

1022.5. con't.

g. "Stored programme controlled" ion plating production equipment allowing for the *in situ* measurement of any of the following:

1. Coating thickness on the substrate and rate control; or
2. Optical characteristics.

Note:

1022.5.a., 1022.5.b., 1022.5.e., 1022.5.f. and 1022.5.g. do not control chemical vapour deposition, cathodic arc, sputter deposition, ion plating or ion implantation equipment specially designed for cutting or machining tools.

6. Dimensional inspection and measuring systems and equipment, as follows:

a. Computer controlled, "numerically controlled" or "stored programme controlled" dimensional inspection machines, having a three dimensional length (volumetric) "measurement uncertainty" equal to or less (better) than $(1.7 + L/1,000) \mu\text{m}$ (L is the measured length in mm) tested according to ISO 10360-2;

b. Linear and angular displacement measuring instruments, as follows:

1. Linear measuring instruments having any of the following:

a) Non-contact type measuring systems with a "resolution" equal to or less (better) than $0.2 \mu\text{m}$ within a measuring range up to 0.2 mm;

b) Linear voltage differential transformer systems having all of the following characteristics:

- (1) "Linearity" equal to or less (better) than 0.1% within a measuring range up to 5 mm; **and**
- (2) Drift equal to or less (better) than 0.1% per day at a standard ambient test room temperature $\pm 1 \text{ K}$; **or**

c) Measuring systems having all of the following:

- (1) Containing a "laser"; **and**
- (2) Maintaining, for at least 12 hours, over a temperature range of $\pm 1 \text{ K}$ around a standard temperature and at a standard pressure, all of the following:
 - a. A "resolution" over their full scale of $0.1 \mu\text{m}$ or less (better); **and**
 - b. A "measurement uncertainty" equal to or less (better) than $(0.2 + L/2,000) \mu\text{m}$ (L is the measured length in mm);

Note:

1022.6.b.1. 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.

2. Angular measuring instruments having an "angular position deviation" equal to or less (better) than 0.00025° ;

Note:

1022.6.b.2. does not control optical instruments, such as autocollimators, using collimated light to detect angular displacement of a mirror.

6. c. Equipment for measuring surface irregularities, by measuring optical scatter as a function of angle, with a sensitivity of 0.5 nm or less (better).

Notes:

1. Machine tools which can be used as measuring machines are controlled if they meet or exceed the criteria specified for the machine tool function or the measuring machine function.
2. A machine described in 1022.6. is controlled if it exceeds the control threshold anywhere within its operating range.

7. "Robots", having any of the following characteristics, and specially designed controllers and "end-effectors" therefor:

a. Capable in real time of full three-dimensional image processing or full three-dimensional scene analysis to generate or modify "programmes" or to generate or modify numerical programme data;

Note:

The scene analysis limitation does not include approximation of the third dimension by viewing at a given angle, or limited grey scale interpretation for the perception of depth or texture for the approved tasks (2 1/2 D).

b. Specially designed to comply with national safety standards applicable to explosive munitions environments;

c. Specially designed or rated as radiation-hardened to withstand greater than $5 \times 10^3 \text{ Gy}$ (Si) without operational degradation; **or**

d. Specially designed to operate at altitudes exceeding 30,000 m.

8. Assemblies, units or inserts specially designed for machine tools, or for equipment controlled by 1022.6. or 1022.7., as follows:

a. Linear position feedback units (e.g., inductive type devices, graduated scales, infrared systems or "laser" systems) having an overall "accuracy" less (better) than $(800 + (600 \times L \times 10^{-3})) \text{ nm}$ (L equals the effective length in mm);

Note:

For "laser" systems see also Note to Item 1022.6.b.1.

b. Rotary position feedback units (e.g., inductive type devices, graduated scales, infrared systems or "laser" systems) having an "accuracy" less (better) than 0.00025° ;

Note:

For "laser" systems see also Note to Item 1022.6.b.1.

c. "Compound rotary tables" and "tilting spindles", capable of upgrading, according to the manufacturer's specifications, machine tools to or above the levels specified in 1022.

9. Spin-forming or flow-forming machines and flow-forming machines, which, according to the manufacturer's technical specification, can be equipped with "numerical control" units or a computer control and having all of the following:

a. Two or more controlled axes of which at least two can be coordinated simultaneously for "contouring control"; **and**

b. A roller force more than 60 kN.

Technical Note:

Machines combining the function of spin-forming and flow-forming are for the purpose of 1022.9. regarded as flow-forming machines.

1023. Materials

None.