applicable, the user and the supplier should develop an agreement on the number of severity of cycles based on specific cylinder applications.

8.2 Figure 2 shows a recommended circuit for endurance testing.

8.3 A cycle for a specific test may be defined by supplying values for the following parameters:

a. Pressure requirement both directions.
b. Length of stroke.

8.4 Test specification to include the total number of cycles of each description.

8.5 An internal leakage test may be required at the conclusion of the endurance test to determine compliance of cylinder packing.

8.6 An external leakage test may be required during the various cycle requirements. Record accumulated leakage at practical intervals and plot against corresponding cycles.

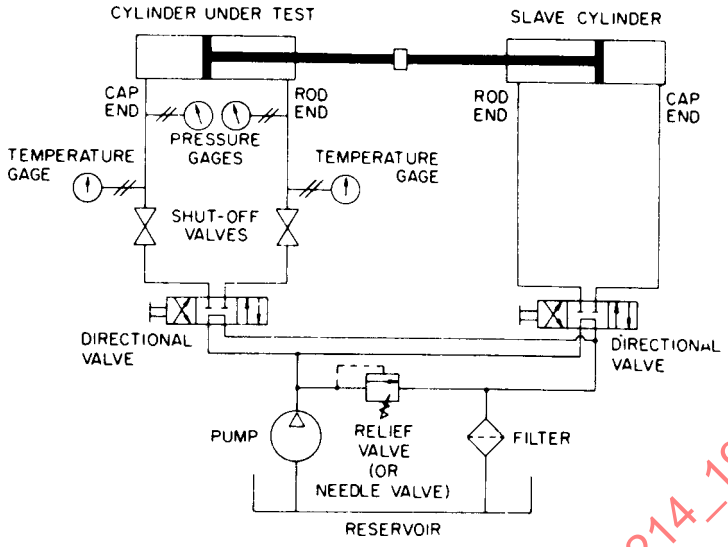

FIGURE 1—TYPICAL TEST SETUP FOR LEAKAGE AND PACKING DRAG DETERMINATIONS

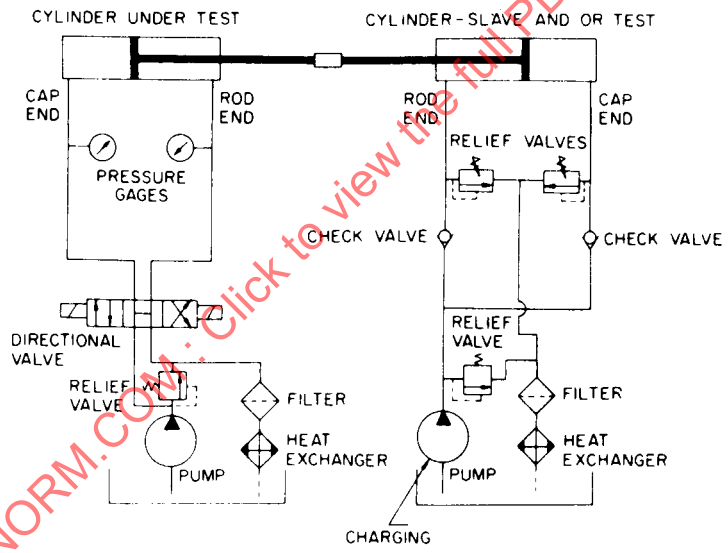

FIGURE 2—TYPICAL TEST SETUP FOR ENDURANCE TESTING

PREPARED BY SAE SUBCOMMITTEE 4—HYDRAULIC FLUID POWER SYSTEMS AND COMPONENTS

APPENDIX A

PERFORMANCE ON HYDRAULIC CYLINDER (SAMPLE)

MANUFACTURER: LIFCYL Corp.

MODEL: 4STR21

SERIES OR TYPE: P1

DESIGNATED PRESSURE: 2000 psi (138 x 10^5 N/m^2)

PROOF PRESSURE: 4000 psi (276 x 10^5 N/m^2)

TEST FLUID: Oil meeting API service MS

Viscosity: 105 SUS (485 cs) at 120 °F (49 °C)

Viscosity Index: 102

TEST at 120 °F (49 °C) or 180 °F (82 °C)

FLUID TEMPERATURE DURING TEST: 120 °F (49 °C)

AMBIENT TEMPERATURE: 70 °F (21.1 °C)

APPENDIX B

INTERNAL LEAKAGE (SAMPLE)

B.1 Total linear movement of rod, pressure applied at cap end, area of cap end 15.902 in^2 (102.59 cm^2).

TABLE B1

% of Rated Pressure	Time Period, min											
	0		3		6		9		12		15	
	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
5	0	0	0.003	0.08	0.006	0.15	0.008	0.20	0.010	0.25	0.011	0.28
50	0	0	0.006	0.15	0.012	0.30	0.014	0.36	0.015	0.38	0.015	0.38
100	0	0	0.010	0.25	0.015	0.38	0.018	0.46	0.019	0.48	0.020	0.51

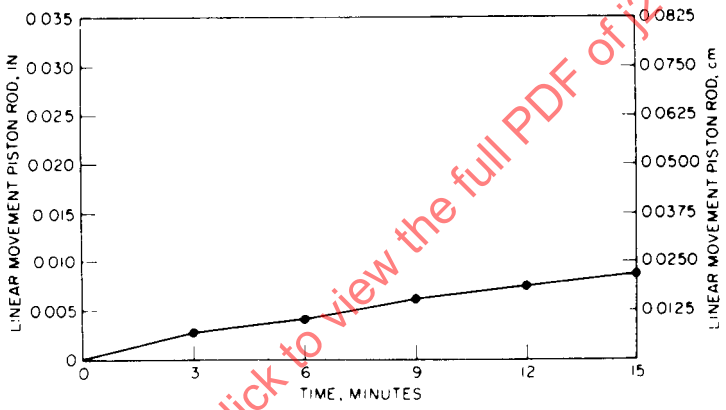

FIGURE B1—

APPENDIX C

PACKING DRAG (SAMPLE)

Cap end:

Starting pressure, 49 psi (33.8 x 10^4 N/m^2)
Average moving pressure, 40 psi (27.6 x 10^4 N/m^2)

Rod end:

Starting pressure, 50 psi (34.5 x 10^4 N/m^2)
Average moving pressure, 45 psi (31 x 10^4 N/m^2)

APPENDIX D

PROOF PRESSURE (SAMPLE)

Rod end:

Proof pressure: 4000 psi (276×10^5 N/m^2), 30 s
Evidence of failure: None

Cap end:

Proof pressure: 4000 psi (276×10^5 N/m^2), 30 s
Evidence of failure: None