

2. Measurements shall be made in an incremental manner from one limit of the axis travel to the other without returning to the starting position for each move to the target position;
3. Axes not being measured shall be retained at mid travel during test of an axis.

c. Presentation of test results (paragraph 2): The results of the measurements must include:

1. positioning accuracy (A); and
2. The mean reversal error (B).

1022. 1. c. 1. b. 6. a. A positioning accuracy less (better) than 0.007 mm; *and*
- b. A slide motion from rest for all slides within 20% of a motion command input for inputs of less than 0.5 micrometre;

Technical Note:

Minimum increment of motion test (slide motion from rest):

The test is conducted only if the machine tool is equipped with a control unit the minimum increment of which is less (better) than 0.5 micrometre.

Prepare the machine for testing in accordance with ISO 230/2 paragraphs 3.1, 3.2, 3.3.

Conduct the test on each axis (slide) of the machine tool as follows:

- a. Move the axis over at least 50% of the maximum travel in plus and minus directions twice at maximum feed rate, rapid traverse rate or jog control;
- b. Wait at least 10 seconds;
- c. With manual data input, input the minimum programmable increment of the control unit;
- d. Measure the axis movement;
- e. Clear the control unit with the servo null, reset or whatever clears any signal (voltage) in the servo loop;
- f. Repeat steps 2 to 5 five times, twice in the same direction of the axis travel and three times in the opposite direction of travel for a total of six test points;
- g. If the axis movement is between 80% and 120% of the minimum programmable input for four of the six test points, the machine is embargoed.

For rotary axes, the measurement is taken 200 mm from the centre of rotation.

NOTES:

1. 1022.1.c.1. does not embargo cylindrical external, internal, and external-internal grinding machines having all of the following characteristics:
 - a. Not centreless (shoe-type) grinding machines;
 - b. Limited to cylindrical grinding;
 - c. A maximum workpiece outside diameter or length of 150 mm;
 - d. Only two axes which can be coordinated simultaneously for "contouring control"; *and*
 - e. No contouring c axis.
2. 1022.1.c.1. does not embargo machines designed specifically as jig grinders having both of the following characteristics:
 - a. Axes limited to x, y, c and a, where the c axis is used to maintain the grinding wheel normal to the work surface and the a axis is configured to grind barrel cams; *and*
 - b. A spindle "run out" not less (not better) than 0.0006 mm.
3. 1022.1.c.1. does not embargo tool or cutter grinding machines having all of the following characteristics:
 - a. Shipped as a complete system with "software" specially designed for the production of tools or cutters;
 - b. No more than two rotary axes which can be coordinated simultaneously for "contouring control";
 - c. "Run out" (out-of-true running) in one revolution of the spindle not less (not better) than 0.0006 mm TIR; *and*
 - d. The positioning accuracies, with all compensations available, are not less (not better) than:

1. 0.004 mm along any linear axis for overall positioning; *or*

2. 0.001° on any rotary axis.

4. The Committee will favourably consider the export of turning machines embargoed by 1022.1.c.1. provided:

a. They are not intended for use in nuclear related activities; *and*

b. They have all of the following characteristics:

1. Only two axes which can be coordinated simultaneously for "contouring control";
2. The positioning accuracy, with all compensations available, is not less (not better) than 0.002 mm per 300 mm of travel;
3. Geometric alignment of the axes, parallel or perpendicular to each other, is not less (not better) than 0.001 mm per 300 mm of travel;
4. Slide travel in both axes is not longer than 400 mm;
5. "Run out" (out-of-true running) in one revolution of the spindle is more (worse) than 0.0004 mm TIR; *and*
6. "Camm" (axial displacement) in one revolution of the spindle is more (worse) than 0.0004 mm TIR.

The Committee will approve the export of equipment described in this Note if no member country has filed an objection within four weeks of the receipt of complete information on the case.

5. Governments may permit, as administrative exceptions, the shipment to the People's Republic of China of machine tools for milling embargoed by 1022.1.c.1. to civil end-users other than nuclear and aerospace, provided they are not embargoed by 1022.1.c.1.b.1, b.4., b.5. or b.6.

1022. 1. c. 2. Electrical discharge machines (EDM) of the wire feed type which have five or more axes which can be coordinated simultaneously for "contouring control";

1022. 1. c. 3. Electrical discharge machines (EDM) of the non-wire type which have two or more rotary axes which can be coordinated simultaneously for "contouring control";

1022. 1. c. 4. Machine tools for removing metals, ceramics or composites:

a. By means of:

1. Water or other liquid jets, including those employing abrasive additives;
2. Electron beam; *or*
3. "Laser" beam; *and*

b. Having two or more rotary axes which:

1. Can be coordinated simultaneously for "contouring control"; *and*
2. Have a positioning accuracy of less (better) than 0.003°;

1022. 2. Non-"numerically controlled" machine tools for generating optical quality surfaces, as follows:

a. Turning machines using a single point cutting tool and having all of the following characteristics:

1. Slide positioning accuracy less (better) than 0.0005 mm per 300 mm of travel;
2. Bidirectional slide positioning repeatability less (better) than 0.00025 mm per 300 mm of travel;
3. Spindle "run out" and "camm" less (better) than 0.0004 mm TIR;
4. Angular deviation of the slide movement (yaw, pitch and roll) less (better) than 2 seconds of arc, TIR, over full travel; *and*
5. Slide perpendicularity less (better) than 0.001 mm per 300 mm of travel;

Technical Note:

The bidirectional slide positioning repeatability (R) of an axis is the maximum value of the repeatability of positioning at any position along or around the axis determined using the procedure and under the conditions specified in part 2.11 of ISO 230/2: 1988.

1022. 2. b. Fly cutting machines having both of the following characteristics:

1. Spindle "run out" and "camm" less (better) than 0.0004 mm TIR; *and*
2. Angular deviation of slide movement (yaw, pitch and roll) less (better) than 2 seconds of arc, TIR, over full travel;

1022. 3. "Numerically controlled" or manual machine tools specially designed for cutting, finishing, grinding or honing either of the following classes of bevel or parallel axis hardened (R_c