

JIS

JAPANESE INDUSTRIAL STANDARD

**Test Code for Performance and
Accuracy of Numerically
Controlled Knee Type
Vertical Milling Machines**

JIS B 6333—1986

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Test Code for Performance and Accuracy of
Numerically Controlled Knee Type
Vertical Milling Machines

B 6333-1986

1. Scope

This Japanese Industrial Standard specifies the test code for operation performance, rigidity, mechanical precision and working precision of numerically controlled knee type vertical milling machines of not more than 1500 mm in the maximum transfer amount of the table in X-axis direction, hereinafter referred to simply as the "transfer amount".

Remark: The units, numerical values and formulae given in { } in this standard, are in accordance with the traditional units and are appended for reference.

2. Operation Test Methods2.1 Function Tests

2.1.1 Function Test According to No Numerical Control The function test according to no numerical control shall be carried out in accordance with Table 1 with manually operating each part.

Table 1

No.	Test item	Test method	Reference Corresponding No. of 3.2 in JIS B 6201 and 3.2.1 in JIS B 6330
1	Starting, stopping and operation of main spindle	Carry out starting, and stopping (including braking) continuously 10 times on positive and reverse rotations at a suitable main-spindle speed to test the smoothness of working and security of function.	1-11
2	Converting operation of main spindle speed	Convert the main spindle speed concerning the all marked speeds ⁽¹⁾ to test the smoothness of working of operating device and security of indication.	1-12
3	Converting operation of feed speed of spindle head or spindle sleeve	Convert the feed speed concerning the three feed speeds of minimum, intermediate and maximum of markings to test the smoothness of working and the security of indication.	1-22

Applicable Standards: See page 37.

Table 1 (Continued)

No.	Test item	Test method	Reference Corresponding No. of 3.2 in JIS B 6201 and 3.2.1 in JIS B 6330
4	Manual feed operation of spindle head or spindle sleeve	Travel the spindle head or spindle sleeve by means of the hand-feed handle, to test the smoothness and uniformity of working over the whole length of movement. Further, carry out the microfeed by the use of micro-hand-feed handle at an arbitrary position of the movement to test the smoothness and uniformity of working.	1-27
5	Operation of putting on and off of power feed of spindle head or spindle sleeve and of automatic stopping device	Test the smoothness of working of putting on and off of power feed of spindle head or spindle sleeve and the security of the function, and concerning the setting of command position of automatic stopping device of spindle head or spindle sleeve and the working, respectively test the smoothness and security.	1-26 1-31 1-32
6	Operation of table-travel-limit automatic stopping device	Carry out travel-limit automatic stopping with quick traverse concerning respectively in X-axis, Y-axis ⁽²⁾ and Z-axis directions of the table to test the smoothness of working and the security of function.	1-26 1-52
7	Clamping operation	Concerning each clamping mechanism of table, saddle, knee and spindle head or spindle sleeve, clamp them at an arbitrary position of respective movements to test the security.	1-33
8	Operation of attaching and detaching of tool	Test the security and smoothness of attaching and detaching of tool.	1-41
9	Electric device	Test the insulation condition respectively once before and after operation test. However, this specification does not apply to the circuit using semiconductor and the like.	1-51
10	Numerical control device	Test the smoothness of working and security of function of each type display lamp, tape leader, fan, etc.	1-57

Table 1 (Continued)

No.	Test item	Test method	Reference Corresponding No. of 3.2 in JIS B 6201 and 3.2.1 in JIS B 6330
11	Safety device	Test the safety relating to worker and the security of machine protective function ⁽³⁾ [see JIS B 6014].	1-52
12	Lubricating device	Test the security of function of oil tightness, adequate distribution of oil amount, etc.	1-53
13	Oil hydraulic and pneumatic devices	Test the security of functions of oil hydraulic tightness pneumatic tightness, pressure regulating, etc.	1-54
14	Accessory devices	Test the security of functions.	1-55

Notes (1) In the case of infinite variable speed, carry out on three speeds of the minimum, medium, and maximum.

(2) Concerning a ram type, it includes the movement in Y-axis direction of main spindle.

(3) For example, it means the travel-limit automatic stopping function of each motion axis, emergency stopping function in case where the synchronization of control system is lost or overheating, and overloading of electrical motor for main spindle are generated, etc.

2.1.2 Function Test by Numerical Control The function test by numerical control shall be carried out with each part working by numerical control tape for test and other numerical control command and in accordance with Table 2.

Table 2

No.	Test item	Test method	Reference Corresponding No. of 3.2 in JIS B 6201 and 3.2.2 in JIS B 6330
1	Starting, stopping and reversing rotation of main spindle and converting of spindle speed	Rotate the main spindle, start, stop, reverse the rotation and convert the spindle speed on all marked speeds ⁽¹⁾ to test the security of function and smoothness of working.	1-13 1-14
2	Starting, stopping of feed and conversion of speeds	Convert to three feed speeds of the marked minimum, medium, and maximum, and to quick traverse, carry out starting and stopping concerning the positive and negative of each feed to test the security of function and the smoothness of working. Carry out this test on each control spindle.	1-28
3	Inching	Carry out inching operation on each control spindle to test the security of function and the smoothness of working.	1-21
4	Returning to original point	Carry out returning to original point ⁽⁵⁾ from an arbitrary position capable of returning on each control spindle to test the security of function and the smoothness of working.	1-35
5	Other functions	Test the security of function and the smoothness of working concerning respective functions to be equipped.	1-61

Notes ⁽⁴⁾ Other numerical control commands include the numerical control commands by card, on-line, input by manual data input device and the manual input by push button on operator pannel, etc.

⁽⁵⁾ The travel shall, as a rule, be quick traverse and shall be not less than the distance including the automatic acceleration and deceleration.

Remark: It may be carried out at the same time as the continuous no-load operation test.

2.2 No-Load Operation Test

out according to the following:

The no-load operation test shall be carried

- (1) **Main Spindle Relation** Starting from the minimum speed of main spindle, operate on each stage, successively continue the operation at the maximum speed, as a rule, for 30 to 60 min to measure each item specified in Table 3 Recording Form 1-1 [see 3.3 of JIS B 6330]. Furthermore, observe the vibration and noise. In the case where the vibration and noise are made specially the problem, the test shall be in accordance with JIS B 6003 and JIS B 6004.

Table 3. Recording Form 1-1

No.	Measuring time	Spindle speed min ⁻¹ {rpm}		Temperature °C			Required electric power (power source frequency Hz)			Description
		Marking	Actual measurement	Main bearing		Room temperature	Voltage V	Current A	Input kW	
	Upper			Lower						
	h/min									

- (2) **Feed Relation** Concerning three feed speeds of the minimum, medium and maximum, and quick traverse, measure each item specified in Table 4 Recording Form 1-2 (see 3.3 of JIS B 6330).

Further, at the medium feed speed, with actuating the feed speed override function, carry out the similar measurement. Furthermore, observe the vibration and noise. In the case where the vibration and noise are made specially the problem, the test shall be in accordance with JIS B 6003 and JIS B 6004.

Table 4. Recording Form 1-2

Measuring item		Feed speed in X-axis direction of table mm/min		Feed speed in Y-axis direction ⁽²⁾ of table mm/min		Feed speed in Z-axis direction of table mm/min		Feed speed in W-axis direction of main spindle mm/min		Description
		Command	Actual measurement	Command	Actual measurement	Command	Actual measurement ⁽⁶⁾	Command	Actual measurement ⁽⁶⁾	
Minimum										
Medium	Without override									
	With override ⁽⁷⁾									
Maximum										
Quick traverse										

Notes ⁽⁶⁾ Record the speed and its direction (±).

⁽⁷⁾ In the case when the function of feed speed override is actuated, record the override rate (%) in the command column.

2.3 Continuous No-Load Operation Test As for the continuous no-load operation test, carry out continuous operation of about 2 h⁽⁸⁾ by the test tape containing each kind function or other numerical control command⁽⁴⁾ to test the existence of abnormalities (see 3.4 of JIS B 6330).

In this case, the test tape or the other numerical control command shall include, at least, the following contents:

- (1) Concerning the marked medium spindle speed⁽⁹⁾, the positive rotation, reverse rotation starting and stopping.
- (2) The feed speed of each spindle shall be of the marked minimum, medium, maximum and the quick traverse. The travel distance shall be approximately the whole marked range and that of each spindle shall include quick traverse of not less than 1/2 of the travel distance.
- (3) For each spindle, positioning⁽¹⁰⁾ at an adequate position over the approximately whole range of travel distance.

Notes ⁽⁸⁾ It shall be continuous operation of not less than two cycles.

⁽⁹⁾ For the machine having automatic conversion function of spindle speed, the speeds of not less than 5 kinds including the minimum, medium and maximum shall be included.

⁽¹⁰⁾ The machine provided with the control function for not less than two spindles at the same time shall include this.

Remark: On the table, there shall be no load.

2.4 Load Operation Test For the load operation test, carry out the cutting power test and chatter test to measure the required electric power. Further, observe the vibration, noise and the condition of finished surface (see 3.5 of JIS B 6330).

In case where the vibration and noise are made particularly the problem, it shall be in accordance with JIS B 6003 and JIS B 6004.

Furthermore, the cutting shall be dry type cutting. In cutting power test, the fact that it is able to withstand the definite electric power at the high speed cutting shall be tested and in chatter test, the stability of cutting shall be tested, and the surface cutting shall be carried out according to the following conditions to measure the required electric power to observe the condition of chatter (see Table 5 Recording Form 2) (see No. 3-11 and 3-14 of 3.4 in JIS B 6201).

Table 5. Recording Form 2

Material of work						Diameter of tool					Number of blade				
No.	Cutting conditions							Electric power for main spindle (power source frequency Hz)					Cutting amount per 1 kW ^(1,2) cm ³ /min	Chatter condition	Description
	Spindle speed (<i>n</i>) min ⁻¹ {rpm}	Cutting speed (<i>V_c</i>) m/min	Cutting depth (<i>a</i>) mm	Cutting width (<i>b</i>) mm	Feed speed (<i>V_f</i>) mm/min	Feed per one blade (<i>S_z</i>) mm	Cutting amount cm ³ /min	Voltage V	Current A	Loading input kW	No-load input kW	Cutting power ^(1,1) kW			

Notes (1¹) It means the difference between the loading input and the no-load input.

(1²) The required electric power in the case of obtaining cutting amount per 1 kW shall be the loading input for main spindle.

- (1) Tool The tool shall, as a rule, be cemented carbide tip face milling cutter and the diameter shall be in accordance with Table 6 and the required items shall be recorded according to Table 7 Recording Form 3.

Table 6

Unit: mm

Travel amount in X-axis direction of table	Diameter (approx.)
500 max.	Not specified specially
Exceeding 500 up to and including 1000	75 to 150
Exceeding 1000 up to and including 1500	150 to 200

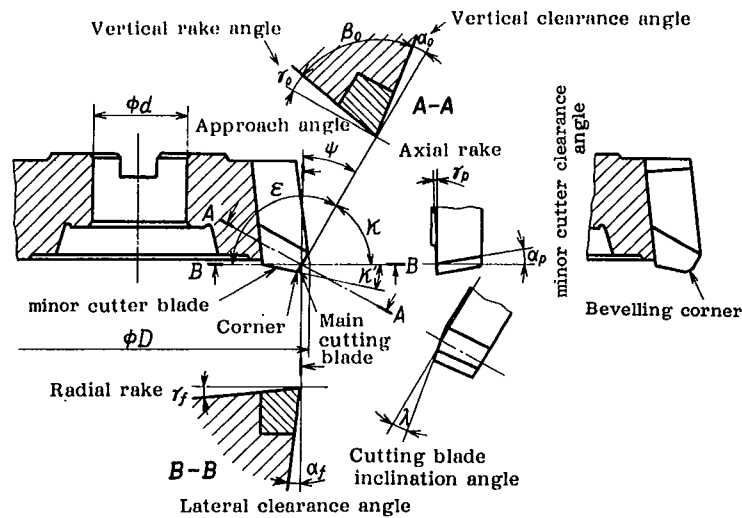
Table 7. Recording Form 3

Cemented carbide tip face milling cutter (1 ³)								Description
Diameter mm	Number of blades	Radial rake degree	Axial rake degree	Lateral clear- ance angle degree	Width cutter clearance angle degree	Approach angle degree	Beveling corner width mm	

Note (1³) Number of blades, blade tip angle and the length of cutting blade shall be suitable, but be recorded in accordance with this form, as appropriate.

Remark: Names of tool blade shall be in accordance with Fig. 1.

Fig. 1

(2) Works

Material: The material shall, as a rule, be S 45 C specified in JIS G 4051.

Shape: The dimensions of cutting part shall be in accordance with Table 8. However, the height of the work may be determined suitably.

Table 8

Unit: mm

Travel amount in X-axis direction of table	Length	Width
500 max.	To be about 1/2 of travel amount in X-axis direction of table	Not specified particularly
Exceeding 500 up to and including 1000	200 to 300	50 to 90
Exceeding 1000 up to and including 1500	300 to 400	90 to 120

(3) Cutting Conditions

Cutting speed: $V_c \approx 100$ (m/min)

Cutting depth: It shall, as a rule, be the numerical value of Table 9.

Cutting width: $b \approx \text{milling cutter diameter} \times \frac{2}{3}$ (mm)

Feed per one blade: $S_z \approx 0.05, 0.1, 0.2, 0.3, 0.4, 0.5$ (mm)

However, when the electric motor for main spindle has reached the specified electric power (see 3.4 of JIS B 6201), stop at that feed, and when it does not reach the specified electric power, increase the cutting depth by each 1 mm.

Furthermore, before reaching the specified electric power, when the cutting has become remarkably difficult due to chatter, stop at that cutting conditions.

Table 9

Unit: mm

Travel amount in X-axis direction of table	Cutting depth (<i>a</i>)
500 max.	1
Exceeding 500 up to and including 1000	2
Exceeding 1000 up to and including 1500	3

Remark: The herein specified cutting power test does not apply to the milling machine for high-speed slight cutting.

Reference

The cutting torque test shown in the following is given for reference and not a part of this standard.

Cutting Torque Test The cutting torque test is to test the fact that the machine endures the specified torque in strong cutting and the strong surface cutting shall be carried out under the following conditions (see Reference Table 1 Reference Recording Form) (see No. 3-12 of 3.4 in JIS B 6201).

Reference Table 1. Reference Recording Form

Material of works		Cutting conditions						Electric power for main spindle (power source frequency Hz)						Description
No.	Spindle speed (n) min^{-1} {rpm}	Cutting speed (V_c) m/min	Cutting depth (a) mm	Cutting width (b) mm	Feed speed (V_f) mm/min	Feed per one blade (S_z) mm	Cutting amount cm^3/min	Voltage V	Current A	Loading input (W) kW	No- load input (W_o) kW	Cutting power ⁽¹⁾ ($W - W_o$) kW	Torque ⁽²⁾ (T) N·m {kgf·m}	

Notes ⁽¹⁾ It means the difference between the loading input and the no-load input.

⁽²⁾ The torque (T) shall be obtained according to the following formula:

When measured by using wattmeter

$$T = \frac{9550 (W - W_o)}{n} (\text{N} \cdot \text{m}) \quad \left\{ T = \frac{974 (W - W_o)}{n} (\text{kgf} \cdot \text{m}) \right\}$$

where W : loading input (kW)

W_o : no load input (kW)

n : spindle speed min^{-1} {rpm}

- (1) **Tools** Tools shall, as a rule, be cemented carbide face milling cutter, their diameter shall be in accordance with Reference Table 2 and the required items be recorded in accordance with Table 7 Recording Form 3.