

JIS

JAPANESE INDUSTRIAL STANDARD

**Test Methods for
Electro-hydraulic Proportional
Pressure Relief Valves**

JIS B 8651—1989

Translated and Published

by

Japanese Standards Association

Printed in Japan

In the event of any doubt arising,
the original Standard in Japanese is to be final authority.

JAPANESE INDUSTRIAL STANDARD

J I S

Test Methods for Electro-hydraulic Proportional
Pressure Relief Valves

B 8651-1989

1 Scope

This Japanese Industrial Standard specifies the test methods to confirm the rated capacity or performance of the electro-hydraulic proportional pressure relief valves.

Remark: The units and numerical values given in { } in this Standard are in accordance with traditional system of units and are the informative reference values.

Further, the conversion factor shall be as follows:

$$1 \text{ MPa } (=10.197 \text{ kgf/cm}^2) \approx 10 \text{ kgf/cm}^2$$

2. Definitions

For the purpose of this Standard, the following definitions apply. Other terms and definitions are given in JIS B 0142.

- (1) electro-hydraulic proportional pressure relief valve The relief valve able to control the pressure proportional to electric analog input signal.
- (2) pressure adjusting range Range of adjustable pressure. This changes according to conditions such as flow rate, oil temperature, etc.
- (3) lowest adjustable pressure The lowest value of adjustable pressure. This changes according to conditions such as flow rate, oil temperature, etc.
- (4) dead zone Range in which the output does not change when the input signal increases from zero. Indicate by the value of input signal.
- (5) repeatability Dispersion of output when the same set input signal is applied repeatedly under the state in which the working conditions such as oil temperature, etc. are constant. Represent the maximum of dispersion by the measured value itself or percentage to the maximum control flow rate or highest working pressure.
- (6) minimum relief flow rate Minimum flow rate to the return port under which the relief valve is able to work stably. This changes according to the conditions such as set pressure, oil temperature, load capacity, etc.
- (7) load capacity Hydraulic oil volume of working oil including the piping connected directly with apparatus.

Applicable Standards: See page 21.

- (8) solenoid Electro-mechanical transducer generating the force proportional to input electric current.
- (9) permissible back pressure The highest pressure not to break even if it is applied continuously or repeatedly to the return side of apparatus and the back of pressure working face.
- (10) input signal Effective signal to the valve or amplifier to cause the defined output.
- (11) absolute precision Precision to the reading of measured value itself but not the precision to the measuring range.
- (12) resolution Changed portion of input signal necessary to generate the change of valve output at defined signal level. Represent by the input signal at the time of maximum control flow rate or the percentage of input signal at the time of highest working pressure. Define the resolution ordinarily as least signal necessary to increase or decrease the valve output. In the case where these signals are different, it is preferable to use the value larger of the two.
- (13) supply flow rate Quantity of fluid flowing through the supply port of device or system.
- (14) internal leakage Flow in the lumen clearance of device.
- (15) external leakage To leak from the inside of device to outer air.

3. Classification of Tests

The test shall be the type test in all.

Remark: The delivery test shall be agreed between the parties concerned with delivery basing on this Standard.

4. Test Items

4.1 Solenoid Test The solenoid test shall be on the following items:

- (1) Test of insulation resistance and withstand voltage.
- (2) Coil resistance test
- (3) Temperature rise test

4.2 Static Characteristic Test The static characteristic test shall be on the following items:

- (1) Test of characteristic for control pressure against input signal.
- (2) Resolution test
- (3) Test of characteristic for control pressure change against flow rate change
- (4) Repeatability test

- (5) Pressure drop characteristic test
- (6) Test of characteristic for control pressure change against oil temperature change
- (7) Internal leakage test
- (8) External leakage test
- (9) Minimum relief flow rate characteristic test
- (10) Guaranteed proof pressure test
- (11) Control pressure pulsation characteristic test
- (12) Test of characteristic for control pressure change against flow rate change in safety valve

4.3 Dynamic Characteristic Test The dynamic characteristic test shall be on the following items.

- (1) Step response test
- (2) Frequency response test

4.4 Environmental Test The environmental test shall be on the following items.

- (1) Vibration resistance test
- (2) Test of moisture resistance and water resistance

5. Test Conditions and Tolerances of Measurements

5.1 Test Conditions The test conditions shall be as follows:

- (1) Classification of Working Oils Class 2 of JIS K 2213 corresponding to ISO VG 46.
- (2) Oil Temperature $50 \pm 5^\circ\text{C}$
- (3) Contamination Level When the size and number of grains of pollutants in 0.1 l of working oil are divided to classify into grades as given in Table, it shall be in the range of 9 to 11 grades.

Table. Divisions of Contamination Level

Contamination level		Grade 4	Grade 5	Grade 6	Grade 7	Grade 8	Grade 9	Grade 10	Grade 11	Grade 12
Size (μm) and number of grains	5 to 15 μm	4 000	8 000	16 000	32 000	64 000	128 000	256 000	512 000	1 024 000
	15 to 25 μm	712	1 425	2 850	5 700	11 400	22 800	45 600	91 200	182 000
	25 to 50 μm	126	253	506	1 012	2 025	4 050	8 100	16 200	32 400
	50 to 100 μm	22	45	90	180	360	720	1 440	2 880	5 760
	100 μm or over	4	8	16	32	64	128	255	512	1 024

- (4) Mounting Orientation In the case specially indicated, this shall comply with the conditions defined by agreement between the parties concerned with delivery.
- (5) Input Signal The input signal (electric current, voltage, dither, etc.) shall comply with conditions defined for each specimen valve.
- (6) Test Pressure Tolerances of test flow rate and input signal.
 - (a) Test Pressure $\pm 2.5 \%$ However, the minimum value shall be 0.1 MPa {1 kgf/cm²}.
 - (b) Test Flow Rate $\pm 5 \%$
 - (c) Input Signal $\pm 1 \%$ However, the minimum value shall be 0.1 % of input signal for highest working pressure.

5.2 Tolerances of Measurements The tolerances of measurements shall be as follows:

- (1) Pressure $\pm 2.5 \%$ absolute precision. However, the minimum value shall be 0.1 MPa {1 kgf/cm²}.
- (2) Flow Rate $\pm 2.5 \%$ static absolute precision. However, the minimum value shall be 1 % of rated flow rate.
- (3) Temperature $\pm 2 \text{ }^{\circ}\text{C}$
- (4) Input Signal $\pm 2.5 \%$ absolute precision
- (5) Electric Resistance $\pm 2.5 \%$ absolute precision

6. Test Devices and Test Methods

6.1 Solenoid Test

6.1.1 Test of Insulation Resistance and Withstand Voltage The test of insulation resistance and withstand voltage does not need to apply the hydraulic oil pressure for specimen valve, but in the specimen valve structured so that the internal electric part (solenoid) contacts with working oil, it shall be conducted under the state where the specimen valve has been filled with working oil as follows:

- (1) Apply AC 1500 V (commercial frequency) between either one of electric input terminals of specimen valve and the specimen valve body by a voltage withstand tester for 60 sec and confirm that the leakage current is 1 mA or under.
- (2) Measure the insulation resistance in the connection same as in the procedure of (1) with using DC 500 V insulation resistance tester. The insulation resistance is desirable to be 100 M Ω or over.
- (3) In the two coil type solenoid, conduct this test between two coils mutually.

6.1.2 Coil Resistance Test As for the coil resistance test, measure the coil resistance between electric input terminals of specimen valve by DC resistance tester. In the measurement, measure room temperature to record in the test results and together indicate the value converted to 20°C.

6.1.3 Temperature Rise Test The temperature rise test shall be as follows:

- (1) Place the specimen valve on the heat insulated stand.
- (2) Apply the input signal corresponding to the highest working pressure of specimen valve.
- (3) After the time for that the temperature rises up to saturate has elapsed sufficiently, measure the surface temperature of solenoid by a surface thermometer and the temperature of solenoid according to the resistance method.

At the time of measurement, measure the room temperature to record in the test results.

Determine the value of temperature rise by resistance method according to the following formula.

$$\theta = \left(\frac{R_2}{R_1} - 1 \right) (234.5 + t_1) - (t_2 - t_1)$$

where θ : value of temperature rise (°C)
 R_1 : value of initial resistance (Ω)
 R_2 : value of resistance at the time of temperature saturation (Ω)
 t_1 : initial ambient temperature (°C)
 t_2 : ambient temperature at the time of saturation (°C)

6.2 Static Characteristic Test

6.2.1 Test of Characteristic for Control Pressure against Input Signal
 The test of characteristic for control pressure against input signal shall be as follows.

- (1) The test (oil hydraulic) circuit shall comply with Attached Fig. 1.
- (2) The measuring circuit shall comply with Attached Fig. 2.
- (3) The set pressure of oil hydraulic power source in the test (oil hydraulic) circuit shall be the pressure sufficiently higher than the highest working pressure of specimen valve.
- (4) In the case where the safety valve is combined with the specimen valve, the safety valve shall be fully closed.
- (5) Set the supply flow rate to the specimen valve to the rated flow rate of specimen valve by the flow rate adjusting valve ⑤ in Attached Fig. 1.

- (6) Conduct once the going and returning of input signal of specimen valve from zero up to the highest working pressure of specimen valve by the signal generator (triangular wave generator) in the speed not affecting dynamically the specimen valve and measuring device and record the input signal on X axis of X-Y recorder (or that substitutable thereto) and the control pressure of specimen valve on Y axis.
- (7) From the test results, read out the following characteristic values basing on Attached Fig. 2.

(a) Hysteresis

$$\text{However, hysteresis (\%)} = \frac{\Delta P_{\max}}{\text{highest working pressure}} \times 100$$

where, $\Delta P_{\max}$: maximum of differences of control pressure of specimen valve to the same input signal during the one going and returning of input signal of specimen valve.

- (b) Pressure adjusting range
- (c) Value of input signal at the time of highest working pressure
- (d) Lowest adjusting pressure
- (e) Dead zone

6.2.2 Resolution Test The resolution test shall be as follows.

- (1) The test (hydraulic) circuit shall comply with Attached Fig. 1.
- (2) The measuring circuit shall comply with Attached Fig. 2.
- (3) The set pressure of oil hydraulic power source in the test (oil hydraulic) circuit shall be the pressure sufficiently higher than the highest working pressure of specimen valve.
- (4) In the case where the safety valve is combined with the specimen valve, the safety valve shall be fully closed.
- (5) Set the supply flow rate to the specimen valve at the rated flow rate of specimen valve by the flow rate control valve ⑤ of Attached Fig. 1.
- (6) Stop the input signal at 15 % of highest working pressure of specimen valve in the process in which the input signal is increased from zero in the procedure of 6.2.1 (6) and record the value of input signal at this time (I_1). Hold the stopped state for 10 sec or over, increase again the input signal slowly and record the value of input signal at the time when the control pressure of specimen valve begins to increase again (I_2). It is allowed to record and read out by X-Y recorder (or that substitutable thereto).