

# Bench Test Procedure for the Performance of Power Steering Pump

## 1. Scope

This standard covers the bench test procedure for the performance of oil pumps for automobile power steering systems.

**Remark:** In this standard, units and numerical values given in { } are based on the International System of Units (SI), and are given for reference.

## 2. Purpose

The purpose of this standard is to establish a general bench test procedure for the performance of pumps.

## 3. Definitions

For the purposes of this standard, the following definitions are applied.

- (1) **Preferred number of revolutions** Shall refer to the preferred number of revolutions per minute of a pump used on a vehicle.
- (2) **No load pressure** Shall refer to the power steering system pressure, generally below  $5\text{kgf/cm}^2$  {  $0.5\text{MPa}$  }, assumed to indicate in its neutral position.
- (3) **Relief pressure** Shall refer to the preset pressure set on a relief valve which allows the working fluid to escape when the system pressure exceeds the preset value.
- (4) **Input torque** Shall refer to the torque required to drive the pump.

## 4. Kinds of Test

The following kinds of test are specified in this standard.

- (1) Test on the effect of the number of revolutions on delivery flow ( $N$ — $Q$  characteristic test)
- (2) Test on the effect of delivery pressure on delivery flow ( $P$ — $Q$  characteristic test)
- (3) Relief pressure test
- (4) Input torque test
- (5) Noise test
- (6) Leak test

## 5. General Test Conditions

The following test conditions shall be used unless otherwise specified.

- (1) **Ambient temperature** shall be based on JIS Z 8703 (Standard Conditions for Testing) Grade 4 or  $20 \pm 15^\circ\text{C}$ .
- (2) **Working fluid** Shall be as agreed between the parties concerned.
- (3) **Temperature of working fluid** Shall be  $55^\circ\text{C} \pm 5^\circ\text{C}$ .
- (4) **Air bleeding** Prior to any test, the pump and the testing system shall be bled sufficiently.
- (5) **Break-in** Prior to any test, a pump to be tested shall be subjected to a proper amount of break-in.
- (6) **Measuring instrument** A suitable measuring instrument or instruments shall be used for the test concerned. Particularly converting delivery flow into an electrical signal, the measuring instrument shall be calibrated before a test is performed.
- (7) **Operation** When an X—Y recorder is used, the number of revolutions and the pressure shall be changed at a rate with which the X—Y recorder can follow.

## 6. Test Pump

A pump to be tested shall either be re-adjusted under official supervision, removed wholly from the vehicle, or reinstalled.

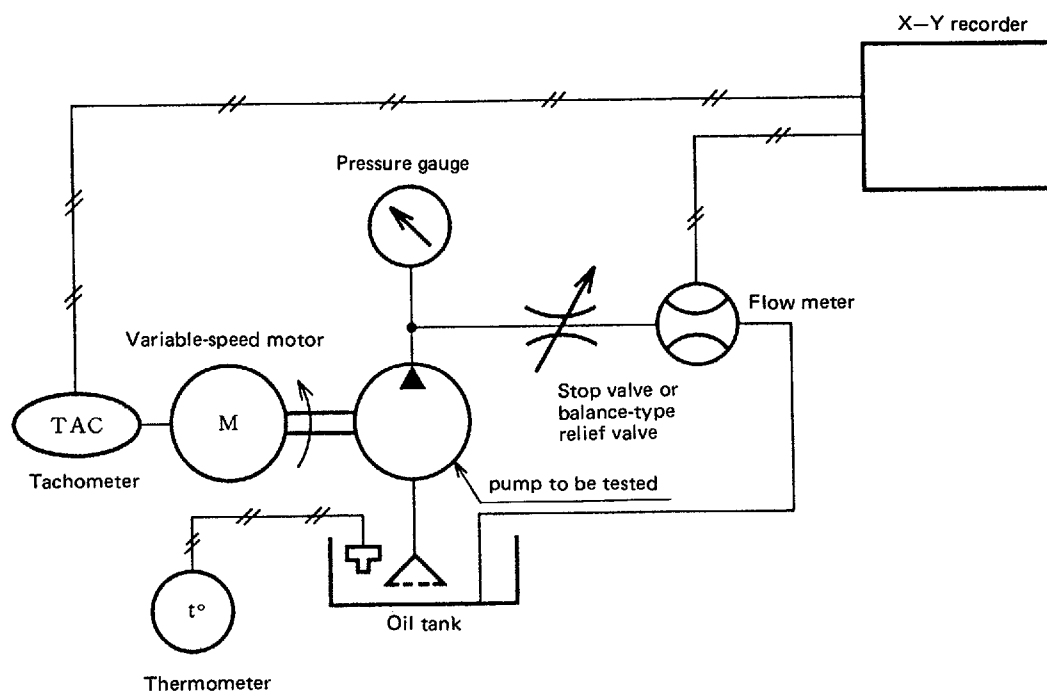
## 7. Testing Method

### 7.1 Test on Effect of Number of Revolutions on Delivery Flow ( $N$ — $Q$ characteristic Test)

This test shall be used to measure the delivery flow of a pump at different numbers of revolutions per minute while holding delivery pressure constant.

- (1) **Instrumentation** Shown in Fig. 1.

|                             |                   |                                                                           |
|-----------------------------|-------------------|---------------------------------------------------------------------------|
| <b>Applicable Standard:</b> | JIS C 1502 — 1977 | Sound Level Meters                                                        |
|                             | JIS Z 8703 — 1976 | Standard Conditions for Testing                                           |
| <b>Reference Standard:</b>  | JIS B 0118 — 1970 | Glossary of Terms for Oil Hydraulics                                      |
|                             | JIS B 0125 — 1972 | Graphical Symbols for Fluid Power Diagrams                                |
|                             | JASO C 711 — 79   | Bench Test Procedure for the Performance of Integral Type, Power Steering |

Fig. 1 Block Diagram for Measuring  $N$ - $Q$  Characteristic**(2) Test Conditions**

- ① Number of revolutions Shall be within the range of preferred revolutions.
- ② Delivery pressure Shall be no-load pressure unless otherwise specified.

**Remark:** Where other than no-load pressure values are required for testing, 30kgf/cm<sup>2</sup> {3.0MPa}, 50kgf/cm<sup>2</sup> {5.0MPa} are recommended.

**(3) Test Procedure**

A test procedure shall consist of (1), varying the number of revolutions gradually from the lowest to the highest value while a constant delivery pressure is maintained by means of controlling stop valve or a balance-type relief valve, and (2), taking a successive record of the delivery flow according to the changes of rpms.

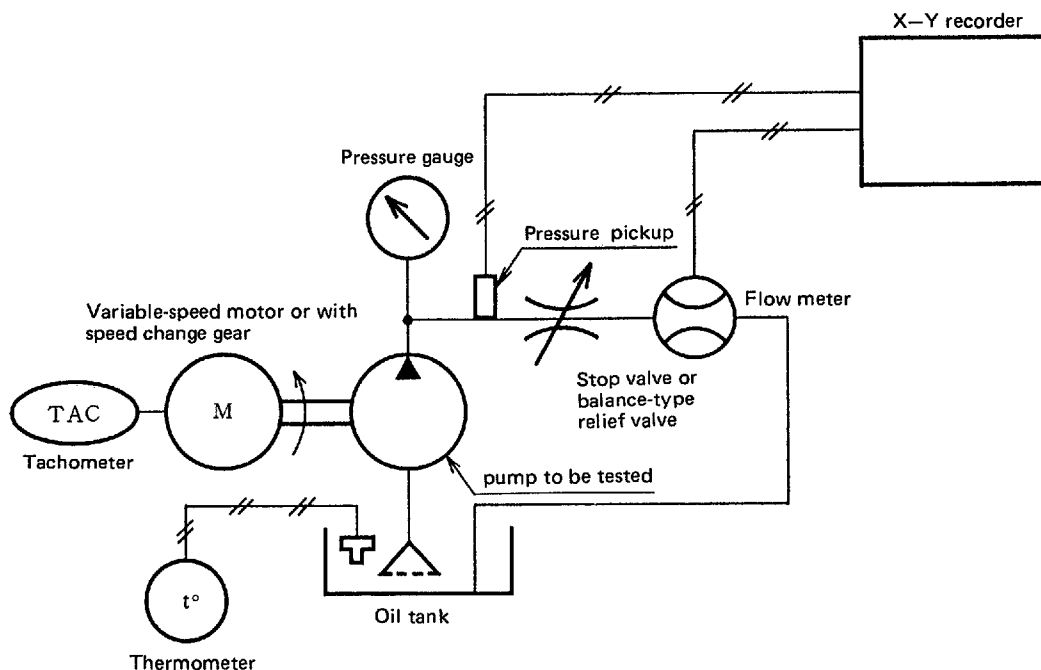
**(4) Recording**

- ① The measurements shall be recorded on the X-Y recorder with graph paper shown in **Attached Table 2**.
- ② Test results and comments shall be filled appropriately in a form shown in **Attached Table 1**.

**7.2 Test on Effect of Delivery Pressure on Delivery Flow ( $P$ - $Q$  Curve Test)**

This test shall be used to measure the delivery flow of a pump at different delivery pressures while holding pump speed constant.

- (1) **Instrumentation** Shown in Fig. 2.

Fig. 2 Block Diagram for Measuring  $P$ - $Q$  Characteristic**(2) Test Conditions**

- ① Temperature of working fluid Shall be  $55 \pm 5^\circ\text{C}$  or  $80 \pm 5^\circ\text{C}$ .
- ② Delivery pressure Shall be between the no-load and pump relief pressures.
- ③ Number of revolutions Shall be 600rpm and values agreed upon between the parties concerned.

**(3) Test Procedure**

A test procedure shall consist of (1), setting the pump at specified values of rpm and no-load pressure, (2), gradually throttling the stop valve or the balance-type relief valve while controlling the speed change gear in order to maintain the rpm, and (3), taking a successive record of delivery flow according to the changes of delivery pressures.

**(4) Recording**

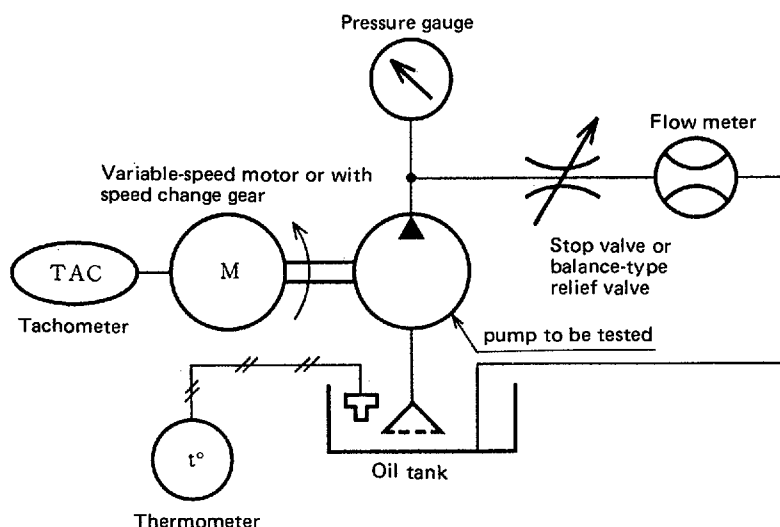
- ① The measurements shall be recorded on the X-Y recorder with graph paper shown in **Attached Table 3**.
- ② Test results and comments shall be filled appropriately in a form shown in **Attached Table 1**.

**7.3 Relief Pressure Test**

This test shall be used to measure the relief pressure of a pump, and may be conducted together with a test specified in 7.2.

(1) **Instrumentation** Shown in Fig. 3.

Fig. 3 Block Diagram for Measuring Relief Pressure



(2) **Test Conditions**

Number of revolutions: Shall be 600rpm or values agreed upon between the parties concerned.

(3) **Test Procedure**

Relief pressure shall be read enough after the stop valve or the balance-type relief valve has been tightly closed. The relief pressure shall not be maintained for more than 5 seconds.

(4) **Recording**

The Results and comments shall be filled in a form as shown in **Attached Table 1**.

(3) **Test Procedure**

The pump speed shall be varied gradually from the lowest value to the highest within the preferred rpm range, and a successive record of input torque shall be taken as it varies according to the changes of rpms.

(4) **Recording**

① The measurements shall be recorded on the X-Y recorder with graph paper shown in **Attached Table 4**.

② Results and comments shall be filled appropriately in a form a shown in **Attached Table 1**.

**7.4 Input Torque Test**

This test shall be used to measure the input torque of a pump at different values of pump rpm and delivery pressure.

(1) **Instrumentation**

An example of testing equipments is shown schematically in **Fig. 4**, in which a torque pickup is set between the pump and the variable-speed motor.

(2) **Test Conditions**

① Number of revolutions Shall be within the range of preferred rpms.

② Delivery pressure Shall be no-load pressure and values agreed upon between the parties concerned.

**7.5 Noise Test**

This test shall be used to determine the noise levels radiated from a pump.

(1) **Instrumentation**

① Environment As shown in **Fig. 5**, the noise test should be carried on in a soundproof test cell. A microphone shall be set 15cm from the pump outer wall.

② Sound level meter A sound level meter depend on **JIS C 1502** or one of higher quality shall be used.

③ Background noise Shall be at least 10 dB (A) lower than the noise level of pumps. Background noise means the noise level generated by the drive system alone.

**Fig. 4 Block Diagram for Measuring Input Torque**

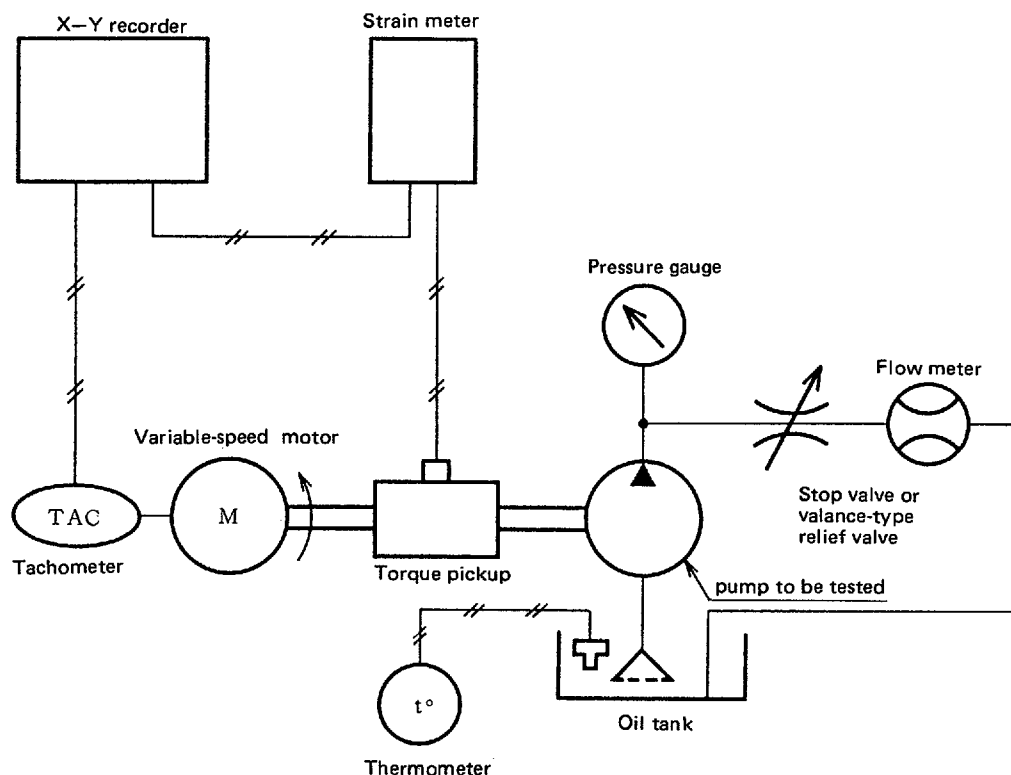
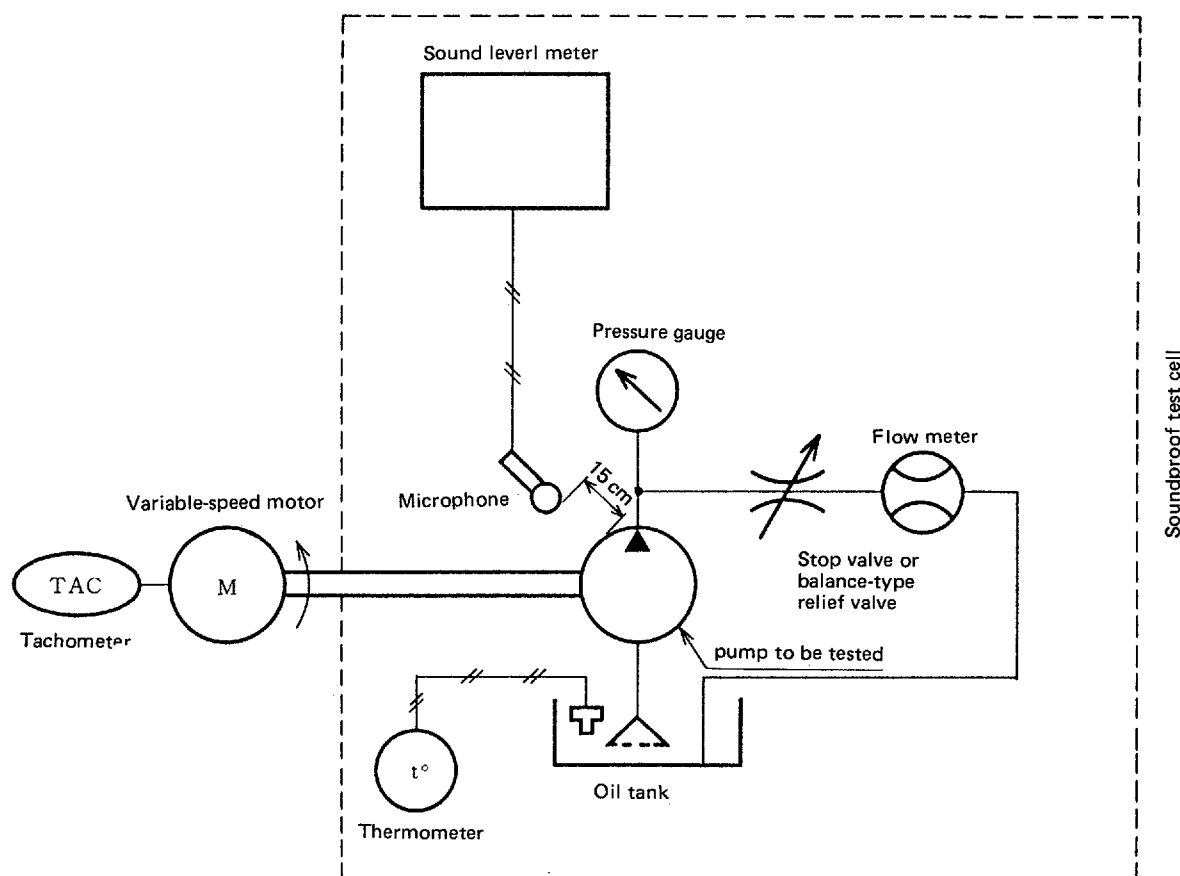


Fig. 5 Block Diagram for Measuring Noise Level

**(2) Test Conditions**

- ① Number of revolutions Shall be 600rpm, 1000rpm, 2000rpm, and values agreed upon between the parties concerned.
- ② Delivery pressure Shall be no-load pressure, 30kgf/cm<sup>2</sup> {3.0MPa}, 50kgf/cm<sup>2</sup> {5.0MPa}, and values agreed upon between the parties concerned.

**(3) Test Procedure**

The noise level should be taken in dB(A), while pump speed and delivery pressure are set constant.

**(4) Recording**

- ① Measured noise levels and pump speeds shall be plotted on a form shown in **Attached Table 5**.
- ② Results and Comments shall be filled appropriately in a form as shown in **Attached Table 1**.

**7.6 Leak Test****7.6.1 High Pressure Leak Test**

This test shall be used to check signs of leak from the high pressure part of the pump.

- (1) **Instrumentation** Same as one in 7.3(1)
- (2) **Test Conditions** Same as one in 7.3(2)
- (3) **Test Procedure**

- ① The delivery pressure shall be increased to the relief pressure and maintained constant for 3 to 5 seconds. Then, the stop valve or the balance-type relief valve shall be released to no load pressure. The above steps shall be repeated 5 times.
- ② The pump shall be checked visually for signs of leaks.

**(4) Recording**

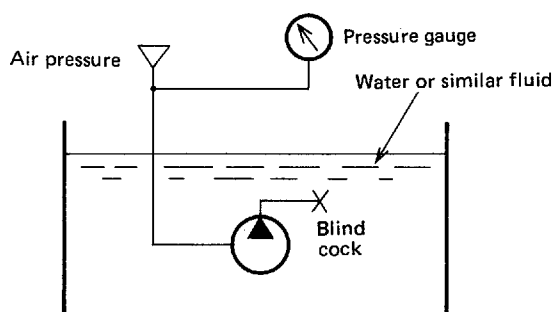
- ① Results and comments shall be filled appropriately in a form as shown in **Attached Table 1**.
- ② If no leak was observed, mark the item "no leak" on **Table 1** with the symbol ○.
- ③ If a leak was found, mark the item "leak" on **Table 1** with the symbol ○ together with a statement of the location and degree of the leak.

**7.6.2 Low Pressure Leak Test**

This test shall be used to check signs of leak from the low pressure part of the pump.

- (1) **Instrumentation** As shown in **Fig. 6**, the pump suction port shall be pressurized with air while the outlet port blocked, and the entire pump body shall be submerged in a container filled with water.

**Fig. 6 Block Diagram for Checking Leakage from the Low Pressure of the Pump**



**(2) Test Conditions**

- ① Air pressure Shall be set within the range from 0.5 to 1.0kgf/cm<sup>2</sup> {50kPa to 100kPa}
- ② Test time Shall be more than 30 seconds.

**(3) Test Procedure**

Holding the pump on test conditions in the container, for more than 30 seconds, signs of leak should be checked visually.

**(4) Recording**

- ① After the pump has been checked for any external leaks, the results shall be recorded appropriately on a form as shown in **Attached Table 1**.
- ② If no leak was observed, mark the item "no leak" on the **Table 1** with the symbol ○ on the form.
- ③ If a leak was found, mark the item "leak" on the **Table 1** with the symbol ○ together with a statement of the location and degree of the leak.

Attached Table 1 Summary for Bench Test for Performance of Power Steering Pump

|                   |                    |                      |
|-------------------|--------------------|----------------------|
| Reference No.     | Vehicle type       |                      |
| Date of test      | Name of pump maker |                      |
| Test site         | Tester             |                      |
| Purpose of test   |                    |                      |
| Pump to be tested |                    |                      |
| Model code        | Vehicle maker      | Manufacturing number |
|                   | Pump maker         |                      |

## Test conditions

|                             |  |                              |                                                  |
|-----------------------------|--|------------------------------|--------------------------------------------------|
| Ambient temperature         |  | Temperature of working fluid |                                                  |
| Brand name of working fluid |  | Loading equipment            | Balance-type relief valve, stop valve, other ( ) |

## Test results

| Testing items             |                         | Results and comments                                  |
|---------------------------|-------------------------|-------------------------------------------------------|
| (N-Q characteristic test) |                         |                                                       |
| (P-Q characteristic test) |                         |                                                       |
| Relief pressure test      |                         | ( ) kgf/cm <sup>2</sup> { MP <sub>a</sub> } at 600rpm |
| Input torque test         |                         |                                                       |
| Noise test                |                         |                                                       |
| Leak test                 | High pressure leak test | Leak, No leak<br>Leak location<br>Degree of leak      |
|                           | Low pressure leak test  | Leak, No leak<br>Leak location<br>Degree of leak      |

## Comment

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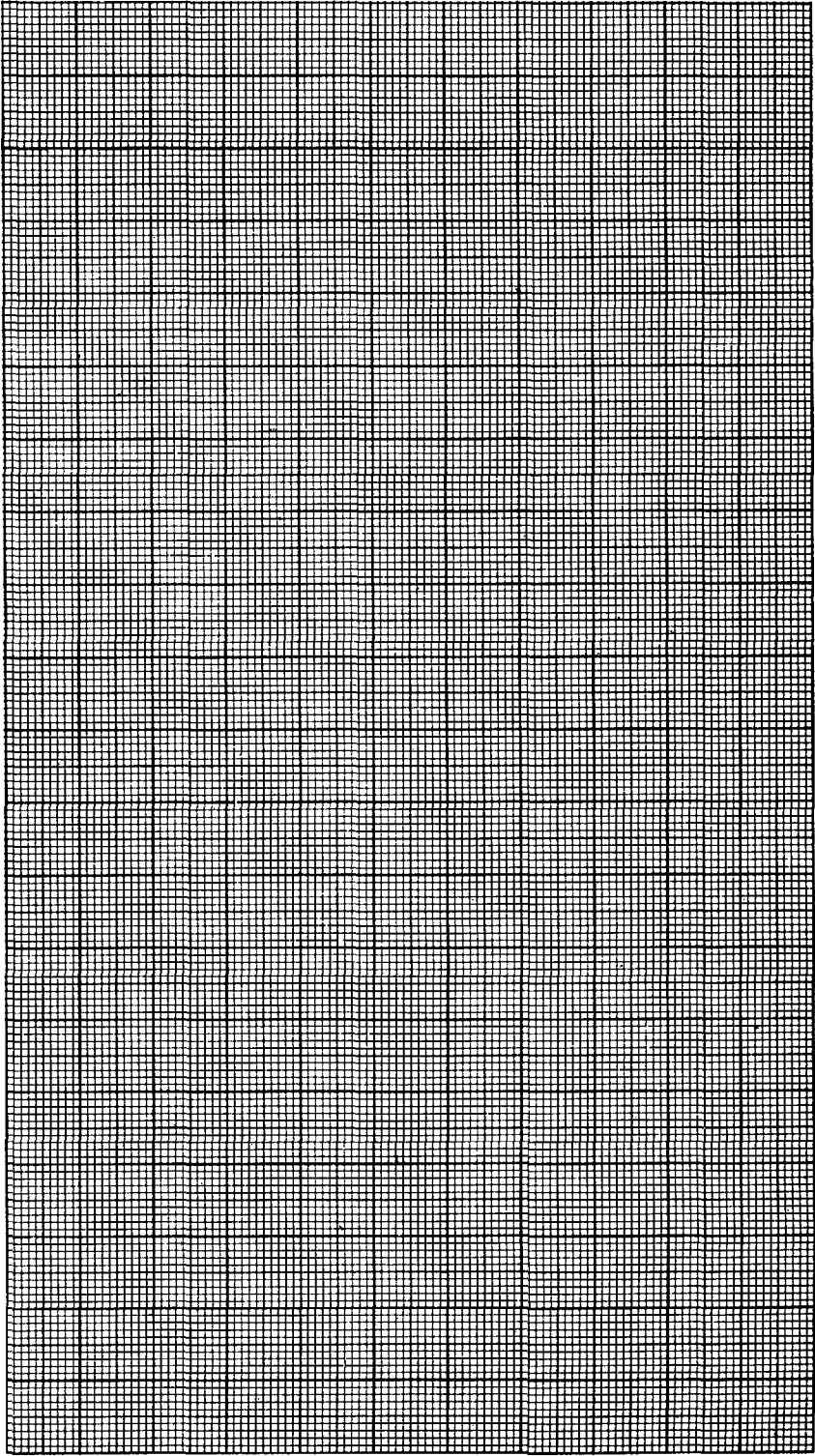
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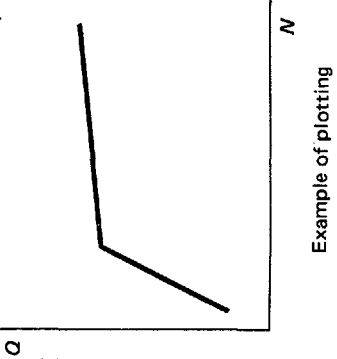
Attached Table 2 Recording Format for *N*–*Q* Characteristic

|                     |               |                              |    |               |  |                         |
|---------------------|---------------|------------------------------|----|---------------|--|-------------------------|
| Pump to be tested   |               | Test conditions              |    | Reference No. |  | Summary of test results |
| Model code          | Vehicle maker | Temperature of working fluid | °C | Date of test  |  |                         |
|                     | Pump maker    | Ambient temperature          | °C | Testing site  |  |                         |
| Manufacturing No.   |               | Brand name of working fluid  |    | Tester        |  |                         |
| Displacement volume | cc/rev        |                              |    |               |  |                         |
| Adjusted flow rate  | l/min         |                              |    |               |  |                         |



Number of revolutions *N* (rpm)

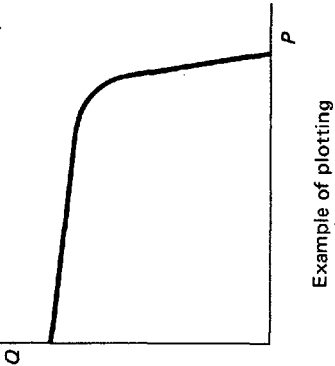
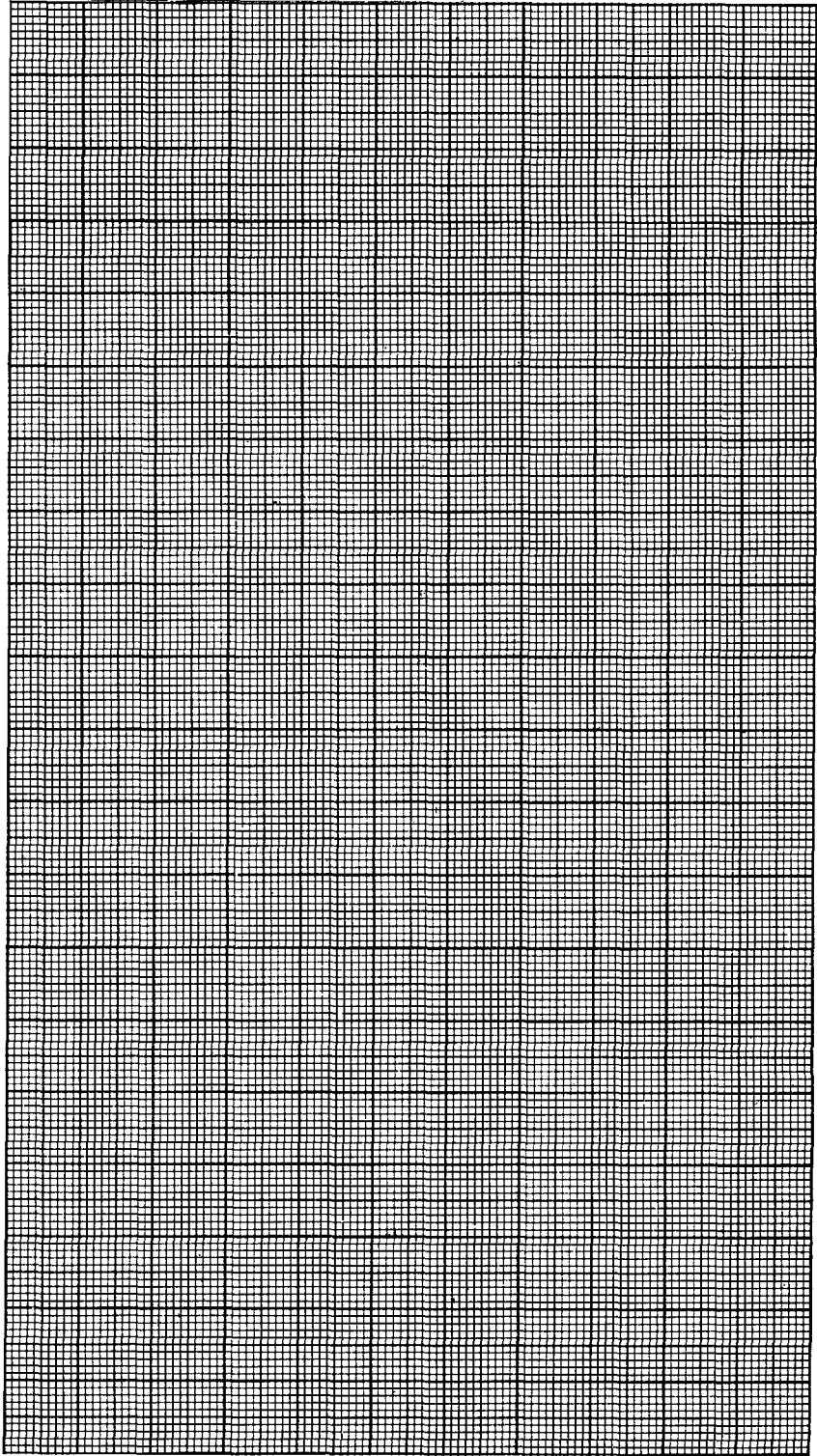
Delivery *Q* (l/min)



Example of plotting

Attached Table 3 Recording Format for P-Q Characteristic

|                                                                                                                                                                                                                                |                                                                                                                                                                      |                                                                                            |                                    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|------------------------------------|
| <div>Pump to be tested</div> <div>Model code</div> <div>Vehicle maker</div> <div>Pump maker</div> <div>Manufacturing No.</div> <div>Displacement volume</div> <div>cc/rev</div> <div>Adjusted flow rate</div> <div>l/min</div> | <div>Test conditions</div> <div>Temperature of working fluid</div> <div>°C</div> <div>Ambient temperature</div> <div>°C</div> <div>Brand name of working fluid</div> | <div>Reference No.</div> <div>Date of test</div> <div>Testing site</div> <div>Tester</div> | <div>Summary of test results</div> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|------------------------------------|

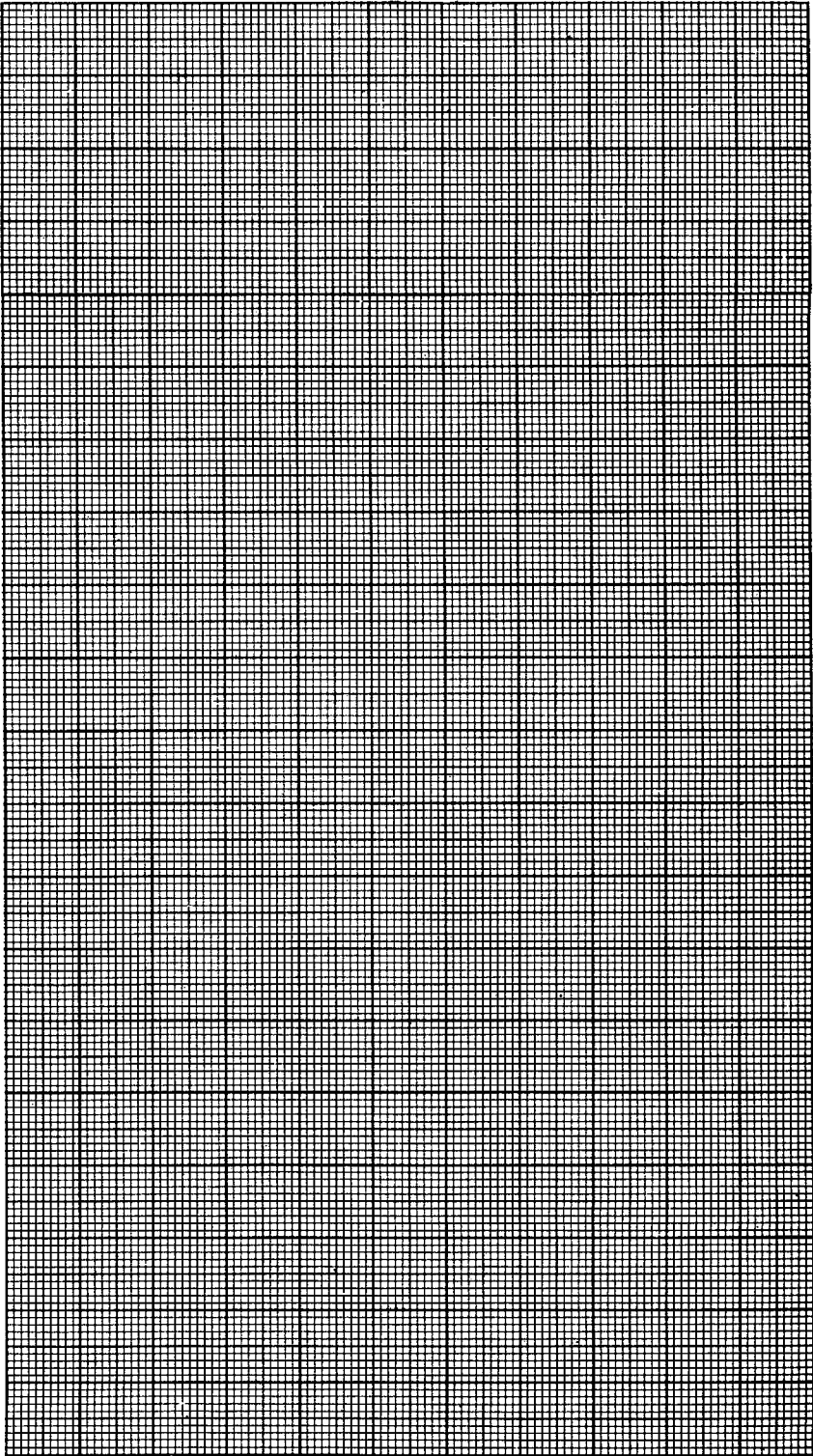


Pumping pressure  $P$  (kgf/cm<sup>2</sup>) { MPa } MPa }

Attached Table 4 Recording Format for Input Torque Test

|                     |               |                              |    |               |  |
|---------------------|---------------|------------------------------|----|---------------|--|
| Pump to be tested   |               | Test conditions              |    | Reference No. |  |
| Model code          | Vehicle maker | Temperature of working fluid | °C | Date of test  |  |
|                     | Pump maker    | Ambient temperature          | °C | Testing site  |  |
| Manufacturing No.   |               | Brand name of working fluid  |    | Tester        |  |
| Displacement volume | cc/rev        |                              |    |               |  |
| Adjusted flow rate  | l/min         |                              |    |               |  |

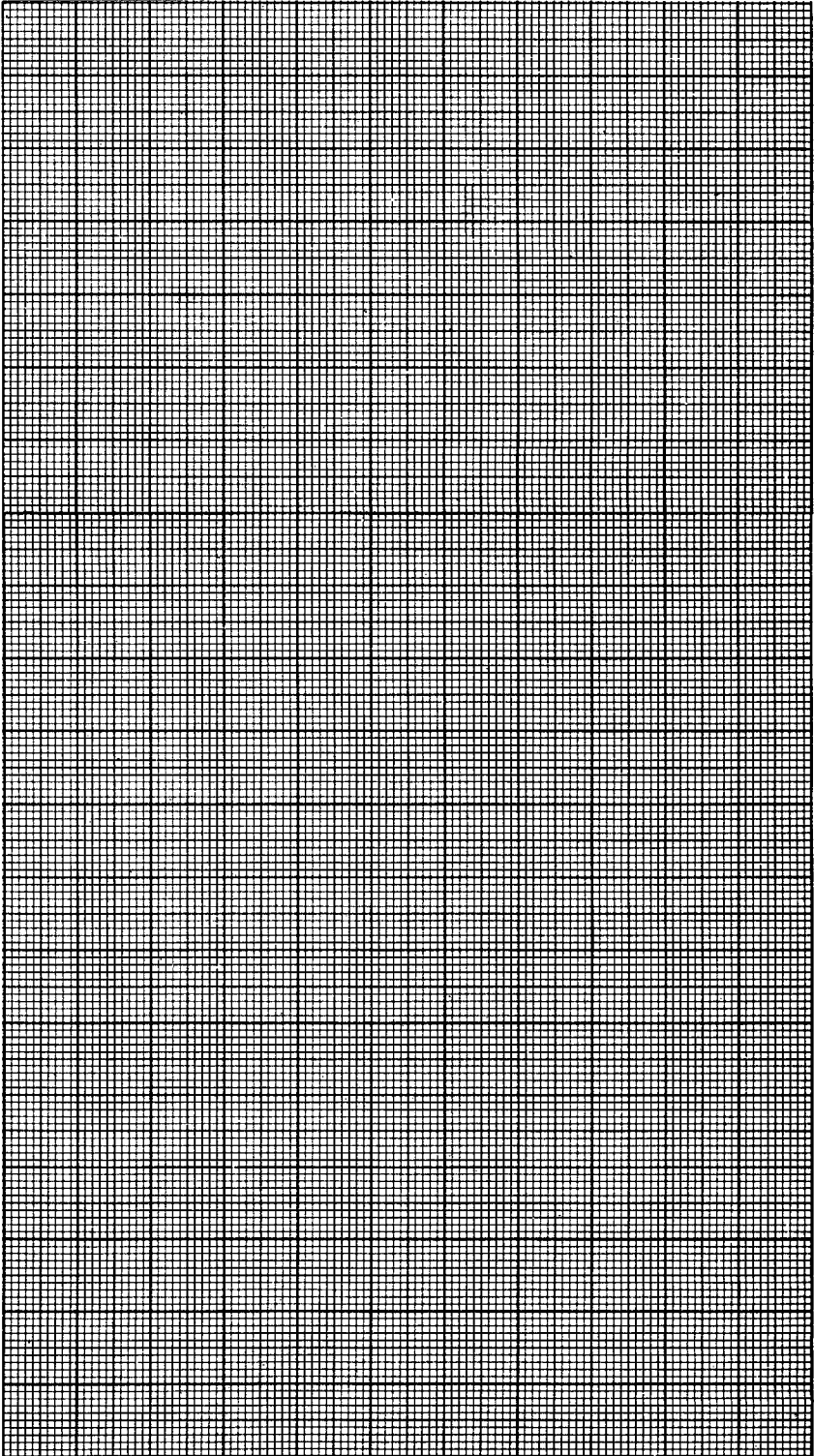
Summary of test results



Attached Table 5 Recording Format for Noise Test

|                     |               |                              |    |               |  |
|---------------------|---------------|------------------------------|----|---------------|--|
| Pump to be tested   |               | Test conditions              |    | Reference No. |  |
| Model code          | Vehicle maker | Temperature of working fluid | °C | Date of test  |  |
|                     | Pump maker    | Ambient temperature          | °C | Testing site  |  |
| Manufacturing No.   |               | Brand name of working fluid  |    | Tester        |  |
| Displacement volume | cc/rev        |                              |    |               |  |
| Adjusted flow rate  | l/min         |                              |    |               |  |

Summary of test results



Number of revolutions *N* (rpm)

**Explanatory Notes**  
**on**  
**JASO C712-82 Bench Test Procedure for the Performance of Power Steering Pump**

The following descriptions will be given for supplemental explanation. (The numbers of items are the same with those in the Text.)

**5. General Test Conditions**

The pump must be tested as it is installed in its power steering unit. However, in this standard a stop valve or a balance-type relief valve replaces the power steering unit as the loading equipment in order to ensure stability of measurement and gauge reading. For a similar reason, an electric motor is used in the drive system.

**(2) Working fluid**

A working fluid shall be as agreed upon between the parties concerned and shall be in accordance with JASO M 314 (Working Fluid for Power Steering Units).

**(3) Temperature of working fluid**

Measurement of temperature shall be taken at a point inside the oil tank. This measuring point, selected for practical reasons, does not basically change except during transient periods from the interior of the pump.

**(4) Air bleeding**

The presence of air in the working fluid can create pressure instability, an increase in noise, or any other inherent adverse effect. Therefore, the pump shall be properly bled of air before a test.

**(5) Break-in**

For a newly installed pump, break-in should be carried out at least for more than 5 minutes.

**(6) Measuring instrument**

In the case of a measuring apparatus that converts the delivery flow to an electrical signal, calibration for each measurement should be required for accuracy of measurement which may be affected by changes in the viscosity and flow rate of the working fluid.

**7. Testing Method**

Tolerance for pumping pressure and rpm for any test are desirable to be within  $\pm 3$  percent of specification.

**7.2 Test on Effect of Delivery Pressure on Delivery Flow**

The deviation from the rpm is required to be within  $\pm 10$ rpm.

**7.5 Noise Test**

The microphone shall be positioned at a distance of 15cm from the pump housing at a point from where the highest noise radiate. The tester should check for any abnormal noises with ears throughout the entire rpm range during the noise test.

**In the event of any doubt, the original  
standards in Japanese should be referred.**

**Established by the Standard Council of JSAE**

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