

2. Operating temperatures include those temperatures obtained when a gas turbine engine has stopped after operation.
(For quiet running bearings, see Item 2009 on the Munitions List.)

1022. Test, Inspection and Production Equipment

Note

1022. does not embargo measuring interferometer systems, without closed or open loop feedback, containing a "laser" to measure slide movement errors of machine-tools, dimensional inspection machines or similar equipment.

1. "Numerical control" units, "motion control boards" specially designed for "numerical control" applications on machine tools, machine tools, and specially designed components therefor, as follows:

Technical Notes

1. Secondary parallel contouring axes, e.g. the w-axis on horizontal boring mills or a secondary rotary axis the centre line of which is parallel to the primary rotary axis, are not counted in the total number of contouring axes.

N.B.:

Rotary axes need not rotate over 360°. A rotary axis can be driven by a linear device, e.g. a screw or a rack-and-pinion.

2. Axis nomenclature shall be in accordance with International Standard ISO 841, 'Numerical Control Machines - Axis and Motion Nomenclature'.

1. a. "Numerical control" units for machine tools, as follows, and specially designed components therefor:

Note:

1022.1.a. does not embargo "numerical control" units:

1. Modified for and incorporated in unembargoed machines; **or**
2. Specially designed for unembargoed machines.

1. a. 1. Having more than four interpolating axes which can be coordinated simultaneously for "contouring control";
2. Having two, three or four interpolating axes which can be coordinated simultaneously for "contouring control" and:
a. Capable of "real time processing" of data to modify, during the machining operation, tool path, feed rate and spindle data by either:
1. Automatic calculation and modification of part programme data for machining in two or more axes by means of measuring cycles and access to source data; **or**
2. "Adaptive control" with more than one physical variable measured and processing by means of a computing model (strategy) to change one or more machining instructions to optimize the process;
b. Capable of receiving directly (on-line) and processing computer aided design (CAD) data for internal preparation of machine instructions; **or**
c. Capable, without modification, according to the manufacturer's technical specifications, of accepting additional boards which would permit an increase above the embargo levels specified in 1022.1., in the number of interpolating axes which can be coordinated simultaneously for "contouring control", even if they do not contain these additional boards;
1. b. "Motion control boards" specially designed for machine tools and having any of the following characteristics:
1. Interpolation in more than four axes;
2. Capable of "real time processing" as described in 1022.1.a.2.a.; **or**
3. Capable of receiving and processing CAD data as described in 1022.1.a.2.b.;
1. c. Machine tools, as follows, for removing or cutting metals, ceramics or composites, which, according to the manufacturer's technical specifications, can be equipped with electronic devices for simultaneous "contouring control" in two or more axes:
1. Machine tools for turning, grinding, milling or any combination thereof which:
a. Have two or more axes which can be coordinated simultaneously for "contouring control"; **and**
b. Have any of the following characteristics:
1. Two or more contouring rotary axes;

Technical Note

The c axis on jig grinders used to maintain grinding wheels normal to the work surface is not considered a contouring rotary axis.

2. One or more contouring "tilting spindles";

Note:

1022.1.c.1.b.2. applies to machine tools for grinding or milling only.

3. "Camming" (axial displacement) in one revolution of the spindle less (better) than 0.0006 mm total indicator reading (TIR);

Note:

1022.1.c.1.b.3. applies to machine tools for turning only.

4. "Run out" (out-of-true running) in one revolution of the spindle less (better) than 0.0006 mm TIR;
5. The positioning accuracies, with all compensations available, are less (better) than:
a. 0.001" on any rotary axis; **or**
b. 1. 0.004 mm along any linear axis (overall positioning) for grinding machines;
2. 0.006 mm along any linear axis (overall positioning) for turning or milling machines; **or**

Note:

1022.1.c.1.b.5. does not embargo milling or turning machine tools with a positioning accuracy along one axis, with all compensations available, equal to or more (worse) than 0.005 mm.

Technical Note

The positioning accuracy of "numerically controlled" machine tools is to be determined and presented in accordance with ISO/DIS 230/2, paragraph 2.13, in conjunction with the requirements below:

- a. Test conditions (paragraph 3):
1. For 12 hours before and during measurements, the machine tool and accuracy measuring equipment will be kept at the same ambient temperature. During the premeasurement time the slides of the machine will be continuously cycled in the same manner that the accuracy measurements will be taken;
2. The machine shall be equipped with any mechanical, electronic, or software compensation to be exported with the machine;
3. Accuracy of measuring equipment for the measurements shall be at least four times more accurate than the expected machine tool accuracy;
4. Power supply for slide drives shall be as follows:
a. Line voltage variation shall not exceed $\pm 10\%$ of nominal rated voltage;
b. Frequency variation shall not exceed ± 2 Hz of normal frequency;
c. Lineouts or interrupted service are not permitted;
- b. Test programme (paragraph 4):
1. Feed rate (velocity of slides) during measurement shall be the rapid traverse rate;
N.B.:
In the case of machines tools which generate optical quality surfaces, the feed rate shall be equal to or less than 50 mm per minute.
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: