Category 4 Nuclear-related other equipment, assemblies and components; test and production equipment; and related technology not controlled under Category 0

4A Equipment, assemblies, components including test and production equipment

4A001 Flow-forming machines, spin-forming machines capable of flow-forming functions, and mandrels, as follows:

a. For flow forming machines refer to 5A205

b. Spin forming machines having both of the following characteristics:

1. Three or more rollers (active or guiding); and
2. Which, according to the manufacturer's technical specification, can be equipped with 'numerical control' units or a computer control.

c. Rotor-forming mandrels designed to form cylindrical rotors of inside diameter between 75 and 400 mm.

Note: Item 4A001a and 4A001b include machines which have only a single roller designed to deform metal plus two auxiliary rollers which support the mandrel, but do not participate directly in the deformation process.

4A002 Machine tools, as follows, and any combination thereof, 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;

N.B.: For "numerical control" units controlled by their associated "software", see Item 4C

a. Machine tools for turning, that have "positioning accuracies" with all compensations available better (less) than 6 µm according to ISO 230/2 (1988) along any linear axis (overall positioning) for machines capable of machining diameters greater than 35 mm;

Note: Item 4A002.a. does not control bar machines (Swissturn), limited to machining only bar feed thru, if maximum bar diameter is equal to or less than 42 mm and there is no capability of mounting chucks. Machines may have drilling and/or milling capabilities for machining parts with diameters less than 42 mm.

b. Machine tools for milling, having any of the following characteristics:

1. "Positioning accuracies" with all compensations available better (less) than 6 µm according to ISO 230/2 (1988) along any linear axis (overall positioning);
2. Two or more contouring rotary axes; or
3. Five or more axes which can be coordinated simultaneously for "contouring control".

Note: Item 4A002.b. does not control milling machines having both of the following characteristics:

1. X-axis travel greater than 2 m; and
2. Overall "positioning accuracy" on the x-axis worse (more) than 30 µm according to ISO 230/2 (1988).

c. Machine tools for grinding, having any of the following characteristics:

1. "Positioning accuracies" with all compensations available better (less) than 4 µm according to ISO 230/2 (1988) along any linear axis (overall positioning);
2. Two or more contouring rotary axes; or
3 Five or more axes which can be coordinated simultaneously for "contouring control".

Note: Item 4A002.c. does not control grinding machines as follows:

1. Cylindrical external, internal, and external-internal grinding machines having all the following characteristics:

a. Limited to a maximum workpiece capacity of 150 mm outside diameter or length; and
b. Axes limited to x, z and c.

2. Jig grinders that do not have a z-axis or a w-axis with an overall positioning accuracy less (better) than 4 microns. Positioning accuracy is according to ISO 230/2 (1988).

d. Non-wire type Electrical Discharge Machines (EDM) that have two or more contouring rotary axes and that can be coordinated simultaneously for "contouring control".

Notes: 1. Stated "positioning accuracy" levels derived under the following procedures from measurements made according to ISO 230/2 (1988) or national equivalents may be used for each machine tool model if provided to, and accepted by, national authorities instead of individual machine tests.

Stated "positioning accuracy" are to be derived as follows:

a. Select five machines of a model to be evaluated;
b. Measure the linear axis accuracies according to ISO 230/2 (1988)
c. Determine the accuracy values (A) for each axis of each machine. The method of calculating the accuracy value is described in the ISO 230/2 (1988) standard;
d. Determine the average accuracy value of each axis. This average value becomes the stated "positioning accuracy" of each axis for the model ($\hat{A}_x$, $\hat{A}_y$...);
e. Since Item 4A002 refers to each linear axis, there will be as many stated "positioning accuracy" values as there are linear axes;
f. If any axis of a machine tool not controlled by Items 4A002.a., 4A002.b., or 4A002.c. has a stated "positioning accuracy" of 6 µm or better (less) for grinding machines, and 8 µm or better (less) for milling and turning machines, both according to ISO 230/2 (1988), then the builder should be required to reaffirm the accuracy level once every eighteen months.

2. Item 4A002. does not control special purpose machine tools limited to the manufacture of any of the following parts:

a. Gears
b. Crankshafts or cam shafts
c. Tools or cutters

d. Extruder worms

Technical Notes:
1. Axis nomenclature shall be in accordance with International Standard ISO 841, "Numerical Control Machines - Axis and Motion Nomenclature".

2. Not counted in the total number of contouring axes are secondary parallel contouring axes (e.g., the w-axis on horizontal boring mills or a secondary rotary axis the centerline of which is parallel to the primary rotary axis).

3. Rotary axes do not necessarily have to rotate over 360 degrees. A rotary axis can be driven by a linear device, e.g., a screw or a rack-and-pinion.

4. For the purposes of 4A002. the number of axes which can be coordinated simultaneously for "contouring control" is the number of axes along or around which, during processing of the workpiece, simultaneous and interrelated motions are performed between the workpiece and a tool. This does not include any additional axes along or around which other relative motions within the machine are performed, such as:

a. *Wheel-dressing systems in grinding machines;*

b. *Parallel rotary axes designed for mounting of separate workpieces;*

c. *Co-linear rotary axes designed for manipulating the same workpiece by holding it in a chuck from different ends.*

5. A machine tool having at least 2 of the 3 turning, milling or grinding capabilities (e.g., a turning machine with milling capability) must be evaluated against each applicable entry, 4A002.a., 4A002.b.

and 4A002.c.

6. Items 4A002.b.3 and 4A002.c.3 include machines based on a parallel linear kinematic design (e.g., hexapods) that have 5 or more axes none of which are rotary axes.

4A003 Dimensional inspection machines, instruments, or systems, as follows:

a. Computer controlled or numerically controlled coordinate measuring machines (CMM) having either of the following characteristics:

1. Having only two axes and having a maximum permissible error of length measurement along any axis (one dimensional), identified as any combination of E0x MPE, E0y MPE or E0z MPE, equal to or less(better) than (1.25 + L/1000) µm (where L is the measured length in mm) at any point within the operating range of the machine (i.e., within the length of the axis), according to ISO 10360-2(2009); or
2. Three or more axes and having a three dimensional (volumetric) maximum permissible error of length measurement (E0, MPE equal to or less (better) than (1.7 + L/800) µm (where L is the measured length in mm) at any point within the operating range of the machine (i.e., within the length of the axis), according to ISO 10360-2(2009).

Technical Note: The E0, MPE of the most accurate configuration of the CMM specified according to ISO 10360-2(2009) by the manufacturer (e.g., best of the following: probe stylus length, motion parameters, environment) and with all compensations available shall be compared to the 1.7 + L/ 800 µm threshold.

b. Linear displacement measuring instruments, as follows:

1. Non-contact type measuring systems with a "resolution" equal to or better (less) than 0.2 µm within a measuring range up to 0.2 mm;

2. Linear variable differential transformer (LVDT) systems having both of the following characteristics:

a. 1. "Linearity" equal to or less (better) than 0.1% measured from 0 to the full operating range, for LVDTs with an operating range up to 5 mm; or

2. "Linearity" equal to or less (better) than 0.1% measured from 0 to 5 mm for LVDTs with an operating range greater than 5 mm; and

b. Drift equal to or better (less) than 0.1% per day at a standard ambient test room temperature ± 1 K;

3. Measuring systems having both of the following characteristics:

a. Contain a laser; and

b. Maintain for at least 12 hours, over a temperature range of ± 1 K around a standard temperature and a standard pressure:

1. A "resolution" over their full scale of 0.1 µm or better; and

2. With a "measurement uncertainty" equal to or better (less) than (0.2 + L/2000) µm (L is the measured length in millimeters);

Note: Item 4A003.b.3 does not control 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

Technical Note: In Item 4A003.b.3 'linear displacement' means the change of distance between the measuring probe and the measured object.