

- of machine tools, dimensional inspection machines, or similar equipment;
3. Rotary position feedback units (e.g., inductive-type devices, graduated scales, "laser," or infrared systems) having, with compensation, an "accuracy" less (better) than 0.0025° of arc; except 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;
4501. 2. f. 4. Slide way assemblies consisting of a minimal assembly of ways, bed, and slide having all of the following characteristics:
- a. A yaw, pitch, or roll of less (better) than 2 seconds of arc TIR (Ref. ISO/DIS 230-1 over full travel);
 - b. A horizontal straightness of less (better) than 2 m per 300 mm length; and
 - c. A vertical straightness of less (better) than 2 m over full travel per 300 mm length;
5. Single-point diamond-cutting tool inserts having all of the following characteristics:
- a. A flawless and chip-free cutting edge when magnified 400 times in any direction;
 - b. A cutting radius out-of-roundness less (better) than 0.002 mm TIR (also peak-to-peak); and
 - c. A cutting radius between 0.1 and 5.0 mm, inclusive.
4501. 2. g. Specially designed components or sub-assemblies, as follows, capable of upgrading, according to the manufacturer's specifications, "numerical control" units, motion control boards, machine tools, or feedback devices to or above the levels controlled in sub-items 4501.2.a., b., c., 4501.2.f.2., or 3.:
1. Printed circuit boards with mounted components and "software" therefor;
 2. "Compound rotary tables."
4501. 3. Dimensional inspection machines, devices, or systems, and specially designed software therefor:
- a. Computer controlled or numerically 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 $(1.25 + L/1000)$ m tested with a probe of an "accuracy" of less (better) than 0.2 m (L is the measured length in millimetres) (Ref: VDI/VDE 2617 parts 1 and 2);
 - b. Linear and angular displacement measuring devices, 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 mm within a measuring range up to 0.2 mm;
 - b. linear variable differential transformer (LVDT) systems having 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 $\pm 1^\circ$ K; or
 3. measuring systems that have both of the following characteristics:
 - a. contain a "laser"; and
 - b. maintain for at least 12 hours, over a temperature range of $\pm 1^\circ$ K around a standard temperature and a standard pressure:
 1. a "resolution" over their full scale of 0.1 m or better; and
 2. with a "measurement uncertainty" equal to or less (better) than $(0.2 + L/2000)$ m (L is the measured length in millimetres); except measuring interferometer systems, without closed or open loop feedback containing a "laser" to measure slide move-

- ment errors of machine tools, dimensional inspection machines, or similar equipment.
4501. 3. b. 2. angular measuring instruments having an "angular position deviation" equal to or less (better) than 0.00025° ;
- NOTE**
This Item does not control optical instruments, such as autocollimators, using collimated light to detect angular displacement of a mirror.
4501. 3. c. Systems for simultaneously 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 m per 5 mm; and
 2. "angular position deviation" equal to or less than 0.02° .
- NOTE:**
Specially designed software for the systems described in paragraph (c) of this item includes software for simultaneous measurements of wall thickness and contour.
4501. 3. c. **TECHNICAL NOTES:**
1. Machine tools that can be used as measuring machines are included in Item 4501 if they meet or exceed the criteria specified for the machine tool function or the measuring machine function.
 2. A machine described in 4501.3 is covered by this item if it exceeds the control threshold anywhere within its operating range.
 3. 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.
 4. All parameters of measurement values in this item represent plus/minus, i.e., not total band.
4501. 4. Vacuum or controlled environment (Inert gas) induction furnaces capable of operation above 850°C and having induction coils 600 mm (24 in.) or less in diameter, and power supplies specially designed for induction furnaces with a power supply of 5 Kw or more.
- TECHNICAL NOTE:**
This item does not include furnaces designed for the processing of semiconductor wafers.
4501. 5. "Isostatic presses" capable of achieving a maximum working pressure of 69 Mpa (10,000 psi) or greater and having a chamber cavity with an inside diameter in excess of 152 mm (6 in.) and specially designed dies and molds, and controls and "specially designed software" therefor.
- TECHNICAL NOTE:**
1. 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.
 2. "Isostatic presses"
Equipment capable of pressurizing a closed cavity through various media (gas, liquid, solid particles, etc.) to create equal pressure in all directions within the cavity upon a workpiece or material.
4501. 6. "Robots" and "end-effectors" having either of the following characteristics:
- a. Specially designed to comply with national safety standards applicable to handling high explosives (for example, meeting electrical code ratings for high explosives); or
 - b. Specially designed or rated as radiation hardened to withstand greater than 5×10^4 grays (Si) (5×10^6 rad (Si) without operational degradation; and specially designed controllers and "specially designed software" therefor.
4501. 6. **TECHNICAL NOTES:**
1. "Robot" as described in item 4501.6 does not include robots specially designed for non-nuclear industrial applications such as automobile paint-spraying booths.
4501. 7. Vibration test equipment using digital control techniques and feedback or closed loop test equipment and software therefor