The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

SURFACE VEHICLE INFORMATION REPORT

SAE J1655

ISSUED AUG96

Issued 1996-08

PREDICTIVE AND PREVENTIVE DIAGNOSTIC MAINTENANCE OF HYDRAULIC SYSTEMS

1. Scope—This SAE Information Report is intended to help promote the proper use of Predictive and Preventive Diagnostic Maintenance in hydraulic systems. This document can be used as a selection guide for the level of diagnostic equipment and methods to specify for a given application. Each application has its own particular requirements.

2. References

2.1 Related Publications—The following publications are provided for information purposes only and are not a required part of this document.

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

SAE J1502—Pressure Test Points Installed in Mobile Equipment

2.1.2 GENERAL MOTORS PUBLICATION—Available from General Motors Corporation, Boise Cascade, 13301 Stephens Road, Warren, MI 48089.

GM-1744—Hydraulic Standard HS1 for Industrial Equipment

2.1.3 ISO PUBLICATIONS—Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ISO 4402—Reference standards for calibration of particle counter
ISO 4406—Classification of particles

2.1.4 MILITARY PUBLICATION—Available from U.S. Government, DoD SSP, Building 4D, 700 Robbins Avenue, Philadephia, PA 19111-5094.

Department of Defense Specification for Hydraulic Test, Vent, and Blend Valves, Hoses and Adapters

2.1.5 NFPA PUBLICATIONS—Available from the National Fluid Power Association, 3333 North Mayfair Road, Milwaukee, WI 53222-3219.

NFPA Glossary of Terms
NFPA/JIC T2.24.1-1990—Systems Standard for Stationary Industry Machinery, Section 18, Diagnostic Testing and Condition Monitoring, An industry standard for Fluid Power, Hydraulic Fluid Power

QUESTIONS REGARDING THIS DOCUMENT: (724) 772-8512 FAX: (724) 776-0243
TO PLACE A DOCUMENT ORDER; (724) 776-4970 FAX: (724) 776-0790
SAE WEB ADDRESS http://www.sae.org

3. Definitions

3.1 Critical Location—Those locations in the circuit where pressure, flow, or direction of flow can be controlled to affect the process.

3.2 Flow Measurement Device—A device which measures the volume or mass of fluid flowing through a conductor per unit of time.

3.3 Instrument, Flow Measuring—A device which measures the flow rate of a fluid.

3.4 Main Flow Line—That part of the hydraulic system from the pump or accumulator discharge to actuator and the return line.

3.5 Turbulent Flow—A flow situation in which the fluid particles move in a random fluctuating manner.

3.6 Laminar Flow—A flow situation in which the fluid moves in parallel lamina or layers.

3.7 Shear Stress—"The force, per unit area, with the direction defined, related to flow."[1]

3.8 Viscosity—A measure of internal friction or the resistance of a fluid to flow.

3.9 Regular Basis—Frequency of fluid sampling that relates to the hydraulic system contamination generation and ingestion rates.

3.10 Trend Analysis—The use of baseline signature and subsequent signatures to predict future performance of the system and scheduled maintenance.

3.11 Fluid Analysis—A chemical analysis of the system hydraulic fluid and its particulate contamination.

3.12 System Inspection—An inspection of components, circuitry, and system variables as listed in Section 4 as they relate to system performance, consistent with the preventive maintenance plan.

3.13 Performance History—A compilation of all signatures, maintenance records, and preventive maintenance data.

3.14 System Flushing—The process of cleaning to remove the initial residual contamination from the inside of conductors and components of the assembled system to achieve a defined level of cleanliness.

3.15 Vibration Analysis—The measurement and recording of vibration parameters to determine trend.[2]

---

1. Fluid Mechanics, Victor L. Streeter, McGraw-Hill, 1958.
2. Vibrations, William W. Seto, B.S. in M.E., M.S.

4. Hydraulic System Categories—Hydraulic systems must be categorized into levels of relative complexity and degrees of criticalness to the process. Complexity shall be rated by the system operating pressure, type of components and their relationships to the overall hydraulic system. There are six levels of complexity.

4.1 Complexity

a. Pressure less than 1000 psi—Solenoid valves.
b. Pressure less than 2000 psi—Solenoid valves.
c. Pressure less than 2000 psi—Proportional valves.
d. Pressure greater than 2000 psi—Proportional valves.
e. Pressure less than 2000 psi—Servo valves.
f. Pressure greater than 2000 psi—Servo valves.

Hydraulic systems shall also be categorized into degrees of criticalness. There are four degrees of criticalness.

4.2 Criticalness

a. Zero Impact—Off-line support equipment with no impact on the process.
b. Minor Impact—System can be shut down, as required, with minimal impact on the process.
c. Major Impact—System can be shut down only at scheduled intervals as dictated by the process.
d. Shutdown Impact—System must run continuously to support the process.

4.3 Category—Based on the level of complexity and the degree of criticalness, each combination falls into one of four categories as shown in Table 1. Once the hydraulic system is categorized, it is necessary to evaluate system variables and the diagnostic requirements.

5. System Variables to Consider—See Section 3.

a. Pressure (static, differential, transient)
b. Flow Rate
c. Temperature
d. Rotation Speed
e. Horsepower
f. Vibration
g. Electrical Current
h. Fluid Contamination
i. Fluid Type
j. Fluid Viscosity
k. Fluid Level
l. Environmental Considerations
m. Any other variable that may impact the reliability of the fluid power system