

**CATEGORY 2 - MATERIALS PROCESSING**

**Note:** For quiet running bearings, see the U.S. Munitions List.

**A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

**2A001 Anti-friction bearings and bearing systems, as follows, (see List of Items Controlled) and components therefor.**

**License Requirements**

*Reason for Control:* NS, AT

<i>Control(s)</i>	<i>Country Chart</i>
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NS applies to entire entry	NS Column 2
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AT applies to entire entry	AT Column 1
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**License Exceptions**

LVS: \$3000  
 GBS: Yes, for 2A001.a and 2A001.b  
 CIV: Yes, for 2A001.a and 2A001.b

**List of Items Controlled**

*Unit:* \$ value  
*Related Controls:* 1.) See also 2A991. 2.) This entry does not control balls with tolerance specified by the manufacturer in accordance with ISO 3290 as grade 5 or worse. 3.) Quiet running bearings are subject to the export licensing authority of the Department of State, Office of Defense Trade Controls. (See 22 CFR part 121.)  
*Related Definitions:* Annular Bearing Engineers Committee (ABEC).  
*Items:*

a. Ball bearings and solid roller bearings having

tolerances specified by the manufacturer in accordance with ABEC 7, ABEC 7P, ABEC 7T or ISO Standard Class 4 or better (or national equivalents), and having rings, balls or rollers made from monel or beryllium;

**Note:** 2A001.a does not control tapered roller bearings.

b. Other ball bearings and solid roller bearings having tolerances specified by the manufacturer in accordance with ABEC 9, ABEC 9P or ISO Standard Class 2 or better (or national equivalents);

**Note:** 2A001.b does not control tapered roller bearings.

c. Active magnetic bearing systems using any of the following:

c.1. Materials with flux densities of 2.0 T or greater and yield strengths greater than 414 MPa;

c.2. All-electromagnetic 3D homopolar bias designs for actuators; *or*

c.3. High temperature (450 K (177° C) and above) position sensors.

**2A225 Crucibles made of materials resistant to liquid actinide metals, as follows (see List of Items Controlled).**

**License Requirements**

*Reason for Control:* NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
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NP applies to entire entry	NP Column 1
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AT applies to entire entry	AT Column 1
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**License Exceptions**

LVS: N/A  
 GBS: N/A  
 CIV: N/A

**List of Items Controlled**

*Unit:* \$ value  
*Related Controls:* N/A  
*Related Definitions:* N/A  
*Items:*

a. Crucibles with a volume of between 150 ml and 8 liters and made of or coated with any of the following materials having a purity of 98% or greater:

- a.1. Calcium fluoride (CaF<sub>2</sub>);
- a.2. Calcium zirconate (metazirconate) (Ca<sub>2</sub>ZrO<sub>3</sub>);
- a.3. Cerium sulphide (Ce<sub>2</sub>S<sub>3</sub>);
- a.4. Erbium oxide (erbia) (Er<sub>2</sub>O<sub>3</sub>);
- a.5. Hafnium oxide (hafnia) (HfO<sub>2</sub>);
- a.6. Magnesium oxide (MgO);
- a.7. Nitrided niobium-titanium-tungsten alloy (approximately 50% Nb, 30% Ti, 20% W);
- a.8. Yttrium oxide (yttria) (Y<sub>2</sub>O<sub>3</sub>); *or*
- a.9. Zirconium oxide (zirconia) (ZrO<sub>2</sub>);

b. Crucibles with a volume of between 50 ml and 2 liters and made of or lined with tantalum, having a purity of 99.9% or greater;

c. Crucibles with a volume of between 50 ml and 2 liters and made of or lined with tantalum (having a purity of 98% or greater) coated with tantalum carbide, nitride or boride (or any combination of these).

**2A226 Valves 5 mm or greater in "nominal size", with a bellows seal, wholly made of or**

**lined with aluminum, aluminum alloy, nickel, or alloy containing 60% or more nickel, either manually or automatically operated.**

**License Requirements**

*Reason for Control:* NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
NP applies to entire entry	NP Column 1
AT applies to entire entry	AT Column 1

**License Exceptions**

LVS: N/A  
 GBS: N/A  
 CIV: N/A

**List of Items Controlled**

*Unit:* \$ value  
*Related Controls:* Valves are also subject to the export licensing authority of the Nuclear Regulatory Commission. (See 10 CFR part 110.)  
*Related Definition:* For valves with different inlet and outlet diameter, the "nominal size" parameter described in the entry refers to the smallest diameter.  
*Items:*

The list of items controlled is contained in the ECCN heading.

**2A290 Generators and other equipment specially designed, prepared, or intended for use with nuclear plants.**

**License Requirements**

*Reason for Control:* NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
NP applies to entire entry	NP Column 2

AT applies to entire entry

AT Column 1

**List of Items Controlled**

**License Exceptions**

LVS: N/A  
 GBS: N/A  
 CIV: N/A

**List of Items Controlled**

*Unit:* \$ value

*Related Controls:* Nuclear equipment is also subject to the export licensing authority of the Nuclear Regulatory Commission. (See 10 CFR part 110.)

*Related Definitions:* N/A

*Items:*

- a. Generators, turbine-generator sets, steam turbines, heat exchangers, and heat exchanger type condensers designed or intended for use in a nuclear reactor;
- b. Process control systems intended for use with the equipment controlled by 2A290.a.

**2A291 Equipment related to nuclear material handling and processing and to nuclear reactors.**

**License Requirements**

*Reason for Control:* NP, AT

*Control(s)* Country Chart

NP applies to entire entry NP Column 2

AT applies to entire entry AT Column 1

**License Exceptions**

LVS: N/A  
 GBS: N/A  
 CIV: N/A

*Unit:* Equipment in number; parts and accessories in \$ value

*Related Controls:* Nuclear equipment is also subject to the export licensing authority of the Nuclear Regulatory Commission. (See 10 CFR part 110.)

*Related Definitions:* N/A

*Items:*

- a. Process control systems, except those controlled by 2A290.b, intended for use with nuclear reactors.
- b. Casks that are specially designed for transportation of high-level radioactive material and that weigh more than 1,000 kg.
- c. Commodities, parts and accessories specially designed or prepared for use with nuclear plants (e.g., snubbers, airlocks, reactor and fuel inspection equipment) except items licensed by the Nuclear Regulatory Commission, pursuant to 10 CFR part 110.

**2A292 Piping, fittings and valves made of, or lined with, stainless steel, copper-nickel alloy or other alloy steel containing 10% or more nickel and/or chromium.**

**License Requirements**

*Reason for Control:* NP, AT

*Control(s)* Country Chart

NP applies to entire entry NP Column 2

AT applies to entire entry AT Column 1

**License Exceptions**

LVS: N/A  
 GBS: N/A  
 CIV: N/A

**List of Items Controlled**

*Unit:* Pressure tubes, pipes, and fittings in kilograms; valves in number; parts and accessories in \$ value  
*Related Controls:* Piping, fittings, and valves are also subject to the export licensing authority of the Nuclear Regulatory Commission. (See 10 CFR part 110.)  
*Related Definitions:* N/A  
*Items:*

- a. Pressure tube, pipe, and fittings of 200 mm (8 inches) or more inside diameter, and suitable for operation at pressures of 3.4 MPa (500 psi) or greater;
- b. Pipe valves having all of the following characteristics:
  - b.1. A pipe size connection of 8 inches or more inside diameter;
  - b.2. Rated at 1,500 psi or more;
- c. Parts, n.e.s.

**2A293 Pumps designed to move molten metals by electromagnetic forces.**

**License Requirements**

*Reason for Control:* NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
NP applies to entire entry	NP Column 2
AT applies to entire entry	AT Column 1

**License Exceptions**

LVS: N/A  
 GBS: N/A  
 CIV: N/A

**List of Items Controlled**

*Unit:* Equipment in number  
*Related Controls:* N/A  
*Related Definitions:* N/A  
*Items:*

The list of items controlled is contained in the ECCN heading.

**2A991 Bearings and bearing systems not controlled by 2A001.**

**License Requirements**

*Reason for Control:* AT

<i>Control(s)</i>	<i>Country Chart</i>
AT applies to entire entry	AT Column 1

**License Exceptions**

LVS: N/A  
 GBS: N/A  
 CIV: N/A

**List of Items Controlled**

*Unit:* \$ value  
*Related Controls:* 1.) This entry does not control balls with tolerance specified by the manufacturer in accordance with ISO 3290 as grade 5 or worse. 2.) Quiet running bearings are subject to the export licensing authority of the Department of State, Office of Defense Trade Controls. (See 22 CFR part 121).  
*Related Definitions:* 1.) (a) DN is the product of the bearing bore diameter in mm and the bearing rotational velocity in rpm. (b)

Operating temperatures include those temperatures obtained when a gas turbine engine has stopped after operation. 2.) Annular Bearing Engineers Committee (ABEC); American National Standards Institute (ANSI); Anti-Friction Bearing Manufacturers Association (AFBMA)

*Items:*

a. Ball bearings or Solid ball bearings (except tapered roller bearings), having tolerances specified by the manufacturer in accordance with ABEC 7, ABEC 7P, or ABEC 7T or ISO Standard Class 4 or better (or equivalents) and having any of the following characteristics.

a.1. Manufactured for use at operating temperatures above 573 K (300° C) either by using special materials or by special heat treatment; *or*

a.2. With lubricating elements or component modifications that, according to the manufacturer's specifications, are specially designed to enable the bearings to operate at speeds exceeding 2.3 million DN.

b. Solid tapered roller bearings, having tolerances specified by the manufacturer in accordance with ANSI/AFBMA Class 00 (inch) or Class A (metric) or better (or equivalents) and having either of the following characteristics.

b.1. With lubricating elements or component modifications that, according to the manufacturer's specifications, are specially designed to enable the bearings to operate at speeds exceeding 2.3 million DN; *or*

b.2. Manufactured for use at operating temperatures below 219 K (-54° C) or above 423 K (150° C).

c. Gas-lubricated foil bearing manufactured for use at operating temperatures of 561 K (288° C) or higher and a unit load capacity exceeding 1 MPa.

d. Active magnetic bearing systems.

e. Fabric-lined self-aligning or fabric-lined journal sliding bearings manufactured for use at operating temperatures below 219 K(-54° C) or above 423 K (150° C).

**2A993 Explosive detection systems, consisting of an automated device, or combination of devices, with the ability to detect the presence of different types of explosives, in passenger checked baggage, without need for human skill, vigilance, or judgement.**

**License Requirements**

*Reason for Control:* AT, UN

<i>Control(s)</i>	<i>Country Chart</i>
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AT applies to entire entry	AT Column 1
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UN applies to entire entry.	Federal Republic of Yugoslavia (Serbia and Montenegro).
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**License Exceptions**

LVS: N/A

GBS: N/A

CIV: N/A

**List of Items Controlled**

*Unit:* Equipment in number

*Related Controls:* N/A

*Related Definitions:* N/A

*Items:*

The list of items controlled is contained in the ECCN heading.

**2A994 Portable electric generators and specially designed parts.**

**License Requirements**

*Reason for Control:* AT

*Control(s)*

AT applies to entire entry. A license is required for items controlled by this entry to Cuba, Iran, Libya, and North Korea. The Commerce Country Chart is not designed to determine licensing requirements for this entry. See part 746 of the EAR for additional information on Cuba, Iran, and Libya. See §742.19 of the EAR for additional information on North Korea.

**License Exceptions**

LVS: N/A  
GBS: N/A  
CIV: N/A

**List of Items Controlled**

*Unit:* \$ value  
*Related Controls:* N/A  
*Related Definitions:* N/A  
*Items:*

The list of items controlled is contained in the ECCN heading.

**2A999 Specific processing equipment, n.e.s., as follows (see List of Items Controlled).**

**License Requirements**

*Reason for Control:* AT

*Control(s)* *Country Chart*

AT applies to entire entry. A license is required for items controlled by this entry to North Korea for anti-terrorism reasons. The Commerce

Country Chart is not designed to determine AT licensing requirements for this entry. See §742.19 of the EAR for additional information.

**License Exceptions**

LVS: N/A  
GBS: N/A  
CIV: N/A

**List of Items Controlled**

*Unit:* \$ value  
*Related Controls:* See also 2A226, 2B350  
*Related Definitions:* N/A  
*Items:*

- a. Bellows sealed valves;
- b. Reserved.

**B. TEST, INSPECTION AND PRODUCTION EQUIPMENT****Notes for Category 2B:**

1. Secondary parallel contouring axes, (e.g., the w-axis on horizontal boring mills or a secondary rotary axis the center line of which is parallel to the primary rotary axis) are not counted in the total number of contouring axes. Rotary axes need not rotate over 360°. A rotary axis can be driven by a linear device (e.g., a screw or a rack-and-pinion).

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

3. For the purposes of 2B001 to 2B009 a "tilting spindle" is counted as a rotary axis.

4. Guaranteed positioning accuracy levels instead of individual test protocols may be used for each machine tool model using the agreed ISO test procedure.

5. The positioning accuracy of "numerically controlled" machine tools is to be determined and presented in accordance with ISO 230/2 (1988).

**2B001 Machine tools and any combination thereof, for removing (or cutting) metals, ceramics or "composites", which, according to the manufacturer's technical specification, can be equipped with electronic devices for "numerical control".**

**License Requirements**

*Reason for Control:* NS, NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
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NS applies to entire entry	NS Column 2
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NP applies to NP Column 1  
 2B001.a,b,c, and d,  
 EXCEPT:(1) turning machines under 2B001.a with a capacity equal to or less than 35 mm diameter; (2) bar machines (Swissturn), limited to machining only bar feed through, 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); or (3) milling machines under 2B001.b with x-axis travel greater than two meters and overall "positioning accuracy" on the x-axis more (worse) than 0.030 mm

AT applies to entire entry	AT Column 1
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**License Requirement Notes:** See §743.1 of the EAR for reporting requirements for exports under License Exceptions.

**License Exceptions**

LVS: N/A  
 GBS: N/A  
 CIV: N/A

**List of Items Controlled**

*Unit:* Equipment in number; parts and accessories in \$ value  
*Related Controls :*1.) See also 2B290 and 2B991; 2.) See also 1B101.d for cutting

equipment designed or modified for removing prepregs and preforms controlled by 9A110.

*Related Definitions:* N/A

*Items:*

a. Machine tools for turning, having all of the following characteristics:

a.1. Positioning accuracy with “all compensations available” of less (better) than 6 m along any linear axis; *and*

a.2. Two or more axes which can be coordinated simultaneously for "contouring control";

**Note:** 2B001.a does not control turning machines specially designed for the production of contact lenses.

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

b.1.a. Positioning accuracy with “all compensations available” of less (better) than 6 m along any linear axis; *and*

b.1.b. Three linear axes plus one rotary axis which can be coordinated simultaneously for "contouring control";

b.2. Five or more axes which can be coordinated simultaneously for "contouring control"; *or*

b.3. A positioning accuracy for jig boring machines, with “all compensations available”, of less (better) than 4 m along any linear axis;

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

c.1.a. Positioning accuracy with “all compensations available” of less (better) than 4 m along any linear axis; *and*

c.1.b. Three or more axes which can be coordinated simultaneously for "contouring control"; *or*

c.2. Five or more axes which can be coordinated simultaneously for "contouring control";

**Notes:** 2B001.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 cylindrical grinding; *and*

b. Limited to a maximum workpiece capacity of 150 mm outside diameter or length.

2. Machines designed specifically as jig grinders having any of following characteristics:

a. The c-axis is used to maintain the grinding wheel normal to the work surface; *or*

b. The a-axis is configured to grind barrel cams.

3. Tool or cutter grinding machines limited to the production of tools or cutters.

4. Crank shaft or cam shaft grinding machines.

5. Surface grinders.

d. Electrical discharge machines (EDM) of the non-wire type which have two or more rotary axes which can be coordinated simultaneously for "contouring control";

e. Machine tools for removing metals, ceramics or "composites":

e.1. By means of:



e.1.a. Water or other liquid jets, including those employing abrasive additives;

e.1.b. Electron beam; *or*

e.1.c. "Laser" beam; *and*

e.2. Having two or more rotary axes which:

e.2.a. Can be coordinated simultaneously for "contouring control"; *and*

e.2.b. Have a positioning accuracy of less (better) than 0.003°;

f. Deep-hole-drilling machines and turning machines modified for deep-hole-drilling, having a maximum depth-of-bore capability exceeding 5,000 mm and specially designed components therefor.

**2B003 "Numerically controlled" or manual machine tools, and specially designed components, controllers and accessories therefor, specially designed for the shaving, finishing, grinding or honing of hardened ( $R_c = 40$  or more) 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).**

**License Requirements**

*Reason for Control:* NS, AT

*Control(s)* *Country Chart*

NS applies to entire entry NS Column 2

AT applies to entire entry AT Column 1

**License Requirement Notes:** See §743.1 of the EAR for reporting requirements for exports under License Exceptions.

**License Exceptions**

LVS: \$5000

GBS: N/A

CIV: N/A

**List of Items Controlled**

*Unit:* Equipment in number; parts and accessories in \$ value

*Related Controls:* See also 2B993

*Related Definitions:* N/A

*Items:*

The list of items controlled is contained in the ECCN heading.

**2B004 Hot "isostatic presses", having all of the following characteristics described in the List of Items Controlled, and specially designed components and accessories therefor.**

**License Requirements**

*Reason for Control:* NS, MT, NP, AT

*Control(s)* *Country Chart*

NS applies to entire entry NS Column 2

MT applies to entire entry MT Column 1

NP applies to entire entry, except 2B004.b.3 and presses with temperatures exceeding 1,733K, and pressure below 69 MPa

AT applies to entire entry AT Column 1

**License Exceptions**

LVS: N/A

GBS: N/A

CIV: N/A

**List of Items Controlled**

*Unit:* Equipment in number; parts and accessories in \$ value

*Related Controls:* 1) See also 2B104 and 2B204. 2) For specially designed dies, molds and tooling, see 1B003, 9B009 and ML18 (22 CFR part 121). 3) In addition, see 1B101.d, 2B104 and 2B204 for controls on dies, molds and tooling.

*Related Definitions:* N/A

*Items:*

a. A controlled thermal environment within the closed cavity and possessing a chamber cavity with an inside diameter of 406 mm or more; *and*

b. Any of the following:

b.1. A maximum working pressure exceeding 207 MPa;

b.2. A controlled thermal environment exceeding 1,773 K (1,500 °C); *or*

b.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.

**2B005 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 2E003.f, and specially designed automated handling,**

**positioning, manipulation and control components therefor.**

**License Requirements**

*Reason for Control:* NS, AT

<i>Control(s)</i>	<i>Country Chart</i>
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NS applies to entire entry	NS Column 2
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AT applies to entire entry	AT Column 1
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**License Exceptions**

LVS: \$1000

GBS: N/A

CIV: N/A

**List of Items Controlled**

*Unit:* \$ value

*Related Controls:* 1.) This entry does not control chemical vapor deposition, cathodic arc, sputter deposition, ion plating or ion implantation equipment specially designed for cutting or machining tools. 2.) Vapor deposition equipment for the production of filamentary materials are controlled by 1B001 or 1B101. 3.) Chemical Vapor Deposition furnaces designed or modified for densification of carbon-carbon composites are controlled by 2B104.

*Related Definitions:* N/A

*Items:*

a. "Stored program controlled" chemical vapor deposition (CVD) production equipment having all of the following:

a.1. Process modified for one of the following:

a.1.a. Pulsating CVD;

a.1.b. Controlled nucleation thermal deposition (CNTD); *or*

a.1.c. Plasma enhanced or plasma assisted CVD; *and*

a.2. Any of the following:

a.2.a. Incorporating high vacuum (equal to or less than 0.01 Pa) rotating seals; *or*

a.2.b. Incorporating *in situ* coating thickness control;

b. "Stored program controlled" ion implantation production equipment having beam currents of 5 mA or more;

c. "Stored program controlled" electron beam physical vapor (EB-PVD) production equipment incorporating power systems rated for over 80 kW, having any of the following:

c.1. A liquid pool level "laser" control system which regulates precisely the ingots feed rate; *or*

c.2. A computer controlled rate monitor operating on the principle of photo-luminescence of the ionized atoms in the evaporant stream to control the deposition rate of a coating containing two or more elements;

d. "Stored program controlled" plasma spraying production equipment having any of the following characteristics:

d.1. Operating at reduced pressure controlled atmosphere (equal 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*

d.2. Incorporating *in situ* coating thickness control;

e. "Stored program controlled" sputter deposition production equipment capable of current densities of 0.1 mA/mm<sup>2</sup> or higher at a deposition rate 15 m/h or more;

f. "Stored program controlled" cathodic arc deposition equipment incorporating a grid of electromagnets for steering control of the arc spot on the cathode;

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

g.1. Coating thickness on the substrate and rate control; *or*

g.2. Optical characteristics.

**2B006 Dimensional inspection or measuring systems and equipment, as follows (see List of Items Controlled).**

**License Requirements**

*Reason for Control:* NS, NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
NS applies to entire entry	NS Column 2
NP applies to 2B006.a and .b	NP Column 1
AT applies to entire entry	AT Column 1

**License Exceptions**

LVS: N/A  
 GBS: N/A  
 CIV: N/A

**List of Items Controlled**

*Unit:* Equipment in number  
*Related Controls:* See also 2B206 and 2B996.  
*Related Definition:* 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 by this entry is controlled if it exceeds the control threshold anywhere within its operating range.

*Items:*

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

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

b.1. Linear measuring instruments having any of the following:

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

b.1.b. Linear voltage differential transformer systems having all of the following characteristics:

b.1.b.1. "Linearity" equal to or less (better) than 0.1% within a measuring range up to 5 mm; *and*

b.1.b.2. Drift equal to or less (better) than 0.1% per day at a standard ambient test room temperature  $\pm 1$  K; *or*

b.1.c. Measuring systems having all of the following:

b.1.c.1. Containing a "laser"; *and*

b.1.c.2. Maintaining, for at least 12 hours, over a temperature range of  $\pm 1$  K around a standard temperature and at a standard pressure, all of the following:

b.1.c.2.a. A "resolution" over their full scale of 0.1 m or less (better); *and*

b.1.c.2.b. A "measurement uncertainty" equal to or less (better) than  $(0.2 + L/2,000)$  m (L is the measured length in mm);

**Note:** 2B006.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.

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

**Note:** 2B006.b.2 does not control optical instruments, such as autocollimators, using collimated light to detect angular displacement of a mirror.

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).

**2B007 "Robots" having any of the following characteristics described in the List of Items Controlled and specially designed controllers and "end-effectors" therefor.**

**License Requirements**

*Reason for Control:* NS, NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
NS applies to entire entry	NS Column 2
NP applies to 2B007.c if specially designed or rated as radiation hardened to withstand greater than $5 \times 10^4$ grays(Si) without	NP Column 1

operational degradation; to 2B007.b; and to specially designed controllers and "end-effectors" therefor.

AT applies to entire entry AT Column 1

**License Exceptions**

LVS: \$5000, except 2B007.b and .c  
 GBS: N/A  
 CIV: N/A

**List of Items Controlled**

*Unit:* \$ value  
*Related Controls:* See also 2B207 and 2B997  
*Related Definitions:* N/A  
*Items:*

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

**Technical 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 x 10<sup>3</sup> Gy (Si) without operational degradation; or

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

**2B008 Assemblies, units or inserts specially designed for machine tools, or for equipment**

**controlled by 2B006 or 2B007, as follows (see List of Items Controlled).**

**License Requirements**

*Reason for Control:* NS, AT

*Control(s)* Country Chart

NS applies to entire entry NS Column 2

AT applies to entire entry AT Column 1

**License Exceptions**

LVS: N/A  
 GBS: N/A  
 CIV: N/A

**List of Items Controlled**

*Unit:* \$ value  
*Related Controls:* See also 2B998  
*Related Definition:* N/A  
*Items:*

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 x L x 10<sup>-3</sup>)) nm (L equals the effective length in mm);

**N.B.:** For "laser" systems see also Note to 2B006.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°;

**N.B.:** For "laser" systems see also Note to 2B006.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 controlled by 2B001 to 2B009.

**2B009 Spin-forming machines and flow-forming machines, which, according to the manufacturer's technical specifications, can be equipped with "numerical control" units or a computer control and having all the characteristics (see List of Items Controlled).**

**License Requirements**

*Reason for Control:* NS, MT, NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
NS applies to entire entry	NS Column 2
MT applies to spin-forming machines combining the functions of spin-forming and flow-forming; and flow-forming machines.	MT Column 1
NP applies to flow-forming machines; and spin-forming machines capable of flow-forming functions.	NP Column 1
AT applies to entire entry	AT Column 1

**License Exceptions**

LVS: N/A  
 GBS: N/A  
 CIV: N/A

**List of Items Controlled**

*Unit:* \$ value

*Related Controls:* See also 2B109 for additional flow-forming machines for MT and NP reasons. See also 2B209 for additional flow-forming machines controlled for NP reasons.

*Related Definitions:* Machines combining the function of spin-forming and flow-forming

are for the purpose of 2B009 regarded as flow-forming machines.

*Items:*

- 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.

**2B018 Equipment on the International Munitions List.**

**License Requirements**

*Reason for Control:* NS, MT, RS, AT, UN

<i>Control(s)</i>	<i>Country Chart</i>
NS applies to entire entry	NS Column 1
MT applies to specialized machinery, equipment, and gear for producing rocket systems (including ballistic missile systems, space launch vehicles, and sounding rockets) and unmanned air vehicle systems (including cruise missile systems, target drones, and reconnaissance drones) usable in systems that are controlled for MT reasons including their propulsion systems and components, and pyrolytic deposition and densification equipment.	MT Column 1
RS applies to entire entry	RS Column 2
AT applies to entire entry	AT Column 1
UN applies to entire entry.	Rwanda; Federal Republic of Yugoslavia

(Serbia and Montenegro).

### License Exceptions

LVS: \$3000, except N/A for Rwanda and the Federal Republic of Yugoslavia (Serbia and Montenegro).

GBS: Yes for Advisory Note in this entry to 2B018, except N/A for Rwanda and the Federal Republic of Yugoslavia (Serbia and Montenegro).

CIV: N/A

### List of Items Controlled

*Unit:* Equipment in number; parts and accessories in \$ value

*Related Controls:* N/A

*Related Definitions:* N/A

*Items:*

Specialized machinery, equipment, gear, and specially designed parts and accessories therefor, including but not limited to the following, that are specially designed for the examination, manufacture, testing, and checking of arms, appliances, machines, and implements of war:

- a. Armor plate drilling machines, other than radial drilling machines;
- b. Armor plate planing machines;
- c. Armor plate quenching presses;
- d. Centrifugal casting machines capable of casting tubes 6 feet (183 cm) or more in length, with a wall thickness of 2 inches (5 cm) and over;
- e. Gun barrel rifling and broaching machines, and tools therefor;
- f. Gun barrel rifling machines;
- g. Gun barrel trepanning machines;

- h. Gun boring and turning machines;
- i. Gun honing machines of 6 feet (183 cm) stroke or more;
- j. Gun jump screw lathes;
- k. Gun rifling machines;
- l. Gun straightening presses;
- m. Induction hardening machines for tank turret rings and sprockets;
- n. Jigs and fixtures and other metal-working implements or accessories of the kinds exclusively designed for use in the manufacture of firearms, ordnance, and other stores and appliances for land, sea, or aerial warfare;
- o. Small arms chambering machines;
- p. Small arms deep hole drilling machines and drills therefor;
- q. Small arms rifling machines;
- r. Small arms spill boring machines;
- s. Tank turret bearing grinding machines.

**Advisory Note:** Licenses are likely to be approved, as administrative exceptions, for export and reexport to Country Group D:1 of equipment used to determine the safety data of explosives, as required by the International Convention on the Transport of Dangerous Goods (C.I.M.) articles 3 and 4 in Annex 1 RID, provided that such equipment will be used only by the railway authorities of current C.I.M. members, or by the Government-accredited testing facilities in those countries, for the testing of explosives to transport safety standards, of the following description:

- a. Equipment for determining the ignition and deflagration temperatures;

b. Equipment for steel-shell tests;

c. Drophammers not exceeding 20 kg in weight for determining the sensitivity of explosives to shock;

d. Equipment for determining the friction sensitivity of explosives when exposed to charges not exceeding 36 kg in weight.

**2B104 Equipment and process controls designed or modified for densification and pyrolysis of structural composite rocket nozzles and reentry vehicle nose tips.**

**License Requirements**

*Reason for Control:* MT, AT

*Control(s)* Country Chart

MT applies to entire entry MT Column 1

AT applies to entire entry AT Column 1

**License Exceptions**

LVS: N/A

GBS: N/A

CIV: N/A

**List of Items Controlled**

*Unit:* Equipment in number

*Related Controls:* The only "isostatic presses" and furnaces controlled by 2B104 are: a.) "Isostatic presses", other than those controlled by 2B004, having all the following characteristics: 1.) Maximum working pressure of 69 MPa or greater; 2.) Designed to achieve and maintain a thermal environment of 873 K (600 °C) or greater; and 3.) Possessing a chamber cavity with a diameter of 254 mm or greater; b.) CVD Furnaces designed or modified for the densification of carbon-carbon composites.

*Related Definitions:* N/A

*Items:*

The list of items controlled is contained in the ECCN heading.

**2B109 Flow-forming machines, other than those controlled by 2B009, and specially designed components therefor.**

**License Requirements**

*Reason for Control:* MT, NP, AT

*Control(s)* Country Chart

MT applies to entire entry MT Column 1

NP applies to entire entry NP Column 1

AT applies to entire entry AT Column 1

**License Exceptions**

LVS: N/A

GBS: N/A

CIV: N/A

**List of Items Controlled**

*Unit:* Equipment in number; parts and accessories in \$ value

*Related Controls:* See also 2B009 and 2B209

*Related Definition:* This entry controls only spin-forming machines combining the functions of spin-forming and flow-forming and flow forming machines.

*Items:*

a. According to the manufacturer's technical specification, can be equipped with "numerical control" units or a computer control, even when not equipped with such units; and



b. With more than two axes which can be coordinated simultaneously for "contouring control."

**Technical Notes:** 1. Machines combining the function of spin-forming and flow-forming are for the purpose of 2B109 regarded as flow-forming machines.

2. 2B109 does not control machines that are not usable in the production of propulsion components and equipment (e.g. motor cases) for systems in 9A005, 9A007.a, or 9A105.

**2B116 Vibration test systems, equipment and components therefor, as follows (see List of Items Controlled).**

**License Requirements**

*Reason for Control:* MT, NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
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MT applies to entire entry	MT Column 1
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NP applies to electrodynamic vibration test systems, employing feedback or closed loop control techniques and incorporating a digital controller, capable of vibrating at 10 g RMS or more between 20 Hz and 2000 Hz and imparting forces of 50 kN (11,250 lbs.) measured "bare table", or greater.	NP Column 1
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AT applies to entire entry	AT Column 1
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**License Exceptions**

LVS: N/A  
 GBS: N/A  
 CIV: N/A

**List of Items Controlled**

*Unit:* \$ value

*Related Controls:* See also 9B990

*Related Definitions:* 1.) The term "digital control" refers to equipment, the functions of which are, partly or entirely, automatically controlled by stored and digitally coded electrical signals. 2.) The term "bare table" means a flat table, or surface, with no fixture or fitting.

*Items:*

a. Vibration test systems employing feedback or closed loop techniques and incorporating a digital controller, capable of vibrating a system at 10 g RMS or more over the entire range 20 Hz to 2,000 Hz and imparting forces of 50 kN (11,250 lbs.), measured "bare table", or greater;

b. Digital controllers, combined with specially designed vibration test "software", with a real-time bandwidth greater than 5 kHz and designed for use with vibration test systems described in 2B116.a;

c. Vibration thrusters (shaker units), with or without associated amplifiers, capable of imparting a force of 50 kN (11,250 lbs.), measured "bare table", or greater, and usable in vibration test systems described in 2B116.a;

d. Test piece support structures and electronic units designed to combine multiple shaker units into a complete shaker system capable of providing an effective combined force of 50 kN, measured "bare table", or greater, and usable in vibration test systems described in 2B116.a.

**2B201 Machine tools, other than those controlled by 2B001 for removing or cutting metals, ceramics or "composites", which, according to manufacturer's technical specification, can be equipped with electronic for simultaneous "contouring control" in two or more axes.**

**License Requirements**

*Reason for Control:* NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
NP applies to entire entry	NP Column 1
AT applies to entire entry	AT Column 1

**License Exceptions**

LVS: N/A  
 GBS: N/A  
 CIV: N/A

**List of Items Controlled**

*Unit:* Equipment in number; parts and accessories in \$ value  
*Related Controls:* See also 2B290, 2B991, and 2D002 "Numerical control" units are controlled by their associated "software".  
*Related Definition:* N/A  
*Items:*

- a. Machine tools for milling, having any of the following characteristics:
  - a.1. "Positioning accuracies" with all compensations available less (better) than 0.006 mm along any linear axis (positioning); *or*
  - a.2. Two or more contouring rotary axes.

**Note:** 2B201.a does not control milling having the following characteristics:

- a. X-axis travel greater than 2 m;

- b. Overall "positioning accuracy" on the x-axis more (worse) than 0.030 mm.

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

- b.1. "Positioning accuracies" with all compensations available less (better) than 0.004 mm along any linear axis (positioning); *or*

- b.2. Two or more contouring rotary axes.

**Note:** 2B201.b does not control the following grinding machines:

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

- 1. Limited to cylindrical grinding;
    - 2. A maximum workpiece outside diameter or length of 150 mm
    - 3. Not more than two axes that can be simultaneously for "contouring control"; *and*
    - 4. No contouring c axis;

- b. Jig grinders with axes limited to x, y, c and a where c-axis is used to maintain the grinding wheel normal to the work surface, and the a axis is configured to grind barrel cams;

- c. Tool or cutter grinding machines with "software" specially designed for the production of tools or cutters; *or*

- d. Crankshaft or camshaft grinding machines.

- c. Machines for turning, that have "positioning accuracies" with all compensations available less (better) than 0.006 mm along any linear axis (overall positioning) for machines capable of machining diameters greater than 35 mm.

**Note:** Bar machines (Swissturn), limited to machining only bar feed thru, are excluded 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.

**2B204 "Isostatic presses," not controlled by 2B004 or 2B104, 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 inches) and specially designed dies, molds, and controls therefor.**

**License Requirements**

*Reason for Control:* NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
NP applies to entire entry	NP Column 1
AT applies to entire entry	AT Column 1

**License Exceptions**

LVS: N/A  
 GBS: N/A  
 CIV: N/A

**List of Items Controlled**

*Unit:* Equipment in number  
*Related Controls:* N/A  
*Related Definition:* The inside chamber dimension is that of the chamber in which both the working temperature and 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 chamber, depending on which of the two chambers is located inside the other.  
*Items:*

The list of items controlled is contained in the ECCN heading.

**2B206 Dimensional inspection machines, devices or systems, other than those controlled by 2B006, as follows (see List of Items Controlled).**

**License Requirements**

*Reason for Control:* NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
NP applies to entire entry	NP Column 1
AT applies to entire entry	AT Column 1

**License Exceptions**

LVS: N/A  
 GBS: N/A  
 CIV: N/A

**List of Items Controlled**

*Unit:* Equipment in number; parts and accessories in \$ value  
*Related Controls:* See also 2B992.  
*Related Definition:* 1.) Machine tools that can be used as measuring machines are controlled if they meet or exceed the criteria specified for the machine function or the measuring machine function. 2.) A machine controlled by 2B206 is controlled 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 described in VDI/VDE 2617 parts 2, 3 and 4.  
*Items:*

a. Computer controlled or numerically controlled dimensional inspection machines having both of the following characteristics:

a.1. Two or more axes; *and*

a.2. A one-dimensional length "measurement uncertainty" equal to or less (better) than  $(1.25 + L/1000)$  m tested with a probe of "accuracy" of less (better) than 0.2 m (L is the measured length millimeters) (Ref.:VDI/VDE 2617 Parts 1 and 2);

b. Systems for simultaneously linear-angular inspection of hemishells having both of the following characteristics:

b.1. "Measurement uncertainty" along any linear axis equal to less (better) than 3.5 m per 5 mm; *and*

b.2. "Angular position deviation" equal to or less than 0.02°.

**2B207 "Robots" or "end-effectors", other than those controlled by 2B007, specially designed to comply with national safety standards applicable to handling high explosives (for example, meeting code ratings for high explosives) and specially designed controllers therefor.**

**License Requirements**

*Reason for Control:* NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
NP applies to entire entry	NP Column 1
AT applies to entire entry	AT Column 1

**License Exceptions**

LVS: N/A

GBS: N/A

CIV: N/A

**List of Items Controlled**

*Unit:* \$ value

*Related Controls:* N/A

*Related Definitions:* N/A

*Items:*

The list of items controlled is contained in the ECCN heading.

**2B209 Flow forming machines, or spin forming machines capable of flow forming functions, other than those controlled by 2B009 or 2B109, or mandrels, as follows (see List of Items Controlled).**

**License Requirements**

*Reason for Control:* NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
NP applies to entire entry	NP Column 1
AT applies to entire entry	AT Column 1

**License Exceptions**

LVS: N/A

GBS: N/A

CIV: N/A

**List of Items Controlled**

*Unit:* Equipment in number; parts and accessories in \$ value

*Related Controls:* N/A

*Related Definition:* This entry includes 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.

*Items:*

a. Machines having any of the following:

a.1. Having three or more rollers (active or guiding); *and*

a.2. According to the manufacturer's technical specification can be equipped with "numerical control" units or a computer control.

b. Rotor-forming mandrels designed to form cylindrical rotors of inside diameter between 75 mm (3 in.) and 400 mm (16 in.).

**2B225 Remote manipulators that can be used to provide remote actions in radiochemical separation operations and hot cells, as follows (see List of Items Controlled).**

**License Requirements**

*Reason for Control:* NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
NP applies to entire entry	NP Column 1
AT applies to entire entry	AT Column 1

**License Exceptions**

LVS: N/A  
 GBS: N/A  
 CIV: N/A

**List of Items Controlled**

*Unit:* \$ value  
*Related Controls:* N/A  
*Related Definition:* Remote manipulators provide translation of human operator actions to a remote operating arm and terminal

fixture. They may be of a "master/slave" type or operated by joystick or keypad.

*Items:*

a. Having a capability of penetrating 0.6 m or more of hot cell wall (operation); *or*

b. Having a capability of bridging over the top of a hot cell wall with a thickness of 0.6 m or more (over-the-wall operation).

**2B226 Vacuum or controlled environment (inert gas) induction furnaces capable of operation above 1,123 K (850 °C) and having induction coils 600 mm or less in diameter, and designed for power inputs of 5 kW or more, and power supplies specially designed therefor with a specified power output of 5 kW or more.**

**License Requirements**

*Reason for Control:* NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
NP applies to entire entry	NP Column 1
AT applies to entire entry	AT Column 1

**License Exceptions**

LVS: N/A  
 GBS: N/A  
 CIV: N/A

**List of Items Controlled**

*Unit:* \$ value  
*Related Controls:* See also Category 3B. This entry does not control furnaces designed for the processing of semiconductor wafers.  
*Related Definition:* N/A  
*Items:*

The list of items controlled is contained in the ECCN heading.

**2B227 Vacuum and controlled atmosphere metallurgical melting and casting furnaces and specially configured computer control and monitoring systems therefor.**

*Control(s)*

*Country Chart*

NP applies to entire entry

NP Column 1

AT applies to entire entry

AT Column 1

**License Requirements**

*Reason for Control:* NP, AT

*Control(s)*

*Country Chart*

NP applies to entire entry

NP Column 1

AT applies to entire entry

AT Column 1

**License Exceptions**

LVS: N/A

GBS: N/A

CIV: N/A

**List of Items Controlled**

*Unit:* \$ value

*Related Controls:* N/A

*Related Definition:* N/A

*Items:*

- a. Arc remelt and casting furnaces with consumable electrode capacities between 1000 cm<sup>3</sup> and 20,000 cm<sup>3</sup>, capable of operating with melting temperatures above 1,973 K (1,700 °C);
- b. Electron beam melting and plasma atomization and furnaces, with a power of 50 kW or greater, capable of operating melting temperatures above 1,473 K (1,200 °C).

**2B228 Rotor fabrication and assembly equipment and bellows-forming mandrels and dies, as follows (see List of Items Controlled).**

**License Requirements**

*Reason for Control:* NP, AT

**License Exceptions**

LVS: N/A

GBS: N/A

CIV: N/A

**List of Items Controlled**

*Unit:* \$ value

*Related Controls:* N/A

*Related Definitions:* N/A

*Items:*

- a. Rotor assembly equipment for assembly of gas centrifuge rotor sections, baffles and end caps, including associated precision mandrels, clamps and shrink fit machines;
- b. Rotor straightening equipment for alignment of gas centrifuge rotor sections to a common axis;

**Technical Note:** Normally such equipment will consist of precision measuring probes linked to a computer that subsequently controls the action of, for example, pneumatic rams used for aligning the rotor tube sections.

- c. Bellows-forming mandrels and dies for producing single-convolution bellows (bellows made of high-strength aluminum alloys, maraging steel or high strength filamentary materials). The bellows have all of the following dimensions:
  - c.1. 75 mm to 400 mm inside diameter;
  - c.2. 12.7 mm or more in length; *and*
  - c.3. Single convolution depth more than 2 mm.

**2B229 Centrifugal multiplane balancing machines, fixed or portable, horizontal or vertical, as follows (see List of Items Controlled).**

**License Requirements**

*Reason for Control:* NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
NP applies to entire entry	NP Column 1
AT applies to entire entry	AT Column 1

**License Exceptions**

LVS: N/A  
 GBS: N/A  
 CIV: N/A

**List of Items Controlled**

*Unit:* \$ value  
*Related Controls:* N/A  
*Related Definitions:* N/A  
*Items:*

a. Centrifugal balancing machines designed for balancing flexible rotors having a length of 600 mm or more and having all of the following characteristics:

- a.1. A swing or journal diameter of 75 mm or more;
- a.2. Mass capability of from 0.9 to 23 kg; *and*
- a.3. Capable of balancing speed of revolution more than 5000 r.p.m.;

b. Centrifugal balancing machines designed for balancing hollow cylindrical rotor components and having all of the following characteristics:

- b.1. A journal diameter of 75 mm or more;

- b.2. Mass capability of from 0.9 to 23 kg;
- b.3. Capable of balancing to a residual imbalance of 0.01 kg mm/kg per plane or better; *and*
- b.4. Belt drive type.

**2B230 "Pressure transducers" which are capable of measuring absolute pressure at any point in the range 0 to 13 kPa, with pressure sensing elements made of or protected by nickel, nickel alloys with more than 60% nickel by weight, aluminum or aluminum alloys, having any of the characteristics (see List of Items Controlled).**

**License Requirements**

*Reason for Control:* NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
NP applies to entire entry	NP Column 1
AT applies to entire entry	AT Column 1

**License Exceptions**

LVS: N/A  
 GBS: N/A  
 CIV: N/A

**List of Items Controlled**

*Unit:* \$ value  
*Related Controls:* N/A  
*Related Definitions:* 1.) Pressure transducers are devices that convert pressure measurements into an electrical signal. 2.) For the purposes of this entry, "accuracy" includes non-linearity, hysteresis and repeatability at ambient temperature.  
*Items:*

- a. A full scale of less than 13 kPa and an "accuracy" of better than +/- 1% (full-scale); *or*
- b. A full scale of 13 kPa or greater and an "accuracy" of better than +/- 130 Pa.

**2B231 Vacuum pumps with an input throat size of 380 mm or greater with a pumping speed of 15,000 liters/s or greater and capable of producing an ultimate vacuum better than 10<sup>-4</sup> Torr (1.33 x 10<sup>-4</sup> mbar).**

**License Requirements**

*Reason for Control:* NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
NP applies to entire entry	NP Column 1
AT applies to entire entry	AT Column 1

**License Exceptions**

LVS: N/A  
 GBS: N/A  
 CIV: N/A

**List of Items Controlled**

*Unit:* \$ value  
*Related Controls:* Vacuum pumps for gaseous diffusion separation process are subject to the export licensing authority of the Nuclear Regulatory Commission. (See 10 CFR part 110.)  
*Related Definition:* 1.) The ultimate vacuum is determined at the input of the pump with the input of the pump blocked off. 2.) The pumping speed is determined at the measurement point with nitrogen gas or air.  
*Items:*

The list of items controlled is contained in the ECCN heading.

**2B232 Multistage light gas guns or other high-velocity gun systems (coil, electromagnetic, electrothermal, or other advanced systems) capable of accelerating projectiles to 2 km/s or greater.**

**License Requirements**

*Reason for Control:* NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
NP applies to entire entry	NP Column 1
AT applies to entire entry	AT Column 1

**License Exceptions**

LVS: N/A  
 GBS: N/A  
 CIV: N/A

**List of Items Controlled**

*Unit:* \$ value  
*Related Controls:* N/A  
*Related Definitions:* N/A  
*Items:*

The list of items controlled is contained in the ECCN heading.

**2B290 "Numerically controlled" machine tools not controlled by 2B001.**

**License Requirements**

*Reason for Control:* NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
NP applies to entire entry	NP Column 2
AT applies to entire entry	AT Column 1

**License Exceptions**



LVS: N/A  
 GBS: N/A  
 CIV: N/A

**List of Items Controlled**

*Unit:* Equipment in number; parts and accessories in \$ value  
*Related Controls:* N/A  
*Related Definition:* N/A  
*Items:*

- a. Turning machines or combination turning/milling machines that are capable of machining diameters greater than 2.5 meters.
- b. Reserved.

**2B350 Chemical manufacturing facilities and equipment, as follows (see List of Items Controlled).**

**License Requirements**

*Reason for Control:* CB, AT

<i>Control(s)</i>	<i>Country Chart</i>
CB applies to entire entry	CB Column 3
AT applies to entire entry	AT Column 1

**License Exceptions**

LVS: N/A  
 GBS: N/A  
 CIV: N/A

**List of Items Controlled**

*Unit:* Equipment in number  
*Related Controls:* The controls in this entry do not apply to equipment that is: a.) specially designed for use in civil applications (e.g., food processing, pulp and paper processing, or water purification); AND b.) inappropriate, by the nature of its design, for use in storing,

processing, producing or conducting and controlling the flow of chemical weapons precursors controlled by 1C350.

*Related Definitions:* For purposes of this entry the term "chemical warfare agents" are those agents subject to the export licensing authority of the U.S. Department of State, Office of Defense Trade Controls. (See 22 CFR part 121)

*Items:*

- a. Reaction vessels or reactors, with or without agitators, with total internal (geometric) volume greater than 0.1 m<sup>3</sup> (100 liters) and less than 20 m<sup>3</sup> (20,000 liters), where all surfaces that come in direct contact with the chemical(s) being processed or contained are made from any of the following materials:

- a.1. Alloys with more than 25% nickel and 20% chromium by weight;
- a.2. Fluoropolymers;
- a.3. Glass (including vitrified or enamelled coating or glass lining);
- a.4. Nickel or alloys with more than 40% nickel by weight;
- a.5. Tantalum or tantalum alloys;
- a.6. Titanium or titanium alloys; *or*
- a.7. Zirconium or zirconium alloys;

- b. Agitators for use in reaction vessels or reactors where all surfaces of the agitator that come in direct contact with the chemical(s) being processed or contained are made from any of the following materials:

- b.1. Alloys with more than 25% nickel and 20% chromium by weight;
- b.2. Fluoropolymers;

b.3. Glass (including vitrified or enamelled coatings or glass lining);

b.4. Nickel or alloys with more than 40% nickel by weight;

b.5. Tantalum or tantalum alloys;

b.6. Titanium or titanium alloys; *or*

b.7. Zirconium or zirconium alloys;

c. Storage tanks, containers or receivers with a total internal (geometric) volume greater than 0.1 m<sup>3</sup> (100 liters) where all surfaces that come in direct contact with the chemical(s) being processed or contained are made from any of the following materials:

c.1. Alloys with more than 25% nickel and 20% chromium by weight;

c.2. Fluoropolymers;

c.3. Glass (including vitrified or enamelled coatings or glass lining);

c.4. Nickel or alloys with more than 40% nickel by weight;

c.5. Tantalum or tantalum alloys;

c.6. Titanium or titanium alloys; *or*

c.7. Zirconium or zirconium alloys;

d. Heat exchangers or condensers with a heat transfer surface area of less than 20 m<sup>2</sup>, but greater than 0.15 m<sup>2</sup>, where all surfaces that come in direct contact with the chemical(s) being processed are made from any of the following materials:

d.1. Alloys with more than 25% nickel and 20% chromium by weight;

d.2. Fluoropolymers;

d.3. Glass (including vitrified or enamelled coatings or glass lining);

d.4. Graphite or carbon-graphite;

d.5. Nickel or alloys with more than 40% nickel by weight;

d.6. Silicon carbide;

d.7. Tantalum or tantalum alloys;

d.8. Titanium or titanium alloys;

d.9. Titanium carbide; *or*

d.10. Zirconium or zirconium alloys

e. Distillation or absorption columns of internal diameter greater than 0.1 m, where all surfaces that come in direct contact with the chemical(s) being processed are made from any of the following materials:

e.1. Alloys with more than 25% nickel and 20% chromium by weight;

e.2. Fluoropolymers;

e.3. Glass (including vitrified or enamelled coatings or glass lining);

e.4. Graphite or carbon-graphite;

e.5. Nickel or alloys with more than 40% nickel by weight;

e.6. Tantalum or tantalum alloys;

e.7. Titanium or titanium alloys; *or*

e.8. Zirconium or zirconium alloys;

f. Remotely operated filling equipment in which all surfaces that come in direct contact with the chemical(s) being processed are made from any of the following materials:

f.1. Alloys with more than 25% nickels and 20% chromium by weight; *or*

f.2. Nickel or alloys with more than 40% nickel by weight;

g. Multiple seal valves incorporating a leak detection port, bellows-seal valves, non-return (check) valves or diaphragm valves, in which all surfaces that come in to direct contact with the chemical(s) being processed or contained are made from any of the following materials:

g.1. Alloys with more than 25% nickel and 20% chromium by weight;

g.2. Fluoropolymers;

g.3. Glass (including vitrified or enamelled coatings or glass lining);

g.4. Nickel or alloys with more than 40% nickel by weight;

g.5. Tantalum or tantalum alloys;

g.6. Titanium or titanium alloys; *or*

g.7. Zirconium or zirconium alloys;

h. Multi-walled piping incorporating a leak detection port, in which all surfaces that come in direct contact with the chemical(s) being processed or contained are made from any of the following materials:

h.1. Alloys with more than 25% nickel and 20% chromium by weight;

h.2. Fluoropolymers;

h.3. Glass (including vitrified or enamelled coatings or glass lining);

h.4. Graphite or carbon-graphite;

h.5. Nickel or alloys with more than 40% nickel by weight;

h.6. Tantalum or tantalum alloys;

h.7. Titanium or titanium alloys; *or*

h.8. Zirconium or zirconium alloys;

i. Multiple-seal, canned drive, magnetic drive, bellows or diaphragm pumps, with manufacturer's specified maximum flow-rate greater than 0.6 m<sup>3</sup>/hour, or vacuum pumps with manufacturer's specified maximum flow-rate greater than 5 m<sup>3</sup>/hour (under standard temperature (273 K (0° C)) and pressure (101.3 kPa) conditions), in which all surfaces that come into direct contact with the chemical(s) being processed are made from any of the of the following materials:

i.1. Alloys with more than 25% nickel and 20% chromium by weight;

i.2. Ceramics;

i.3. Ferrosilicon;

i.4. Fluoropolymers;

i.5. Glass (including vitrified or enamelled coatings or glass lining);

i.6. Graphite or carbon-graphite;

i.7. Nickel or alloys with more than 40% nickel by weight;

i.8. Tantalum or tantalum alloys;

i.9. Titanium or titanium alloys, *or*

i.10. Zirconium or zirconium alloys;

j. Incinerators designed to destroy chemical warfare agents, or chemical weapons precursors controlled by 1C350, having specially designed waste supply systems, special handling facilities

and an average combustion chamber temperature greater than 1000° C in which all surfaces in the waste supply system that come into direct contact with the waste products are made from or lined with any of the following materials:

j.1. Alloys with more than 25% nickel and 20% chromium by weight;

j.2. Ceramics; *or*

j.3. Nickel or alloys with more than 40% nickel by weight.

**Technical Note:** Carbon-graphite is a composition consisting primarily of graphite and amorphous carbon, in which the graphite is 8 percent or more by weight of the composition.

**2B351 Toxic gas monitoring systems that operate on-line and dedicated detectors therefor.**

**License Requirements**

*Reason for Control:* CB, AT

<i>Control(s)</i>	<i>Country Chart</i>
CB applies to entire entry	CB Column 3
AT applies to entire entry	AT Column 1

**License Exceptions**

LVS: N/A  
 GBS: N/A  
 CIV: N/A

**List of Items Controlled**

*Unit:* Equipment in number  
*Related Controls:* N/A  
*Related Definitions:* For the purposes of this entry, the term “continuous operation” describes the capability of the equipment to

operate on line without human intervention. The intent of this entry is to control toxic gas monitoring systems capable of collection and detection of samples in environments such as chemical plants, rather than those used for batch-mode operation in laboratories.

*Items:*

a. Designed for continuous operation and usable for the detection of chemical warfare agents or chemicals controlled by 1C350 at concentrations of less than 0.3mg/m<sup>3</sup> (see technical note below); *or*

b. Designed for the detection of cholinesterase-inhibiting activity.

**Technical Note:** Toxic Gas Monitoring Systems, controlled under 2B351.a., include those with detection capability for chemicals containing phosphorus, sulfur, fluorine or chlorine, other than those specified in 1C350.

**2B352 Equipment capable of use in handling biological materials, as follows (see List of Items Controlled).**

**License Requirements**

*Reason for Control:* CB, AT

<i>Control(s)</i>	<i>Country Chart</i>
CB applies to entire entry	CB Column 3
AT applies to entire entry	AT Column 1

**License Exceptions**

LVS: N/A  
 GBS: N/A  
 CIV: N/A

**List of Items Controlled**

*Unit:* Equipment in number

*Related Controls:* N/A

*Related Definitions:* For purposes of this entry, isolators include flexible isolators, dry boxes, anaerobic chambers and glove boxes.

*Items:*

a. Complete containment facilities at P3 or P4 containment level;

**Technical Note:** P3 or P4 (BL3, BL4, L3, L4) containment levels are as specified in the World Health Organization Laboratory Biosafety Manual (Geneva, 1983).

b. Fermenters capable of cultivation of pathogenic microorganisms, viruses, or for toxin production, without the propagation of aerosols, having a capacity equal to or greater than 100 liters.

**Technical Note:** Fermenters include bioreactors, chemostats, and continuous-flow systems.

c. Centrifugal separators capable of the continuous separation of pathogenic microorganisms, without the propagation of aerosols, and having all of the following characteristics:

c.1. One or more sealing joints within the steam containment area;

c.2. A flow rate greater than 100 liters per hour;

c.3. Components of polished stainless steel or titanium; *and*

c.4. Capable of *in situ* steam sterilization in a closed state.

**Technical Note:** Centrifugal separators include decanters.

d. Cross (tangential) flow filtration equipment capable of continuous separation of pathogenic

microorganisms, viruses, toxins, and cell cultures without the propagation of aerosols, having all of the following characteristics:

d.1. Equal to or greater than 5 square meters;

d.2. Capable of *in situ* sterilization.

e. Steam sterilizable freeze-drying equipment with a condenser capacity greater than 50 kgs of ice in 24 hours but less than 1,000 kgs;

f. Equipment that incorporates or is contained in P3 or P4 containment housing, as follows:

f.1. Independently ventilated protective full or half suits;

f.2. Class III biological safety cabinets or isolators with similar performance standards;

g. Chambers designed for aerosol challenge testing with microorganisms, viruses, or toxins and having a capacity of 1 m<sup>3</sup> or greater.

**2B991 Numerical control units for machine tools and "numerically controlled" machine tools, n.e.s.**

**License Requirements**

*Reason for Control:* AT

<i>Control(s)</i>	<i>Country Chart</i>
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AT applies to entire entry	AT Column 1
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**License Exceptions**

LVS: N/A

GBS: N/A

CIV: N/A

**List of Items Controlled**

*Unit:* Equipment in number

*Related Controls:* N/A

*Related Definitions:* N/A

*Items:*

a. "Numerical control" units for machine tools:

a.1. Having four interpolating axes that can be coordinated simultaneously for "contouring control"; *or*

a.2. Having two or more axes that can be coordinated simultaneously for "contouring control" and a minimum programmable increment better (less) than 0.001 mm;

a.3. "Numerical control" units for machine tools having two, three or four interpolating axes that can be coordinated simultaneously for "contouring control", and capable of receiving directly (on-line) and processing computer-aided-design (CAD) data for internal preparation of machine instructions; *or*

b. "Motion control boards" specially designed for machine tools and having any of the following characteristics:

b.1. Interpolation in more than four axes;

b.2. Capable of "real time processing" of data to modify tool path, feed rate and spindle data, during the machining operation, by any of the following:

b.2.a. Automatic calculation and modification of part program data for machining in two or more axes by means of measuring cycles and access to source data; *or*

b.2.b. "Adaptive control" with more than one physical variable measured and processed by means of a computing model (strategy) to change one or more machining instructions to optimize the process.

b.3. Capable of receiving and processing CAD data for internal preparation of machine instructions; *or*

c. "Numerically controlled" machine tools that, according to the manufacturer's technical specifications, can be equipped with electronic devices for simultaneous "contouring control" in two or more axes and that have both of the following characteristics:

c.1. Two or more axes that can be coordinated simultaneously for contouring control; *and*

c.2. "Positioning accuracies", with all compensations available:

c.2.a. Better than 0.020 mm along any linear axis (overall positioning) for grinding machines;

c.2.b. Better than 0.020 mm along any linear axis (overall positioning) for milling machines; *or*

c.2.c. Better than 0.020 mm along any linear axis (overall positioning) for turning machines; *or*

d. Machine tools, as follows, for removing or cutting metals, ceramics or composites, that, according to the manufacturer's technical specifications, can be equipped with electronic devices for simultaneous "contouring control" in two or more axes:

d.1. Machine tools for turning, grinding, milling or any combination thereof, having two or more axes that can be coordinated simultaneously for "contouring control" and having any of the following characteristics:

d.1.a. One or more contouring "tilting spindles";

**Note:** 2B991.d.1.a. applies to machine tools for grinding or milling only.

d.1.b. "Camming" (axial displacement) in one revolution of the spindle less (better) than 0.0006 mm total indicator reading (TIR);

**Note:** 2B991.d.1.b. applies to machine tools for turning only.

d.1.c. "Run out" (out-of-true running) in one revolution of the spindle less (better) than 0.0006 mm total indicator reading (TIR);

d.1.d. The "positioning accuracies", with all compensations available, are less (better) than: 0.001° on any rotary axis;

d.2. Electrical discharge machines (EDM) of the wire feed type that have five or more axes that can be coordinated simultaneously for "contouring control".

**2B992 Non-"numerically controlled" machine tools for generating optical quality surfaces, and specially designed components therefor.**

**License Requirements**

*Reason for Control:* AT

<i>Control(s)</i>	<i>Country Chart</i>
AT applies to entire entry	AT Column 1

**License Exceptions**

- LVS: N/A
- GBS: N/A
- CIV: N/A

**List of Items Controlled**

*Unit:* Equipment in number  
*Related Controls:* N/A  
*Related Definitions:* N/A

*Items:*

a. Turning machines using a single point cutting tool and having all of the following characteristics:

a.1. Slide positioning accuracy less (better) than 0.0005 mm per 300 mm of travel;

a.2. Bidirectional slide positioning repeatability less (better) than 0.00025 mm per 300 mm of travel;

a.3. Spindle "run out" and "camming" less (better) than 0.0004 mm total indicator reading (TIR);

a.4. Angular deviation of the slide movement (yaw, pitch and roll) less (better) than 2 seconds of arc, TIR, over full travel; *and*

a.5. Slide perpendicularity less (better) than 0.001 mm per 300 mm of travel;

**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.

b. Fly cutting machines having all of the following characteristics:

b.1. Spindle "run out" and "camming" less (better) than 0.0004 mm TIR; *and*

b.2. Angular deviation of slide movement (yaw, pitch and roll) less (better) than 2 seconds of arc, TIR, over full travel.

**2B993 Gearmaking and/or finishing machinery not controlled by 2B003 capable of producing gears to a quality level of better than AGMA 11.**

**License Requirements**

*Reason for Control:* AT

*Control(s)*

*Country Chart*

AT applies to entire entry

AT Column 1

**License Exceptions**

LVS: N/A

GBS: N/A

CIV: N/A

**List of Items Controlled**

*Unit:* \$ value

*Related Controls:* N/A

*Related Definitions:* N/A

*Items:*

The list of items controlled is contained in the ECCN heading.

**2B996 Dimensional inspection or measuring systems or equipment not controlled by 2B006.**

**License Requirements**

*Reason for Control:* AT

*Control(s)*

*Country Chart*

AT applies to entire entry

AT Column 1

**License Exceptions**

LVS: N/A

GBS: N/A

CIV: N/A

**List of Items Controlled**

*Unit:* Equipment in number

*Related Controls:* N/A

*Related Definitions:* N/A

*Items:*

a. Manual dimensional inspection machines, having both of the following characteristics:

a.1. Two or more axes; *and*

a.2. A measurement uncertainty equal to or less (better) than  $(3 + L/300)$  micrometer in any axes (L measured length in mm).

**2B997 "Robots" not controlled by 2B007 or 2B207 that are capable of employing feedback information in real-time processing from one or more sensors to generate or modify "programs" or to generate or modify numerical program data.**

**License Requirements**

*Reason for Control:* AT

*Control(s)*

*Country Chart*

AT applies to entire entry

AT Column 1

**License Exceptions**

LVS: N/A

GBS: N/A

CIV: N/A

**List of Items Controlled**

*Unit:* \$ value

*Related Controls:* N/A

*Related Definitions:* N/A

*Items:*

The list of items controlled is contained in the ECCN heading.

**2B998 Assemblies, units or inserts specially designed for machine tools controlled by**



**2B991, or for equipment controlled by 2B993, 2B996 or 2B997.**

**License Requirements**

*Reason for Control:* AT

*Control(s)* Country Chart

AT applies to entire entry AT Column 1

**License Exceptions**

LVS: N/A  
 GBS: N/A  
 CIV: N/A

**List of Items Controlled**

*Unit:* \$ value

*Related Controls:* This entry 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.

*Related Definition:* N/A

*Items:*

- 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 total indicator reading (TIR);
- b. Single point diamond cutting tool inserts, having all of the following characteristics:
  - b.1. Flawless and chip-free cutting edge when magnified 400 times in any direction;
  - b.2. Cutting radius from 0.1 to 5 mm inclusive; *and*
  - b.3. Cutting radius out-of-roundness less (better) than 0.002 mm TIR.

- c. Specially designed printed circuit boards with mounted components 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 ECCNs 2B991, 2B993, 2B996, 2B997, or 2B998.

**2B999 Specific processing equipment, n.e.s., as follows (see List of Items Controlled).**

**License Requirements**

*Reason for Control:* AT

*Control(s)* Country Chart

AT applies to entire entry. A license is required for items controlled by this entry to North Korea for anti-terrorism reasons. The Commerce Country Chart is not designed to determine AT licensing requirements for this entry. See §742.19 of the EAR for additional information.

**License Exceptions**

LVS: N/A  
 GBS: N/A  
 CIV: N/A

**List of Items Controlled**

*Unit:* \$ value

*Related Controls:* See also 0B001, 0B002, 0B004, 1B233, 2A293, 2B001.f, 2B004, 2B009, 2B104, 1B109, 2B204, 2B209, 2B228, 2B229, 2B231, 2B350.

*Related Definitions:* N/A

*Items:*

- a. Isostatic presses, n.e.s.;
- b. Bellows manufacturing equipment, including hydraulic forming equipment and bellows forming dies;
- c. Laser welding machines;

- d. MIG welders;
- e. E-beam welders;
- f. Monel equipment, including valves, piping, tanks and vessels;
- g. 304 and 316 stainless steel valves, piping, tanks and vessels;
- h. Mining and drilling equipment, as follows:
  - h.1. Large boring equipment capable of drilling holes greater than two feet in diameter;
  - h.2. Large earth-moving equipment used in the mining industry;
- i. Electroplating equipment designed for coating parts with nickel or aluminum;
- j. Pumps designed for industrial service and for use with an electrical motor of 5 HP or greater;
- k. Vacuum valves, piping, flanges, gaskets and related equipment specially designed for use in high-vacuum service, n.e.s.;
- l. Spin forming and flow forming machines, n.e.s.;
- m. Centrifugal multiplane balancing machines, n.e.s.;
- n. Austenitic stainless steel plate, valves, piping, tanks and vessels.

**D. SOFTWARE**

**2D001 "Software", other than that controlled by 2D002, specially designed or modified for the "development", "production" or "use" of equipment controlled by 2A001 or 2B001 to 2B009.**

**License Requirements**

*Reason for Control:* NS, MT, NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
NS applies to entire entry	NS Column 1
MT applies to "software" for equipment controlled by 2B004 and 2B009 for MT reasons	MT Column 1
NP applies to specially designed or modified "software" for equipment controlled by 2B001 for NP reasons, and to specially designed "software" for equipment controlled by 2B004, 2B006, 2B007, or 2B009 for NP reasons	NP Column 1
AT applies to entire entry	AT Column 1

**License Requirement Notes:** See §743.1 of the EAR for reporting requirements for exports under License Exceptions.

**License Exceptions**

CIV: N/A  
 TSR: Yes, except N/A for MT

**List of Items Controlled**

*Unit:* N/A

**C. MATERIALS [RESERVED]**

*Related Controls:* This entry controls software, not covered by 2D101, that are specially designed or modified for the controllers of flow forming machines specified by 2B109.

*Related Definitions:* N/A

*Items:*

The list of items controlled is contained in the ECCN heading.

**2D002 "Software" for electronic devices, even when residing in an electronic device or system, enabling such devices or systems to function as a "numerical control" unit, capable of any of the following (see List of Items Controlled).**

**License Requirements**

*Reason for Control:* NS, NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
NS applies to entire entry	NS Column 1
NP applies to entire entry, except 2D002.b	NP Column 1
AT applies to entire entry	AT Column 1

**License Exceptions**

CIV: N/A

TSR: Yes

**List of Items Controlled**

*Unit:* \$ value

*Related Controls:* 1.) See also 2D202. 2.) This entry does not control "software" specially designed or modified for the operation of machine tools not controlled by Category 2.

*Related Definitions:* N/A

*Items:*

a. Coordinating simultaneously more than 4 axes for "contouring control"; *or*

b. "Real time processing" of data to modify tool path, feed rate and spindle data, during the machining operation, by any of the following:

b.1. Automatic calculation and modification of part program data for machining in two or more axes by means of measuring cycles and access to source data; *or*

b.2. "Adaptive control" with more than one physical variable measured and processed by means of a computing model (strategy) to change one or more machining instructions to optimize the process.

**2D018 "Software" for the "development", "production" or "use" of equipment controlled by 2B018.**

**License Requirements**

*Reason for Control:* NS, MT, AT, UN

<i>Control(s)</i>	<i>Country Chart</i>
NS applies to entire entry	NS Column 1
MT applies to "software" for equipment controlled by 2B018 for MT reasons	MT Column 1
AT applies to entire entry	AT Column 1

UN applies to entire entry. Rwanda; Federal Republic of Yugoslavia (Serbia and Montenegro).

**License Exceptions**

CIV: N/A

TSR: Yes, except N/A for Rwanda and the Federal Republic of Yugoslavia (Serbia and Montenegro).

**2D201 "Software" specially designed for the "use" of equipment controlled by 2B204, 2B206, 2B207, 2B209, 2B227 or 2B229.**

**List of Items Controlled**

*Unit:* \$ value  
*Related Controls:* N/A  
*Related Definitions:* N/A  
*Items:*

The list of items controlled is contained in the ECCN heading.

**2D101 "Software" specially designed for the "use" of equipment controlled by 2B104, 2B109 or 2B116.**

**License Requirements**

*Reason for Control:* NS, MT, AT

<i>Control(s)</i>	<i>Country Chart</i>
NS applies to entire entry	NS Column 1
MT applies to entire entry	MT Column 1
AT applies to entire entry	AT Column 1

**License Exceptions**

CIV: N/A  
 TSR: N/A

**List of Items Controlled**

*Unit:* \$ value  
*Related Controls:* See also 9D004  
*Related Definitions:* N/A  
*Items:*

The list of items controlled is contained in the ECCN heading.

**License Requirements**

*Reason for Control:* NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
NP applies to entire entry	NP Column 1
AT applies to entire entry	AT Column 1

**License Exceptions**

CIV: N/A  
 TSR: N/A

**List of Items Controlled**

*Unit:* \$ value  
*Related Controls:* N/A  
*Related Definitions:* N/A  
*Items:*

The list of items controlled is contained in the ECCN heading.

**2D202 "Software" specially designed or modified for the "development", "production" or "use" of equipment controlled by 2B201.**

**License Requirements**

*Reason for Control:* NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
NP applies to entire entry	NP Column 1
AT applies to entire entry	AT Column 1

**License Exceptions**

CIV: N/A

TSR: N/A

**equipment controlled by 2B991, 2B993, or 2B996, 2B997, and 2B998.**

**List of Items Controlled**

*Unit:* \$ value  
*Related Controls:* N/A  
*Related Definitions:* N/A  
*Items:*

The list of items controlled is contained in the ECCN heading.

**2D290 "Software" specially designed or modified for the "development", "production" or "use" of items controlled by 2A290, 2A291, 2A292, 2A293, or 2B290.**

**License Requirements**

*Reason for Control:* NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
NP applies to entire entry	NP Column 2
AT applies to entire entry	AT Column 1

**License Exceptions**

CIV: N/A  
 TSR: N/A

**List of Items Controlled**

*Unit:* \$ value  
*Related Controls:* N/A  
*Related Definitions:* N/A  
*Items:*

The list of items controlled is contained in the ECCN heading.

**2D991 "Software" specially designed for the "development", "production", or "use" of**

**License Requirements**

*Reason for Control:* AT

<i>Control(s)</i>	<i>Country Chart</i>
AT applies to entire entry	AT Column 1

**License Exceptions**

CIV: N/A  
 TSR: N/A

**List of Items Controlled**

*Unit:* \$ value  
*Related Controls:* N/A  
*Related Definitions:* N/A  
*Items:*

The list of items controlled is contained in the ECCN heading.

**2D992. Specific "software", as follows (see List of Items Controlled).**

**License Requirements**

*Reason for Control:* AT

<i>Control(s)</i>	<i>Country Chart</i>
AT applies to entire entry	AT Column 1

**License Exceptions**

CIV: N/A  
 TSR: N/A

**List of Items Controlled**

*Unit:* \$ value  
*Related Controls:* N/A

*Related Definitions:* N/A

*Items:*

a. "Software" to provide "adaptive control" and having both of the following characteristics:

a.1. For "flexible manufacturing units" (FMUs) which consist at least of equipment described in b.1 and b.2 of the definition of "flexible manufacturing unit" contained in part 772 of the EAR; *and*

a.2. Capable of generating or modifying, in "real time processing", programs or data by using the signals obtained simultaneously by means of at least two detection techniques, such as:

a.2.a. Machine vision (optical ranging);

a.2.b. Infrared imaging;

a.2.c. Acoustical imaging (acoustical ranging);

a.2.d. Tactile measurement;

a.2.e. Inertial positioning;

a.2.f. Force measurement; *and*

a.2.g. Torque measurement.

**Note:** 2D992.a does not control "software" which only provides rescheduling of functionally identical equipment within "flexible manufacturing units" using pre-stored part programs and a pre-stored strategy for the distribution of the part programs.

b. Reserved.

**2D994 "Software" specially designed for the "development" or "production" of portable electric generators controlled by 2A994.**

**License Requirements**

*Reason for Control:* AT

*Control(s)*

AT applies to entire entry. A license is required for items controlled by this entry to Cuba, Iran, Libya, and North Korea for anti-terrorism reasons. The Commerce Country Chart is not designed to determine licensing requirements for this entry. See part 746 of the EAR for additional information on Cuba, Iran, and Libya. See §742.19 of the EAR for additional information on North Korea.

**License Exceptions**

CIV: N/A

TSR: N/A

**List of Items Controlled**

*Unit:* \$ value

*Related Controls:* N/A

*Related Definitions:* N/A

*Items:*

The list of items controlled is contained in the ECCN heading.

**E. TECHNOLOGY**

**2E001 "Technology" according to the General Technology Note for the "development" of equipment or "software" controlled by 2A (except 2A991, 2A993, or 2A994), 2B (except 2B991, 2B993, 2B996, 2B997, or 2B998), or 2D (except 2D991, 2D992, or 2D994).**

**License Requirements**

*Reason for Control:* NS, MT, NP, CB, AT

*Control(s)*

*Country Chart*

NS applies to "technology"

NS Column 1

for items controlled by  
2A001, 2B001 to  
2B009, 2D001 or 2D002

The list of items controlled is contained in the  
ECCN heading.

MT applies to "technology" MT Column 1  
for items controlled by  
2B004, 2B009, 2B018, 2B104,  
2B109, 2B116, 2D001 or 2D101  
for MT reasons

**2E002 "Technology" according to the General  
Technology Note for the "production" of  
equipment controlled by 2A (except 2A991,  
2A993, or 2A994), or 2B (except 2B991, 2B993,  
2B996, 2B997, or 2B998).**

NP applies to "technology" NP Column 1  
for items controlled by  
2B001, 2B004, 2B006, 2B007  
2B009, 2B104, 2B109, 2B204  
2B206, 2B207, 2B209, 2B225,  
2B226, 2B228, 2B229, 2B231,  
2D001, 2D002, or 2D201  
for NP reasons

**License Requirements**

*Reason for Control:* NS, MT, NP, CB, AT

<i>Control(s)</i>	<i>Country Chart</i>
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NS applies to "technology" for equipment controlled by 2A001, 2B001 to 2B009	NS Column 1
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NP applies to "technology" NP Column 2  
for equipment controlled by  
2A290

MT applies to "technology" for equipment controlled by 2B004, 2B009, 2B018, 2B104, 2B109, and 2B116 for MT reasons	MT Column 1
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CB applies to "technology" CB Column 3  
for equipment controlled  
by 2B350 to 2B352

NP applies to "technology" for equipment controlled by 2B001, 2B004, 2B006, 2B007, 2B009, 2B104, 2B109, 2B204, 2B206, 2B207, 2B209, 2B225, 2B226, 2B228, 2B229, or 2B231 for NP reasons	NP Column 1
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AT applies to entire entry AT Column 1

**License Requirement Notes:** See §743.1 of  
the EAR for reporting requirements for exports  
under License Exceptions.

**License Exceptions**

CIV: N/A  
TSR: Yes, except N/A for MT

NP applies to "technology" for equipment controlled by 2A290	NP Column 2
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**List of Items Controlled**

*Unit:* N/A  
*Related Controls:* See also 2E101, 2E201,  
and 2E301  
*Related Definitions:* N/A  
*Items:*

CB applies to "technology" for equipment controlled by 2B350 to 2B352	CB Column 3
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AT applies to entire entry	AT Column 1
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**License Requirement Notes:** See §743.1 of the EAR for reporting requirements for exports under License Exceptions.

**License Exceptions**

CIV: N/A  
TSR: Yes, except N/A for MT

**List of Items Controlled**

*Unit:* N/A  
*Related Controls:* N/A  
*Related Definitions:* N/A  
*Items:*

The list of items controlled is contained in the ECCN heading.

**2E003 Other "technology", as follows (see List of Items Controlled).**

**License Requirements**

*Reason for Control:* NS, AT

<i>Control(s)</i>	<i>Country Chart</i>
NS applies to entire entry	NS Column 1
AT applies to entire entry	AT Column 1

**License Exceptions**

CIV: N/A  
TSR: Yes, except 2E003.a, .b, .e and .f

**List of Items Controlled**

*Unit:* N/A  
*Related Controls:* See 2E001, 2E002, and 2E101 for “development” and “use” technology for equipment that are designed or modified for densification of carbon-carbon

composites, structural composite rocket nozzles and reentry vehicle nose tips.

*Related Definitions:* N/A

*Items:*

- a. "Technology" for the "development" of interactive graphics as an integrated part in



"numerical control" units for preparation or modification of part programs;

b. "Technology" for metal-working manufacturing processes, as follows:

b.1. "Technology" for the design of tools, dies or fixtures specially designed for any of the following processes:

b.1.a. "Superplastic forming";

b.1.b. "Diffusion bonding"; *or*

b.1.c. "Direct-acting hydraulic pressing";

b.2. Technical data consisting of process methods or parameters as listed below used to control:

b.2.a. "Superplastic forming" of aluminum alloys, titanium alloys or "superalloys":

b.2.a.1. Surface preparation;

b.2.a.2. Strain rate;

b.2.a.3. Temperature;

b.2.a.4. Pressure;

b.2.b. "Diffusion bonding" of "superalloys" or titanium alloys:

b.2.b.1. Surface preparation;

b.2.b.2. Temperature;

b.2.b.3. Pressure;

b.2.c. "Direct-acting hydraulic pressing" of aluminum alloys or titanium alloys:

b.2.c.1. Pressure;

b.2.c.2. Cycle time;

b.2.d. "Hot isostatic densification" of titanium alloys, aluminum alloys or "superalloys":

b.2.d.1. Temperature;

b.2.d.2. Pressure;

b.2.d.3. Cycle time;

c. "Technology" for the "development" or "production" of hydraulic stretch-forming machines and dies therefor, for the manufacture of airframe structures;

d. "Technology" for the "development" of generators of machine tool instructions (e.g., part programs) from design data residing inside "numerical control" units;

e. "Technology" for the development" of integration "software" for incorporation of expert systems for advanced decision support of shop floor operations into "numerical control" units;

f. "Technology" for the application of inorganic overlay coatings or inorganic surface modification coatings (specified in column 3 of the following table) to non-electronic substrates (specified in column 2 of the following table), by processes specified in column 1 of the following table and defined in the Technical Note.

**N.B.** This table should be read to control the technology of a particular 'Coating Process' only when the 'Resultant Coating' in column 3 is in a paragraph directly across from the relevant 'Substrate' under column 2. For example, Chemical Vapor Deposition (CVD) coating process technical data are controlled for the application of 'silicides' to 'Carbon-carbon, Ceramic and Metal "matrix" "composites" substrates, but are not controlled for the application of 'silicides' to 'Cemented tungsten carbide (16), Silicon carbide (18)' substrates. In the second case, the 'Resultant Coating' is not listed in the paragraph under column 3 directly across from the paragraph under column 2 listing

'Cemented tungsten carbide (16), Silicon carbide (18)'

**Category 2E - Materials Processing Table; Deposition Techniques**

1. <i>Coating Process</i> (1) <sup>1</sup>	2. <i>Substrate</i>	3. <i>Resultant Coating</i>
A. Chemical Vapor Deposition (CVD)	"Superalloys"	Aluminides for internal passages
	Ceramics (19) and Low-expansion glasses(14)	Silicides Carbides Dielectric layers (15) Diamond Diamond-like carbon (17)
	Carbon-carbon, Ceramic, and Metal "matrix" "composites"	Silicides Carbides Refractory metals Mixtures thereof (4) Dielectric layers (15) Aluminides Alloyed aluminides (2) Boron nitride
	Cemented tungsten carbide (16), Silicon carbide (18)	Carbides Tungsten Mixtures thereof (4) Dielectric layers (15)
	Molybdenum and Molybdenum alloys	Dielectric layers (15)
	Beryllium and Beryllium alloys	Dielectric layers (15) Diamond Diamond-like carbon (17)
	Sensor window materials (9)	Dielectric layers (15) Diamond Diamond-like carbon (17)

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<sup>1</sup> The numbers in parenthesis refer to the Notes following this Table.

1. <i>Coating Process</i> (1) <sup>2</sup>	2. <i>Substrate</i>	3. <i>Resultant Coating</i>
B. Thermal-Evaporation Physical Vapor Deposition (TE-PVD)		
B. 1. Physical Vapor Deposition (PVD): Electron-Beam (EB-PVD)	"Superalloys"	Alloyed silicides Alloyed aluminides (2) MCrAlX (5) Modified zirconia (12) Silicides Aluminides Mixtures thereof (4)
	Ceramics (19) and Low-expansion glasses (14)	Dielectric layers (15)
	Corrosion resistant steel (7)	MCrAlX (5) Modified zirconia (12) Mixtures thereof (4)
	Carbon-carbon, Ceramic and Metal "matrix" "composites"	Silicides Carbides Refractory metals Mixtures thereof (4) Dielectric layers (15) Boron nitride
	Cemented tungsten carbide (16), Silicon carbide (18)	Carbides Tungsten Mixtures thereof (4) Dielectric layers (15)
	Molybdenum and Molybdenum alloys	Dielectric layers (15)
	Beryllium and Beryllium alloys	Dielectric layers (15) Borides Beryllium
	Sensor window materials (9)	Dielectric layers (15)
	Titanium alloys (13)	Borides Nitrides

<sup>2</sup> The numbers in parenthesis refer to the Notes following this Table.

1. <i>Coating Process</i> (1) <sup>3</sup>	2. <i>Substrate</i>	3. <i>Resultant Coating</i>
B.2. Ion assisted resistive heating Physical Vapor Deposition (PVD)(Ion Plating)	Ceramics (19) and Low-expansion glasses (14)	Dielectric layers (15) Diamond-like carbon (17)
	Carbon-carbon, Ceramic and Metal "matrix" "composites"	Dielectric layers (15)
	Cemented tungsten carbide (16) Silicon carbide	Dielectric layers (15)
	Molybdenum and Molybdenum alloys	Dielectric Layers (15)
	Beryllium and Beryllium alloys	Dielectric layers (15)
	Sensor window materials (9)	Dielectric Layers (15) Diamond-like carbon (17)
B.3. Physical Vapor Deposition (PVD): "Laser" Vaporization	Ceramics (19) and Low-expansion glasses (14)	Silicides Dielectric layers (15) Diamond-like carbon (17)
	Carbon-carbon,Ceramic and Metal "matrix" "composites"	Dielectric layers (15)
	Cemented tungsten carbide (16), Silicon carbide	Dielectric Layers (15)
	Molybdenum and Molybdenum alloys	Dielectric layers (15)
	Beryllium and Beryllium alloys	Dielectric layers (15)
	Sensor window materials (9)	Dielectric layers (15) Diamond-like carbon
B.4. Physical Vapor Deposition (PVD): Cathodic Arc Discharge.	"Superalloys"	Alloyed silicides Alloyed Aluminides (2) MCrAlX (5)
	Polymers (11) and Organic "matrix" "composites"	Borides Carbides Nitrides Diamond-like carbon (17)

<sup>3</sup> The numbers in parenthesis refer to the Notes following this Table.

1. <i>Coating Process</i> (1) <sup>4</sup>	2. <i>Substrate</i>	3. <i>Resultant Coating</i>
C. Pack cementation (see A above for out-of-pack cementation) (10)	Carbon-carbon, Ceramic and Metal "matrix" composites"	Silicides Carbides Mixtures thereof (4)
	Titanium alloys (13)	Silicides Aluminides Alloyed aluminides (2)
	Refractory metals and alloys (8)	Silicides Oxides
D. Plasma spraying	"Superalloys"	MCrAlX (5) Modified zirconia (12) Mixtures thereof (4) Abradable Nickel-Graphite Abradable materials containing Ni-Cr-Al Abradable Al-Si-Polyester Alloyed aluminides (2)
	Aluminum alloys (6)	MCrAlX (5) Modified zirconia (12) Silicides Mixtures thereof (4)
	Refractory metals and alloys (8)	Aluminides Silicides Carbides
	Corrosion resistant steel (7)	MCrAlX (5) Modified zirconia (12) Mixtures thereof (4)

<sup>4</sup> The numbers in parenthesis refer to the Notes following this Table.

1. <i>Coating Process</i> (1) <sup>5</sup>	2. <i>Substrate</i>	3. <i>Resultant Coating</i>
D. Plasma spraying (continued)	Titanium alloys (13)	Carbides Aluminides Silicides Alloyed aluminides (2) Abradable materials containing Abradable Nickel-Graphite Ni-Cr-Al Abradable Al-Si-Polyester
E. Slurry Deposition	Refractory metals and alloys (8)	Fused silicides Fused aluminides except for resistance heating elements
	Carbon-carbon, Ceramic and Metal "matrix" "composites"	Silicides Carbides Mixtures thereof (4)
F. Sputter Deposition	"Superalloys"	Alloyed silicides Alloyed aluminides (2) Noble metal modified aluminides (3) MCrAlX (5) Modified zirconia (12) Platinum Mixtures thereof (4)
	Ceramics and Low-expansion glasses (14)	Silicides Platinum Mixtures thereof (4) Dielectric layers (15) Diamond-like carbon (17)
	Titanium alloys (13)	Borides Nitrides Oxides Silicides Aluminides Alloyed aluminides (2) Carbides
1. <i>Coating Process</i> (1) <sup>6</sup>	2. <i>Substrate</i>	3. <i>Resultant Coating</i>

<sup>5</sup> The numbers in parenthesis refer to the Notes following this Table.

<sup>6</sup> The numbers in parenthesis refer to the Notes following this Table.

F. Sputter Deposition (continued)	Carbon-carbon, Ceramic and Metal "matrix" "Composites"	Silicides Carbides Refractory metals Mixtures thereof (4) Dielectric layers (15) Boron nitride
	Cemented tungsten carbide (16), Silicon carbide (18)	Carbides Tungsten Mixtures thereof (4) Dielectric layers (15) Boron nitride
	Molybdenum and Molybdenum alloys	Dielectric layers (15)
	Beryllium and Beryllium alloys	Borides Dielectric layers (15) Beryllium
	Sensor window materials (9)	Dielectric layers (15) Diamond-like carbon (17)
	Refractory metals and alloys (8)	Aluminides Silicides Oxides Carbides
G. Ion Implantation	High temperature bearing steels	Additions of Chromium, Tantalum, or Niobium (Columbium)
	Titanium alloys (13)	Borides Nitrides
	Beryllium and Beryllium alloys	Borides
	Cemented tungsten carbide (16)	Carbides Nitrides

**Notes to Table on Deposition Techniques:**

1. The term 'coating process' includes coating repair and refurbishing as well as original coating.

2. The term 'alloyed aluminide coating'

includes single or multiple-step coatings in which an element or elements are deposited prior to or during application of the aluminide coating, even if these elements are deposited by another coating process. It does not, however, include the multiple use of single-step pack cementation



processes to achieve alloyed aluminides.

3. The term 'noble metal modified aluminide' coating includes multiple-step coatings in which the noble metal or noble metals are laid down by some other coating process prior to application of the aluminide coating.

4. The term 'mixtures thereof' includes infiltrated material, graded compositions, co-deposits and multilayer deposits and are obtained by one or more of the coating processes specified in the Table.

5. MCrAlX refers to a coating alloy where M equals cobalt, iron, nickel or combinations thereof and X equals hafnium, yttrium, silicon, tantalum in any amount or other intentional additions over 0.01 weight percent in various proportions and combinations, except:

a. CoCrAlY coatings which contain less than 22 weight percent of chromium, less than 7 weight percent of aluminum and less than 2 weight percent of yttrium;

b. CoCrAlY coatings which contain 22 to 24 weight percent of chromium, 10 to 12 weight percent of aluminum and 0.5 to 0.7 weight percent of yttrium; *or*

c. NiCrAlY coatings which contain 21 to 23 weight percent of chromium, 10 to 12 weight percent of aluminum and 0.9 to 1.1 weight percent of yttrium.

6. The term 'aluminum alloys' refers to alloys having an ultimate tensile strength of 190 MPa or more measured at 293 K (20 °C).

7. The term 'corrosion resistant steel' refers to AISI (American Iron and Steel Institute) 300 series or equivalent national standard steels.

8. 'Refractory metals and alloys' include the following metals and their alloys: niobium (columbium), molybdenum, tungsten and

tantalum.

9. 'Sensor window materials', as follows: alumina, silicon, germanium, zinc sulphide, zinc selenide, gallium arsenide, diamond, gallium phosphide, sapphire and the following metal halides: sensor window materials of more than 40 mm diameter for zirconium fluoride and hafnium fluoride.

10. "Technology" for single-step pack cementation of solid airfoils is not controlled by this Category.

11. 'Polymers', as follows: polyimide, polyester, polysulfide, polycarbonates and polyurethanes.

12. 'Modified zirconia' refers to additions of other metal oxides, (e.g., calcia, magnesia, yttria, hafnia, rare earth oxides) to zirconia in order to stabilize certain crystallographic phases and phase compositions. Thermal barrier coatings made of zirconia, modified with calcia or magnesia by mixing or fusion, are not controlled.

13. 'Titanium alloys' refers only to aerospace alloys having an ultimate tensile strength of 900 MPa or more measured at 293 K (20 °C).

14. 'Low-expansion glasses' refers to glasses which have a coefficient of thermal expansion of  $1 \times 10^{-7} \text{ K}^{-1}$  or less measured at 293 K (20°C).

15. 'Dielectric layers' are coatings constructed of multi-layers of insulator materials in which the interference properties of a design composed of materials of various refractive indices are used to reflect, transmit or absorb various wavelength bands. Dielectric layers refers to more than four dielectric layers or dielectric/metal "composite" layers.

16. 'Cemented tungsten carbide' does not include cutting and forming tool materials consisting of tungsten carbide/(cobalt, nickel), titanium carbide/(cobalt, nickel), chromium

carbide/nickel-chromium and chromium carbide/nickel.

17. "Technology" specially designed to deposit diamond-like carbon on any of the following is not controlled: magnetic disk drives and heads, polycarbonate eyeglasses, equipment for the manufacture of disposals, bakery equipment, valves for faucets, acoustic diaphragms for speakers, engine parts for automobiles, cutting tools, punching-pressing dies, high quality lenses designed for cameras or telescopes, office automation equipment, microphones or medical devices.

18. 'Silicon carbide' does not include cutting and forming tool materials.

19. Ceramic substrates, as used in this entry, does not include ceramic materials containing 5% by weight, or greater, clay or cement content, either as separate constituents or in combination.

**Technical Note to Table on Deposition Techniques:** Processes specified in Column 1 of the Table are defined as follows:

a. Chemical Vapor Deposition (CVD) is an overlay coating or surface modification coating process wherein a metal, alloy, "composite", dielectric or ceramic is deposited upon a heated substrate. Gaseous reactants are decomposed or combined in the vicinity of a substrate resulting in the deposition of the desired elemental, alloy or compound material on the substrate. Energy for this decomposition or chemical reaction process may be provided by the heat of the substrate, a glow discharge plasma, or "laser" irradiation.

**Note 1:** CVD includes the following processes: directed gas flow out-of-pack deposition, pulsating CVD, controlled nucleation thermal decomposition (CNTD), plasma enhanced or plasma assisted CVD processes.

**Note 2:** Pack denotes a substrate immersed in a powder mixture.

**Note 3:** The gaseous reactants used in the out-of-pack process are produced using the same basic reactions and parameters as the pack cementation process, except that the substrate to be coated is not in contact with the powder mixture.

b. Thermal Evaporation-Physical Vapor Deposition (TE-PVD) is an overlay coating process conducted in a vacuum with a pressure less than 0.1 Pa wherein a source of thermal energy is used to vaporize the coating material. This process results in the condensation, or deposition, of the evaporated species onto appropriately positioned substrates. The addition of gases to the vacuum chamber during the coating process to synthesize compound coatings is an ordinary modification of the process. The use of ion or electron beams, or plasma, to activate or assist the coating's deposition is also a common modification in this technique. The use of monitors to provide in-process measurement of optical characteristics and thickness of coatings can be a feature of these processes. Specific TE-PVD processes are as follows:

1. Electron Beam PVD uses an electron beam to heat and evaporate the material which forms the coating;

2. Ion Assisted Resistive Heating PVD employs electrically resistive heating sources in combination with impinging ion beam(s) to produce a controlled and uniform flux of evaporated coating species;

3. "Laser" Vaporization uses either pulsed or continuous wave "laser" beams to vaporize the material which forms the coating;

4. Cathodic Arc Deposition employs a consumable cathode of the material which forms the coating and has an arc discharge established on the surface by a momentary contact of a ground trigger. Controlled motion of arcing erodes the cathode surface creating a highly ionized plasma. The anode can be either a cone

attached to the periphery of the cathode, through an insulator, or the chamber. Substrate biasing is used for non line-of-sight deposition.

**Note:** This definition does not include random cathodic arc deposition with non-biased substrates.

5. Ion Plating is a special modification of a general TE-PVD process in which a plasma or an ion source is used to ionize the species to be deposited, and a negative bias is applied to the substrate in order to facilitate the extraction of the species from the plasma. The introduction of reactive species, evaporation of solids within the process chamber, and the use of monitors to provide in-process measurement of optical characteristics and thicknesses of coatings are ordinary modifications of the process.

c. Pack Cementation is a surface modification coating or overlay coating process wherein a substrate is immersed in a powder mixture (a pack), that consists of:

1. The metallic powders that are to be deposited (usually aluminum, chromium, silicon or combinations thereof);

2. An activator (normally a halide salt);  
*and*

3. An inert powder, most frequently alumina.

**Note:** The substrate and powder mixture is contained within a retort which is heated to between 1,030 K (757 °C) to 1,375 K (1,102 °C) for sufficient time to deposit the coating.

d. Plasma Spraying is an overlay coating process wherein a gun (spray torch) which produces and controls a plasma accepts powder or wire coating materials, melts them and propels them towards a substrate, whereon an integrally bonded coating is formed. Plasma spraying constitutes either low pressure plasma spraying or

high velocity plasma spraying.

**Note 1:** Low pressure means less than ambient atmospheric pressure.

**Note 2:** High velocity refers to nozzle-exit gas velocity exceeding 750 m/s calculated at 293 K (20° C) at 0.1 MPa.

e. Slurry Deposition is a surface modification coating or overlay coating process wherein a metallic or ceramic powder with an organic binder is suspended in a liquid and is applied to a substrate by either spraying, dipping or painting, subsequent air or oven drying, and heat treatment to obtain the desired coating.

f. Sputter Deposition is an overlay coating process based on a momentum transfer phenomenon, wherein positive ions are accelerated by an electric field towards the surface of a target (coating material). The kinetic energy of the impacting ions is sufficient to cause target surface atoms to be released and deposited on an appropriately positioned substrate.

**Note 1:** The Table refers only to triode, magnetron or reactive sputter deposition which is used to increase adhesion of the coating and rate of deposition and to radio frequency (RF) augmented sputter deposition used to permit vaporization of non-metallic coating materials.

**Note 2:** Low-energy ion beams (less than 5 keV) can be used to activate the deposition.

g. Ion Implantation is a surface modification coating process in which the element to be alloyed is ionized, accelerated through a potential gradient and implanted into the surface region of the substrate. This includes processes in which ion implantation is performed simultaneously with electron beam physical vapor deposition or sputter deposition.

**Accompanying Technical Information to Table on Deposition Techniques:**

1. "Technology" for pretreatments of the substrates listed in the Table, as follows:

a. Chemical stripping and cleaning bath cycle parameters, as follows:

1. Bath composition;

a. For the removal of old or defective coatings corrosion product or foreign deposits;

b. For preparation of virgin substrates;

2. Time in bath;

3. Temperature of bath;

4. Number and sequences of wash cycles;

b. Visual and macroscopic criteria for acceptance of the cleaned part;

c. Heat treatment cycle parameters, as follows:

1. Atmosphere parameters, as follows:

a. Composition of the atmosphere;

b. Pressure of the atmosphere;

2. Temperature for heat treatment;

3. Time of heat treatment;

d. Substrate surface preparation parameters, as follows:

1. Grit blasting parameters, as follows:

a. Grit composition;

b. Grit size and shape;

c. Grit velocity;

2. Time and sequence of cleaning cycle after grit blast;

3. Surface finish parameters;

4. Application of binders to promote adhesion;

e. Masking technique parameters, as follows:

1. Material of mask;

2. Location of mask;

2. "Technology" for in situ quality assurance techniques for evaluation of the coating processes listed in the Table, as follows:

a. Atmosphere parameters, as follows:

1. Composition of the atmosphere;

2. Pressure of the atmosphere;

b. Time parameters;

c. Temperature parameters;

d. Thickness parameters;

e. Index of refraction parameters;

f. Control of composition;

3. "Technology" for post deposition treatments of the coated substrates listed in the Table, as follows:

a. Shot peening parameters, as follows:

1. Shot composition;

2. Shot size;

3. Shot velocity;

b. Post shot peening cleaning parameters;

c. Heat treatment cycle parameters, as follows:

1. Atmosphere parameters, as follows:
  - a. Composition of the atmosphere;
  - b. Pressure of the atmosphere;
2. Time-temperature cycles;

d. Post heat treatment visual and macroscopic criteria for acceptance of the coated substrates;

4. "Technology" for quality assurance techniques for the evaluation of the coated substrates listed in the Table, as follows:

- a. Statistical sampling criteria;
- b. Microscopic criteria for:
  1. Magnification;
  2. Coating thickness, uniformity;
  3. Coating integrity;
  4. Coating composition;
  5. Coating and substrates bonding;
  6. Microstructural uniformity.

c. Criteria for optical properties assessment (measured as a function of wavelength):

1. Reflectance;
2. Transmission;
3. Absorption;
4. Scatter;

5. "Technology" and parameters related to specific coating and surface modification

processes listed in the Table, as follows:

a. For Chemical Vapor Deposition (CVD):

1. Coating source composition and formulation;
2. Carrier gas composition;
3. Substrate temperature;
4. Time-temperature-pressure cycles;
5. Gas control and part manipulation;

b. For Thermal Evaporation-Physical Vapor Deposition (PVD):

1. Ingot or coating material source composition;
2. Substrate temperature;
3. Reactive gas composition;
4. Ingot feed rate or material vaporization rate;
5. Time-temperature-pressure cycles;
6. Beam and part manipulation;
7. "Laser" parameters, as follows:

- a. Wave length;
- b. Power density;
- c. Pulse length;
- d. Repetition ratio;
- e. Source;

c. For Pack Cementation:

1. Pack composition and formulation;

- 2. Carrier gas composition;
- 3. Time-temperature-pressure cycles;
- d. For Plasma Spraying:
  - 1. Powder composition, preparation and size distributions;
  - 2. Feed gas composition and parameters;
  - 3. Substrate temperature;
  - 4. Gun power parameters;
  - 5. Spray distance;
  - 6. Spray angle;
  - 7. Cover gas composition, pressure and flow rates;
  - 8. Gun control and part manipulation;
- e. For Sputter Deposition:
  - 1. Target composition and fabrication;
  - 2. Geometrical positioning of part and target;
  - 3. Reactive gas composition;
  - 4. Electrical bias;
  - 5. Time-temperature-pressure cycles;
  - 6. Triode power;
  - 7. Part manipulation;
- f. For Ion Implantation:
  - 1. Beam control and part manipulation;
  - 2. Ion source design details;

- 3. Control techniques for ion beam and deposition rate parameters;
- 4. Time-temperature-pressure cycles.
- g. For Ion Plating:
  - 1. Beam control and part manipulation;
  - 2. Ion source design details;
  - 3. Control techniques for ion beam and deposition rate parameters;
  - 4. Time-temperature-pressure cycles;
  - 5. Coating material feed rate and vaporization rate;
  - 6. Substrate temperature;
  - 7. Substrate bias parameters.

**2E018 "Technology" for the "use" of equipment controlled by 2B018.**

**License Requirements**

*Reason for Control:* NS, MT, AT

<i>Control(s)</i>	<i>Country Chart</i>
NS applies to entire entry	NS Column 1
MT applies to "technology" for equipment controlled by 2B018 for MT reasons	MT Column 1
AT applies to entire entry	AT Column 1

**License Exceptions**

CIV: N/A  
 TSR: Yes

**List of Items Controlled**

*Unit:* N/A  
*Related Controls:* N/A  
*Related Definitions:* N/A  
*Items:*

The list of items controlled is contained in the ECCN heading.

**2E101 "Technology" according to the General Technology Note for the "use" of equipment or "software" controlled by 2B004, 2B009, 2B104, 2B109, 2B116, or 2D101.**

**License Requirements**

*Reason for Control:* MT, NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
MT applies to entire entry	MT Column 1
NP applies to 2B004, 2B104, 2B109, and 2B116	NP Column 1
AT applies to entire entry	AT Column 1

**License Exceptions**

CIV: N/A  
 TSR: N/A

**List of Items Controlled**

*Unit:* N/A  
*Related Controls:* This entry controls only "technology" for 2B009 for spin forming machines combining the functions of spin forming and flow forming, and flow forming machines.  
*Related Definitions:* N/A  
*Items:*

The list of items controlled is contained in the ECCN heading.

**2E201 "Technology" according to the General Technology Note for the "use" of equipment or "software" controlled by 2A225, 2A226, 2B001, 2B006, 2B007.b, 2B007.c, 2B008, 2B009, 2B201, 2B204, 2B207, 2B209, 2B225 to 2B232, 2D201 or 2D202.**

**License Requirements**

*Reason for Control:* NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
NP applies to entire entry	NP Column 1
AT applies to entire entry	AT Column 1

**License Exceptions**

CIV: N/A  
 TSR: N/A

**List of Items Controlled**

*Unit:* N/A  
*Related Controls:* N/A  
*Related Definitions:* N/A  
*Items:*

The list of items controlled is contained in the ECCN heading.

**2E290 "Technology" according to the General Technology Note for the "use" of equipment controlled by 2A290, 2A291, 2A292, 2A293, and 2B290.**

**License Requirements**

*Reason for Control:* NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
NP applies to entire entry	NP Column 2
AT applies to entire entry	AT Column 1

**License Exceptions**

CIV: N/A  
 TSR: N/A

**List of Items Controlled**

*Unit:* N/A  
*Related Controls:* N/A  
*Related Definitions:* N/A  
*Items:*

The list of items controlled is contained in the ECCN heading.

**2E301 "Technology" according to the "General Technology Note" for "use" of items controlled by 2B350, 2B351 and 2B352.**

**License Requirements**

*Reason for Control:* CB, AT

<i>Control(s)</i>	<i>Country Chart</i>
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CB applies to entire entry	CB Column 3
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AT applies to entire entry	AT Column 1
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**License Exceptions**

CIV: N/A  
 TSR: N/A

**List of Items Controlled**

*Unit:* N/A  
*Related Controls:* N/A  
*Related Definitions:* N/A  
*Items:*

The lists of items controlled are contained in the ECCN headings.

**2E991 "Technology" for the "use" of equipment controlled by 2B991, 2B993, 2B996, or 2B997.**

**License Requirements**

*Reason for Control:* AT

<i>Control(s)</i>	<i>Country Chart</i>
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AT applies to entire entry	AT Column 1
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**License Exceptions**

CIV: N/A  
 TSR: N/A

**List of Items Controlled**

*Unit:* N/A  
*Related Controls:* N/A  
*Related Definitions:* N/A  
*Items:*

The list of items controlled is contained in the ECCN heading.

**2E994 "Technology" for the "use" of portable electric generators controlled by 2A994.**

**License Requirements**

*Reason for Control:* AT

*Control(s)*

AT applies to entire entry. A license is required for items controlled by this entry to Cuba, Iran, Libya, and North Korea for anti-terrorism reasons. The Commerce Country Chart is not designed to determine licensing requirements for this entry. See part 746 of the EAR for additional information on Cuba, Iran, and Libya. See §742.19 of the EAR for additional information on North Korea.



**License Exceptions**

CIV: N/A  
TSR: N/A

The list of items controlled is contained in the ECCN heading.

**List of Items Controlled**

*Unit:* N/A  
*Related Controls:* N/A  
*Related Definitions:* N/A  
*Items:*

**EAR99** Items subject to the EAR that are *not* elsewhere controlled by this CCL Category *or* in any other category in the CCL are designated by the number **EAR99**.