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SAE J643 JUN89

Hydrodynamic Drive Test Code

SAE Recommended Practice
Revised June 1989

Submitted for Recognition as
an American National Standard

The Engineering Society For Advancing Mobility Land Sea Air and Space®
400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

HIGHWAY VEHICLE PRACTICE

Submitted for recognition as an American National Standard

SAE J643

Issued January 1951
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Superseding J643 JUN79

HYDRODYNAMIC DRIVE TEST CODE

1. PURPOSE:

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This code provides a means of determining operating characteristics of hydrodynamic drives used in motor vehicle installations. It outlines a series of dynamometer tests and provides a method of presenting data from these tests. The results obtained are complete enough to provide a basis for estimating vehicle performance. Other special tests, such as centrifugal bursting, heat rejection, extreme temperature, cavitation, and charging pressure, may be required to evaluate the unit for particular applications or conditions.

2. SCOPE OF TESTS:

The range of test conditions on the dynamometer shall be sufficient to determine the primary operating characteristics corresponding to the full range of vehicle operations.

The characteristics to be determined are:

a. Torque ratio versus speed ratio and output speed.

b. Input speed versus speed ratio and output speed.

c. Efficiency versus speed ratio and output speed.

d. Capacity factor versus speed ratio and output speed.

e. Input torque versus input speed.

NOTE: For more information about these characteristics and the design of hydrodynamic drives, see "Design Practices--Passenger Car Automatic Transmissions," SAE Advances in Engineering, Vol. 5.

3. EQUIPMENT AND TEST PROCEDURES:

3.1 Driving and absorbing dynamometer capable of torque measurement within ±0.7 Nm and speed measurement within ±5 rpm are to be used for most tests (same as required in SAE J651 JUN79). When extremely high torques are required, an accuracy range of ±0.5% of full load reading is considered acceptable.

3.2 An independently operating fluid supply system with provisions for pumping, heating, cooling, and regulating the flow and pressure of the fluid to the test unit should be used.

3.3 Instrumentation for measuring temperature and pressure of the fluid at the inlet and outlet of the hydrodynamic drive is required.

3.4 Before starting tests for the characteristics, calibration curves should be obtained on the dynamometers and instruments indicating torque, speed, pressure, and temperature.

3.5 A fluid of known physical and chemical characteristics and approved by the manufacturer of the unit should be used.

3.6 Fluid temperatures for all standard tests should be 90-100°C at the inlet, and 130°C maximum at the outlet of the hydrodynamic drive. Higher or lower temperatures may be used if recommended by the manufacturer or if representative of the application. At or near stall, the inlet temperature may be reduced to maintain outlet temperature.

3.7 Unless otherwise specified, fluid pressures for standard tests should be enough to avoid cavitation.

All readings should be taken simultaneously with loads, speeds, temperatures, and pressures stabilized when possible. When such stabilization is not possible, the time interval between readings and the rate of change must be noted.

STANDARD TESTS

4. OPERATING MODES:

There are two usual performance modes for recording and collecting data.

Drive Performance: Normal rotation with normal power flow (impeller driving).

Coast Performance: Normal rotation with reverse power flow (turbine driving) as in vehicle closed throttle coasting operation.

PASSENGER CARS, TRUCKS, BUSES, AND MOTORCYCLES

Required Data:

Input torque	Fluid flow rate
Input speed	Inlet pressure
Output torque	Outlet pressure
Output speed	Inlet temperature
	Outlet temperature

Physical and chemical characteristics of the fluid

4.1 Drive Performance:

4.1.1 Constant Input Torque: This test is run by increasing the speed of the driving dynamometer to obtain the torque selected for the test while keeping the output dynamometer speed at or near zero. The output speed is next increased in equal increments, keeping the input torque constant. The procedure is repeated for several input torque values. Torque values are chosen that represent a typical application of the hydrodynamic unit being tested. The speed and torque values must be selected to span the full range of vehicle operating speed ratios.

4.1.2 Full Throttle Performance: This test is run by setting the input dynamometer speed and torque to corresponding values on the full throttle installed net torque curve of an engine. The output speed is set at or near stall and increased at selected increments to span the full range of vehicle speeds. Pressures at the inlet and outlet of the hydrodynamic unit are set equal to values existing in the transmission at the corresponding operating conditions.

4.1.3 Road Load Performance: This test is run by adjusting the input dynamometer speed and torque to obtain the required output speed and torque values. These values correspond to zero acceleration requirements of the vehicle on level ground for the full range of vehicle speeds. Pressures are set equal to values existing in the tranmission at corresponding operating conditions.

NOTE: Full throttle and road load performance are frequently calculated from test (4.1.2).

4.2 Coast Performance:

4.2.1 Constant Input Torque: The test method is the same as test 1 (4.1.2). Values are chosen to span the range of engine closed throttle motoring torque for a typical application of the HD unit.

4.2.2 Engine Motoring Friction: The test method is to set the absorbing dynamometer speed and torque to corresponding values on the curve of friction torque versus speed.

This friction curve is obtained on a previous test by driving the engine at various speeds after setting the engine at its standard idling condition.

NOTE: Vehicle coast performance is frequently calculated from test 2 (4.2.2) data.

COMPUTATIONS

1. Speed ratio = Output speed/Input speed
2. Torque ratio = Output torque/Input torque
3. Efficiency = (Speed ratio)(Torque ratio)
4. Capacity factor (input) $K = \frac{\text{Input speed}}{\sqrt{\text{Input torque}}}$
5. Capacity characteristic, (input) $\bar{K} = \frac{\text{Input speed} \quad \text{Diameter}^5}{\sqrt{\text{Input torque}}}$

5. PRESENTATION OF RESULTS:

5.1 Completely identify the hydrodynamic unit, and record the test conditions on all data and curve sheets.

5.2 Develop performance curves of the primary characteristics. Examples of typical plots of these are shown on Figs. 1-4. Additional useful engineering curves using data from these performance tests are shown on Figs. 5 and 6. In preparing curves using engine and vehicle data, it is essential that the data precisely describe the net power to and from the hydrodynamic unit. All corrections for accessories, air temperature and pressure, barometer reading, air cleaners, mufflers, fans, and transmissions input and output losses must be considered. The words "installed net" torque and horsepower are intended to express this condition.

5.3 Include copies of the data or identify the data sheets with the reported results.

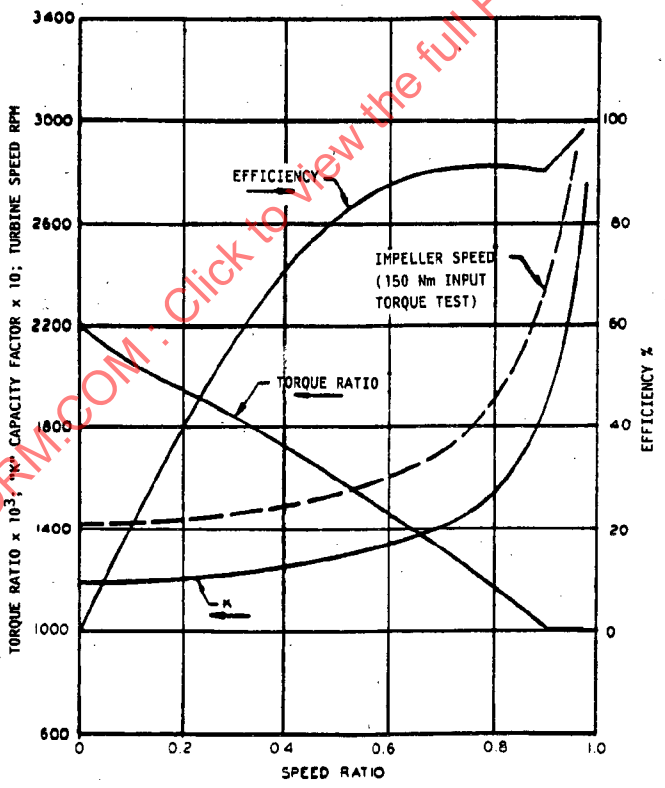

FIGURE 1 - Typical Speed Ratio Plot of Converter Characteristics

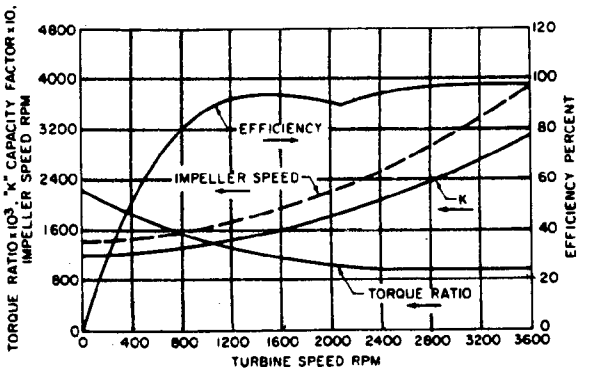

FIGURE 2 - Typical Ouput Speed Plot of Converter Characteristics (150 N·m Input Torque)

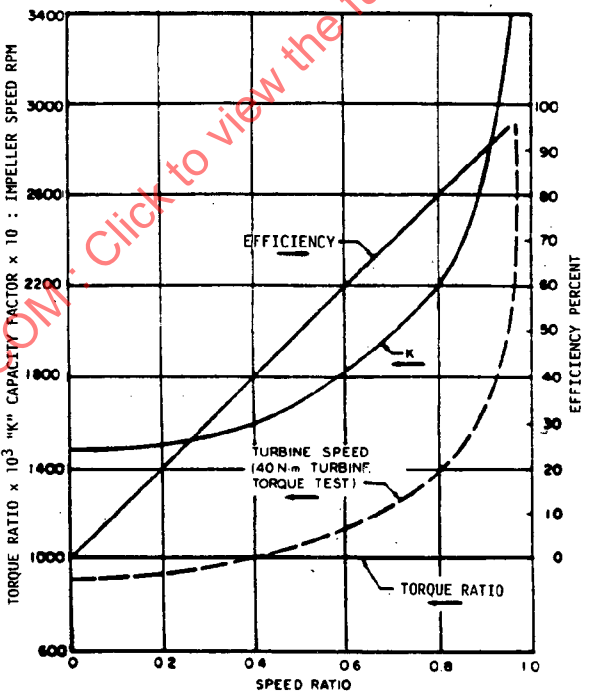

FIGURE 3 - Typical Speed Ratio Plot of Converter Characteristics in Coast

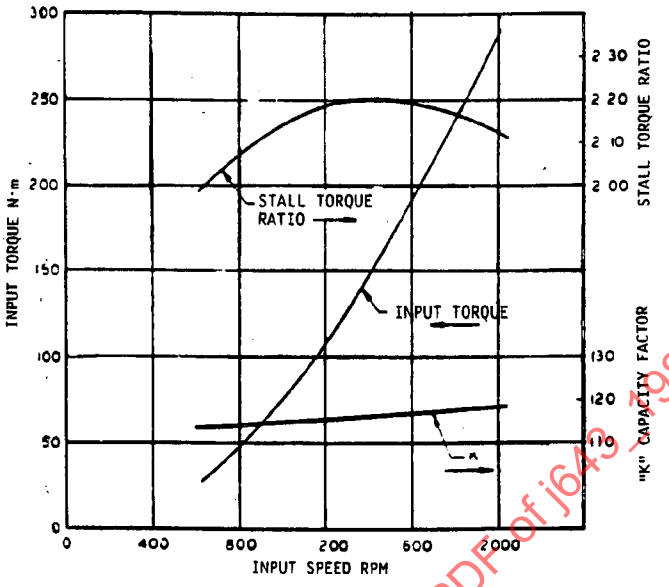

FIGURE 4 - Typical Input Speed Plot of Converter Stall Characteristics

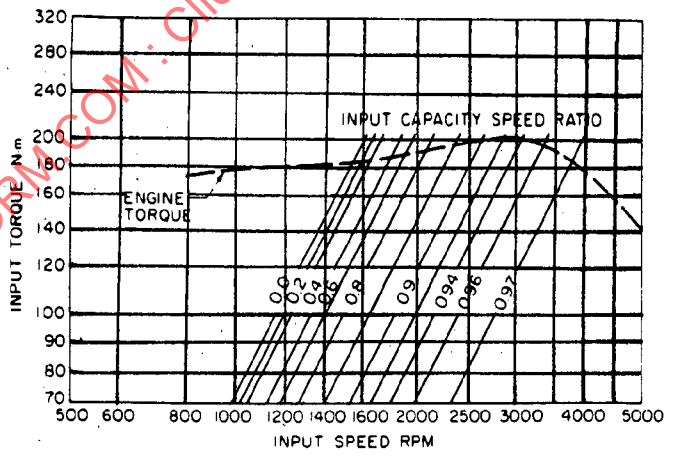

FIGURE 5 - Typical Input Capacity Plot Used to Determine Operating Conditions of Engine and Converter