

1022. cont'd.

- a. Pulsating CVD;
- b. Controlled nucleation thermal decomposition (CNTD); **or**
- c. Plasma enhanced or plasma assisted CVD; **and**
2. Either of the following:
 - a. Incorporating high vacuum (equal to or less than 0.01 Pa) rotating seals; **or**
 - b. Incorporating in situ coating thickness control;
- b. "Stored programme controlled" ion implantation production equipment having beam currents of 5 mA or more;
- c. "Stored programme controlled" electron beam physical vapour deposition (EB-PVD) production equipment incorporating:
 1. Power systems rated for over 80 kW;
 2. A liquid pool level "laser" control system which regulates precisely the ingots feed rate; **and**
 3. A computer controlled rate monitor operating on the principle of photo-luminescence of the ionised atoms in the evaporant stream to control the deposition rate of a coating containing two or more elements;
- d. "Stored programme controlled" plasma spraying production equipment having either of the following characteristics:
 1. Operating at reduced pressure controlled atmosphere (equal to or less than 10 kPa measured above and within 300 mm of the gun nozzle exit) in a vacuum chamber capable of evacuation down to 0.01 Pa prior to the spraying process; **or**
 2. Incorporating in situ coating thickness control;
- e. "Stored programme controlled" sputter deposition production equipment capable of current densities of 0.1 mA/mm² or higher at a deposition rate of 15 µm/hr or more;
- f. "Stored programme controlled" cathodic arc deposition production equipment incorporating a grid of electromagnets for steering control of the arc spot on the cathode;
- g. "Stored programme controlled" ion plating production equipment allowing for the in situ measurement of either:
 1. Coating thickness on the substrate and rate control; **or**
 2. Optical characteristics;

Note:

1022.5.g. does not embargo standard ion plating coating equipment for cutting or machining tools.

6. Dimensional inspection or measuring systems or equipment, as follows:
 - a. Computer controlled, "numerically controlled" or "stored programme controlled" dimensional inspection machines, having both of the following characteristics:
 1. Two or more axes; **and**
 2. A one dimensional length "measurement uncertainty" equal to or less (better) than $(1.25 + L/1,000)$ µm tested with a probe with an "accuracy" of less (better) than 0.2 µm (L is the measured length in mm);
 - b. Linear and angular displacement measuring instruments, as follows:
 1. Linear measuring instruments having any of the following characteristics:
 - a. Non-contact type measuring systems with a "resolution" equal to or less (better) than 0.2 µm within a measuring range up to 0.2 mm;
 - b. Linear voltage differential transformer systems with both 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 ±1 K; **or**
 - c. Measuring systems having both of the following characteristics:
 1. Containing a "laser"; **and**
 2. Maintaining, for at least 12 hours, over a temperature range of ±1 K around a standard temperature and at a standard pressure:
 - a. A "resolution" over their full scale of 0.1 µm or less (better); **and**
 - b. A "measurement uncertainty" equal to or less (better) than $(0.2 + L/2,000)$ µm (L is the measured length in mm);

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

Note:

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

- c. Systems for simultaneous linear-angular inspection of hemishells, having both of the following characteristics:
 1. "Measurement uncertainty" along any linear axis equal to or less (better) than 3.5 µm per 5 mm; **and**
 2. "Angular position deviation" equal to or less (better) than 0.02°;
- d. Equipment for measuring surface irregularities, by measuring optical scatter as a function of angle, with a sensitivity of 0.5 nm or less (better);

Technical Notes

1. The probe used in determining the "measurement uncertainty" of a dimensional inspection system shall be as described in VDI/VDE 2617 Parts 2, 3 and 4.
2. All measurement values in 1022.6. represent permissible positive and negative deviations from the target value, i.e. not total band.

Notes

1. Machine tools which can be used as measuring machines are embargoed 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 embargoed if it exceeds the embargo threshold anywhere within its operating range.

7. "Robots", as follows, 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; **or**
- c. Specially designed or rated as radiation-hardened beyond that necessary to withstand normal industrial (i.e. non-nuclear industry) ionizing radiation;
8. Assemblies, units or inserts specially designed for machine tools, or for equipment embargoed by 1022.6. or 7., as follows:
 - a. Spindle assemblies, consisting of spindles and bearings as a minimal assembly, with radial ("run out") or axial ("camming") axis motion in one revolution of the spindle less (better) than 0.0006 mm TIR;
 - b. Linear position feedback units (e.g. inductive type devices, graduated scales, infrared systems or "laser" systems) having an overall "accuracy" less (better) than $(800 + (600 \times L \times 10^{-3}))$ nm (L equals the effective length in mm);
 - c. Rotary position feedback units, e.g. inductive type devices, graduated scales, infrared systems or "laser" systems, having an "accuracy" less (better) than 0.00025°;
 - d. Slide way assemblies consisting of a minimal assembly of ways, bed and slide having all of the following characteristics:
 1. A yaw, pitch or roll of less (better) than 2 seconds of arc TIR (reference: ISO/DIS 230/1) over full travel;
 2. A horizontal straightness of less (better) than 2 µm per 300 mm length; **and**
 3. A vertical straightness of less (better) than 2 µm per 300 mm length;
 - e. Single point diamond cutting tool inserts, having all of the following characteristics:
 1. Flawless and chip-free cutting edge when magnified 400 times in any direction;
 2. Cutting radius from 0.1 to 5 mm inclusive; **and**
 3. Cutting radius out-of-roundness less (better) than 0.002 mm TIR;
9. Specially designed printed circuit boards with mounted components and "software" therefor, or "compound rotary tables" or "tilting spindles", capable of upgrading, according to the manufacturer's specifications, "numerical control" units, machine tools or feed-back devices to or above the levels specified in 1022.