

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 "camming" 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 ($R_c = 40$ or more) gears, and specially designed components, controls and accessories therefor:
- a. Hardened bevel gears finished to a quality of better than AGMA 13 (equivalent to ISO 1328 class 4); *or*
 - b. Hardened spur, helical and double-helical gears with a pitch diameter exceeding 1,250 mm and a face width of 15% of pitch diameter or larger finished to a quality of AGMA 14 or better (equivalent to ISO 1328 class 3);
1022. 4. Hot "isostatic presses", as follows, and specially designed dies, moulds, components, accessories and controls therefor:
- a. Having a controlled thermal environment within the closed cavity and possessing a chamber cavity with an inside diameter of 406 mm or more; *and*
 - b. Having:
 1. A maximum working pressure exceeding 207 Mpa;
 2. A controlled thermal environment exceeding 1,773 K (1,500°C); *or*
 3. A facility for hydrocarbon impregnation and removal of resultant gaseous degradation products;

Technical Note:

The inside chamber dimension is that of the chamber in which both the working temperature and the working pressure are achieved and does not include fixtures. That dimension will be the smaller of either the inside diameter of the pressure chamber or the inside diameter of the insulated furnace chamber, depending on which of the two chambers is located inside the other.

1022. 5. Equipment specially designed for the deposition, processing and in-process control of inorganic overlays, coatings and surface modifications, as follows, for non-electronic substrates, by processes shown in the Table and associated Notes following 1025.3.d., and specially designed automated handling, positioning, manipulation and control components therefor:
- a. "Stored programme controlled" chemical vapour deposition (CVD) production equipment with both of the following:
 1. Process modified for one of the following:
 - 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 micrometre/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.

1022. 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 $(1.25 + L/1,000)$ micrometre tested with a probe with an "accuracy" of less (better) than 0.2 micrometre (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 micrometre 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 micrometre or less (better); *and*
 - b. A "measurement uncertainty" equal to or less (better) than $(0.2 + L/2,000)$ micrometre (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 micrometre 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.