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From:	Secretary-General of the European Commission, signed by Mr Jordi AYET PUIGARNAU, Director
date of receipt:	10 October 2018
To:	Mr Jeppe TRANHOLM-MIKKELSEN, Secretary-General of the Council of the European Union
No. Cion doc.:	C(2018) 6511 final Annex 1 Part 4/11
Subject:	ANNEX 1 Part 4/11 to the Commission Delegated Regulation amending Council Regulation (EC) No 428/2009 setting up a Community regime for the control of exports, transfer, brokering and transit of dual-use items

Delegations will find attached document C(2018) 6511 final Annex 1 Part 4/11.

Encl.: C(2018) 6511 final Annex 1 Part 4/11

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ANNEX 1 – PART 4/11

ANNEX

to the

Commission Delegated Regulation

amending Council Regulation (EC) No 428/2009 setting up a Community regime for the control of exports, transfer, brokering and transit of dual-use items

ANNEX I (Part IV – Category 2)

CATEGORY 2 - MATERIALS PROCESSING

2A Systems, Equipment and Components

N.B. For quiet running bearings, see the Military Goods Controls.

2A001 Anti-friction bearings and bearing systems, as follows, and components therefor:

N.B. SEE ALSO 2A101.

Note: 2A001 does not control balls with tolerances specified by the manufacturer in accordance with ISO 3290 as grade 5 (or national equivalents) or worse.

a. Ball bearings and solid roller bearings, having all tolerances specified by the manufacturer in accordance with ISO 492 Tolerance Class 4 (or national equivalents), or better, and having both 'rings' and 'rolling elements', made from monel or beryllium;

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

Technical Notes:

1. 'Ring' - annular part of a radial rolling bearing incorporating one or more raceways (ISO 5593:1997).

2. 'Rolling element' - ball or roller which rolls between raceways (ISO 5593:1997).

b. Not used;

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

1. Materials with flux densities of 2,0 T or greater and yield strengths greater than 414 MPa;

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

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

2A101 Radial ball bearings, other than those specified in 2A001, having all tolerances specified in accordance with ISO 492 Tolerance Class 2 (or ANSI/ABMA Std 20 Tolerance Class ABEC-9 or other national equivalents), or better and having all the following characteristics:

a. An inner ring bore diameter between 12 mm and 50 mm;

b. An outer ring outside diameter between 25 mm and 100 mm; and

c. A width between 10 mm and 20 mm.

2A225 Crucibles made of materials resistant to liquid actinide metals, as follows:

a. Crucibles having both of the following characteristics:

1. A volume of between 150 cm^3 and 8 000 cm^3; and

2. Made of or coated with any of the following materials, or combination of the following materials, having an overall impurity level of 2% or less by weight:

a. Calcium fluoride (CaF_2);
b. Calcium zirconate (metazirconate) ($CaZrO_3$);
c. Cerium sulphide (Ce_2S_3);
d. Erbium oxide (erbia) (Er_2O_3);
e. Hafnium oxide (hafnia) (HfO_2);
f. Magnesium oxide (MgO);
g. Nitrided niobium-titanium-tungsten alloy (approximately 50% Nb, 30%Ti, 20% W);
h. Yttrium oxide (yttria) (Y_2O_3); or
i. Zirconium oxide (zirconia) (ZrO_2);

b. Crucibles having both of the following characteristics:

1. A volume of between 50 cm^3 and 2 000 cm^3; and

2. Made of or lined with tantalum, having a purity of 99,9% or greater by weight;

c. Crucibles having all of the following characteristics:

1. A volume of between 50 cm^3 and 2 000 cm^3;

2. Made of or lined with tantalum, having a purity of 98% or greater by weight; and

3. Coated with tantalum carbide, nitride, boride, or any combination thereof.

2A226 Valves having all of the following characteristics:

a. A 'nominal size' of 5 mm or greater;

b. Having a bellows seal; and

c. Wholly made of or lined with aluminium, aluminium alloy, nickel, or nickel alloy containing more than 60% nickel by weight.

Technical Note:
For valves with different inlet and outlet diameters, the 'nominal size' in 2A226 refers to the smallest diameter.

2B Test, Inspection and Production Equipment

Technical Notes:

1. *Secondary parallel contouring axes, (e.g., the w-axis on horizontal boring mills or a secondary rotary axis the centre 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. *For the purposes of 2B, the number of axes which can be co-ordinated simultaneously for "contouring control" is the number of axes along or around which, during processing of the workpiece, simultaneous and interrelated motions are performed between the workpiece and a tool. This does not include any additional axes along or around which other relative movement within the machine are performed such as:*
   a. *Wheel-dressing systems in grinding machines;*
   b. *Parallel rotary axes designed for mounting of separate workpieces;*
   c. *Co-linear rotary axes designed for manipulating the same workpiece by holding it in a chuck from different ends.*
3. *Axis nomenclature shall be in accordance with International Standard ISO 841:2001, Industrial automation systems and integration - Numerical control of machines - Coordinate system and motion nomenclature.*
4. *For the purposes of 2B001 to 2B009 a "tilting spindle" is counted as a rotary axis.*
5. *'Stated "unidirectional positioning repeatability"' may be used for each machine tool model as an alternative to individual machine tests and is determined as follows:*

a. *Select five machines of a model to be evaluated;*

b. *Measure the linear axis repeatability (R↑,R↓) according to ISO 230-2:2014 and evaluate "unidirectional positioning repeatability" for each axis of each of the five machines;*

c. *Determine the arithmetic mean value of the "unidirectional positioning repeatability"-values for each axis of all five machines together. These arithmetic mean values of "unidirectional positioning repeatability"* $(\overline{UPR})$ *become the stated value of each axis for the model* $(\overline{UPR}_x, \overline{UPR}_y, \ldots)$*;*

d. *Since the Category 2 list refers to each linear axis there will be as many 'stated "unidirectional positioning repeatability" values as there are linear axes;*

e. *If any axis of a machine model not specified in 2B001.a. to 2B001.c. has a 'stated "unidirectional positioning repeatability" equal to or less than the specified "unidirectional positioning repeatability" of each machine tool model plus 0,7 µm, the builder should be required to reaffirm the accuracy level once every eighteen months.*

6. *For the purposes of 2B001.a. to 2B001.c., measurement uncertainty for the "unidirectional positioning repeatability" of machine tools, as defined in the International Standard ISO 230-2:2014 or national equivalents, shall not be considered.*

7. *For the purpose of 2B001.a. to 2B001.c.., the measurement of axes shall be made according to test procedures in 5.3.2. of ISO 230-2:2014. Tests for axes longer than 2 meters shall be made over 2 m segments. Axes longer than 4 m require multiple tests (e.g., two tests for axes longer than 4 m and up to 8 m, three tests for axes longer than 8 m and up to 12 m), each over 2 m segments and distributed in equal intervals over the axis length. Test segments are equally spaced along the full axis length, with any excess length equally divided at the beginning, in between, and at the end of the test segments. The smallest "unidirectional positioning repeatability"-value of all test segments is to be reported.*

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", as follows:

N.B. SEE ALSO 2B201.

Note 1: 2B001 does not control special purpose machine tools limited to the manufacture of gears. For such machines see 2B003.

Note 2: 2B001 does not control special purpose machine tools limited to the manufacture of any of the following:

a. Crankshafts or camshafts;
b. Tools or cutters;
c. Extruder worms;
d. Engraved or facetted jewellery parts; or
e. Dental prostheses.

Note 3: A machine tool having at least two of the three turning, milling or grinding capabilities (e.g., a turning machine with milling capability), must be evaluated against each applicable entry 2B001.a., b. or c.

N.B. For optical finishing machines, see 2B002.

a. Machine tools for turning having two or more axes which can be coordinated simultaneously for "contouring control" having any of the following:
   1. "Unidirectional positioning repeatability" equal to or less (better) than 0,9 µm along one or more linear axis with a travel length less than 1,0 m; or
   2. "Unidirectional positioning repeatability" equal to or less (better) than 1,1 µm along one or more linear axis with a travel length equal to or greater than 1,0 m;

   Note 1: 2B001.a. does not control turning machines specially designed for producing contact lenses, having all of the following:
      a. Machine controller limited to using ophthalmic based software for part programming data input; and
      b. No vacuum chucking.

   Note 2: 2B001.a. does not control bar machines (Swissturn), limited to machining only bar feed thru, if maximum bar diameter is equal to or less than 42 mm and there is no capability of mounting chucks. Machines may have drilling or milling capabilities for machining parts with diameters less than 42 mm.

2B001 continued

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

1. Three linear axes plus one rotary axis which can be coordinated simultaneously for "contouring control" having any of the following:

a. "Unidirectional positioning repeatability" equal to or less (better) than 0,9 µm along one or more linear axis with a travel length less than 1,0 m; or

b. "Unidirectional positioning repeatability" equal to or less (better) than 1,1 µm along one or more linear axis with a travel length equal to or greater than 1,0m;

2. Five or more axes which can be coordinated simultaneously for "contouring control" having any of the following;

a. "Unidirectional positioning repeatability" equal to or less (better) than 0,9 µm along one or more linear axis with a travel length less than 1,0 m;

b. "Unidirectional positioning repeatability" equal to or less (better) than 1,4 µm along one or more linear axis with a travel length equal to or greater than 1 m and less than 4 m; or

c. "Unidirectional positioning repeatability" equal to or less (better) than 6,0 µm (along one or more linear axis with a travel length equal to or greater than 4 m;

2B001.b. continued

3. A "unidirectional positioning repeatability" for jig boring machines, equal to or less (better) than 1,1 μm along one or more linear axis; or

4. Fly cutting machines having all of the following:

a. Spindle "run-out" and "camming" less (better) than 0,0004 mm TIR; and

b. Angular deviation of slide movement (yaw, pitch and roll) less (better) than 2 seconds of arc, TIR over 300 mm of travel;

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

1. Having all of the following:

a. "Unidirectional positioning repeatability" equal to or less (better) than 1,1 μm along one or more linear axis; and

b. Three or four axes which can be coordinated simultaneously for "contouring control"; or

2. Five or more axes which can be coordinated simultaneously for "contouring control" having any of the following:

a. "Unidirectional positioning repeatability" equal to or less (better) than 1,1 μm along one or more linear axis with a travel length less than 1 m;

b. "Unidirectional positioning repeatability" equal to or less (better) than 1,4 μm along one or more linear axis with a travel length equal to or greater than 1 m and less than 4 m; or

c. "Unidirectional positioning repeatability" equal to or less (better) than 6,0 μm along one or more linear axis with a travel length equal to or greater than 4 m.

Note: 2B001.c. does not control grinding machine as follows:

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

1. Limited to cylindrical grinding; and

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

b. Machines designed specifically as jig grinders that do not have a z-axis or a w-axis, with a "unidirectional positioning repeatability" less (better) than 1,1 μm

c. Surface grinders.

2B001 continued

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", having all of the following:

1. Removing material by means of any of the following:

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

b. Electron beam; or

c. "Laser" beam; and

2. At least two rotary axes having all of the following:

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

b. 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 5m.

2B002 Numerically controlled optical finishing machine tools equipped for selective material removal to produce non-spherical optical surfaces having all of the following characteristics:

a. Finishing the form to less (better) than 1,0 μm;

b. Finishing to a roughness less (better) than 100 nm rms.

c. Four or more axes which can be coordinated simultaneously for "contouring control"; and

d. Using any of the following processes:

1. Magnetorheological finishing ('MRF');
2. Electrorheological finishing ('ERF');
3. 'Energetic particle beam finishing';
4. 'Inflatable membrane tool finishing'; or
5. 'Fluid jet finishing'.

2B002 continued

Technical Notes:

For the purposes of 2B002:

1. *'MRF' is a material removal process using an abrasive magnetic fluid whose viscosity is controlled by a magnetic field.*
2. *'ERF' is a removal process using an abrasive fluid whose viscosity is controlled by an electric field.*
3. *'Energetic particle beam finishing' uses Reactive Atom Plasmas (RAP) or ion-beams to selectively remove material.*
4. *'Inflatable membrane tool finishing' is a process that uses a pressurized membrane that deforms to contact the workpiece over a small area.*
5. *'Fluid jet finishing' makes use of a fluid stream for material removal.*

2B003 "Numerically controlled" or manual machine tools, and specially designed components, controls 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).

2B004 Hot "isostatic presses" having all of the following, and specially designed components and accessories therefor:

N.B. *SEE ALSO 2B104 and 2B204.*

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

b. Having any of the following:

1. A maximum working pressure exceeding 207 MPa;

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

3. A facility for hydrocarbon impregnation and removal of resultant gaseous degradation products.

2B004 continued

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.

N.B.: For specially designed dies, moulds and tooling see 1B003, 9B009 and the Military Goods Controls.

2B005 Equipment specially designed for the deposition, processing and in-process control of inorganic overlays, coatings and surface modifications, as follows, for substrates specified in column 2, by processes shown in column 1 in the Table following 2E003.f., and specially designed automated handling, positioning, manipulation and control components therefor:

a. Chemical vapour deposition (CVD) production equipment having all of the following:

N.B.: SEE ALSO 2B105.

1. A process modified for one of the following:
   a. Pulsating CVD;
   b. Controlled nucleation thermal deposition (CNTD); or
   c. Plasma enhanced or plasma assisted CVD; and
2. Having any of the following:
   a. Incorporating high vacuum (equal to or less than 0,01 Pa) rotating seals; or
   b. Incorporating *in situ* coating thickness control;

b. Ion implantation production equipment having beam currents of 5 mA or more;

2B005 continued

c. Electron beam physical vapour deposition (EB-PVD) production equipment incorporating power systems rated for over 80 kW and having any of the following:

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

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

d. Plasma spraying production equipment having any of the following:

1. Operating at reduced pressure controlled atmosphere (equal to or less than 10 kPa measured above and within 300 mm of the gun nozzle exit) in a vacuum chamber capable of evacuation down to 0,01 Pa prior to the spraying process; or

2. Incorporating *in situ* coating thickness control;

e. Sputter deposition production equipment capable of current densities of 0,1 mA/mm^2 or higher at a deposition rate of 15 μm/h or more;

f. Cathodic arc deposition production equipment incorporating a grid of electromagnets for steering control of the arc spot on the cathode;

g. Ion plating production equipment capable of the *in situ* measurement of any of the following:

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

2. Optical characteristics.

Note: 2B005 does not control chemical vapour deposition, cathodic arc, sputter deposition, ion plating or ion implantation equipment, specially designed for cutting or machining tools.

2B006 Dimensional inspection or measuring systems, equipment, position feedback units and "electronic assemblies", as follows:

a. Computer controlled or "numerical controlled" Coordinate Measuring Machines (CMM), having a three dimensional (volumetric) maximum permissible error of length measurement ($E_{0,MPE}$) at any point within the operating range of the machine (i.e., within the length of axes) equal to or less (better) than (1,7 + L/1 000) µm (L is the measured length in mm), according to ISO 10360-2:2009;

Technical Note:
The $E_{0,MPE}$ of the most accurate configuration of the CMM specified by the manufacturer (e.g., best of the following: probe, stylus length, motion parameters, environment) and with "all compensations available" shall be compared to the 1,7+L/1 000 µm threshold.

N.B. SEE ALSO 2B206.

b. Linear displacement measuring instruments or systems, linear position feedback units, and "electronic assemblies", as follows:

Note: Interferometer and optical-encoder measuring systems containing a "laser" are only specified in 2B006.b.3 and 2B206.c.

1. 'Non-contact type measuring systems' with a "resolution" equal to or less (better) than 0,2 µm within a measuring range up to 0,2 mm;

2B006.b. continued

Technical Note:
For the purposes of 2B006.b.1. 'non-contact type measuring systems' are designed to measure the distance between the probe and measured object along a single vector, where the probe or measured object is in motion.

2. Linear position feedback units specially designed for machine tools and having an overall "accuracy" less (better) than (800 + (600 x L/1 000)) nm (L equals effective length in mm);

3. Measuring systems having all of the following:

   a. Containing a "laser";

   b. A "resolution" over their full scale of 0,200 nm or less (better); and

   c. Capable of achieving a "measurement uncertainty" equal to or less (better) than (1,6 + L/2 000) nm (L is the measured length in mm) at any point within a measuring range, when compensated for the refractive index of air and measured over a period of 30 seconds at a temperature of 20±0,01°C; or

4. "Electronic assemblies" specially designed to provide feedback capability in systems specified in 2B006.b.3.;

2B006 continued

c. Rotary position feedback units specially designed for machine tools or angular displacement measuring instruments, having an angular position "accuracy" equal to or less (better) than 0,9 second of arc;

Note: 2B006.c. does not control optical instruments, such as autocollimators, using collimated light (e.g. "laser" light) to detect angular displacement of a mirror.

d. Equipment for measuring surface roughness (including surface defects), by measuring optical scatter with a sensitivity of 0,5 nm or less (better).

Note: 2B006 includes machine tools, other than those specified in 2B001, that can be used as measuring machines if they meet or exceed the criteria specified for the measuring machine function.

2B007 "Robots" having any of the following characteristics and specially designed controllers and "end-effectors" therefor:

N.B. SEE ALSO 2B207.

a. Not used;

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

Note: 2B007.b. does not control "robots" specially designed for paint-spraying booths.

c. Specially designed or rated as radiation-hardened to withstand a total radiation dose greater than 5×10^3 Gy (silicon) without operational degradation; or

Technical Note:
The term Gy(silicon) refers to the energy in Joules per kilogram absorbed by an unshielded silicon sample when exposed to ionising radiation.

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

2B008 'Compound rotary tables' and "tilting spindles", specially designed for machine tools, as follows:

a. Not used;

b. Not used;

c. 'Compound rotary tables' having all of the following:

1. Designed for machine tools for turning, milling or grinding; and

2. Two rotary axes designed to be coordinated simultaneously for “contouring control”;

Technical Note:
A 'compound rotary table' is a table allowing the workpiece to rotate and tilt about two non-parallel axes

d. "Tilting spindles" having all of the following :

1. Designed for machine tools for turning, milling or grinding; and

2. Designed to be coordinated simultaneously for "contouring control".

2B009 Spin-forming machines and flow-forming machines, which, according to the manufacturer's technical specification, can be equipped with "numerical control" units or a computer control and having all of the following:

N.B. SEE ALSO 2B109 AND 2B209.

a. Three or more axes which can be coordinated simultaneously for "contouring control"; and

b. A roller force more than 60 kN.

Technical Note:
For the purpose of 2B009, machines combining the function of spin-forming and flow-forming are regarded as flow-forming machines.

2B104 "Isostatic presses", other than those specified in 2B004, having all of the following:

N.B. SEE ALSO 2B204.

a. Maximum working pressure of 69 MPa or greater;

b. Designed to achieve and maintain a controlled thermal environment of 873 K (600°C) or greater; and

c. Possessing a chamber cavity with an inside diameter of 254 mm or greater.

2B105 Chemical vapour deposition (CVD) furnaces, other than those specified in 2B005.a., designed or modified for the densification of carbon-carbon composites.

2B109 Flow-forming machines, other than those specified in 2B009, usable in the "production" of propulsion components and equipment (e.g. motor cases and interstages) for "missiles", and specially designed components as follows:

N.B. SEE ALSO 2B209.

a. Flow-forming machines having all of the following:

1. Equipped with, or according to the manufacturer's technical specification are capable of being equipped with "numerical control" units or computer control; and

2. More than two axes which can be coordinated simultaneously for "contouring control".

b. Specially designed components for flow-forming machines specified in 2B009 or 2B109.a.

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

2B116 Vibration test systems, equipment and components therefor, as follows:

a. Vibration test systems employing feedback or closed loop techniques and incorporating a digital controller, capable of vibrating a system at an acceleration equal to or greater than 10 g rms between 20 Hz and 2 kHz while imparting forces equal to or greater than 50 kN, measured 'bare table';

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

Technical Note:
In 2B116.b., 'real-time control bandwidth' means the maximum rate at which a controller can execute complete cycles of sampling, processing data and transmitting control signals.

c. Vibration thrusters (shaker units), with or without associated amplifiers, capable of imparting a force equal to or greater than 50 kN, measured 'bare table', and usable in vibration test systems specified in 2B116.a.;

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

Technical Note:
In 2B116, 'bare table' means a flat table, or surface, with no fixture or fittings.

2B117 Equipment and process controls, other than those specified in 2B004, 2B005.a., 2B104 or 2B105, designed or modified for densification and pyrolysis of structural composite rocket nozzles and reentry vehicle nose tips.

2B119 Balancing machines and related equipment, as follows:

N.B. SEE ALSO 2B219.

a. Balancing machines having all the following characteristics:

1. Not capable of balancing rotors/assemblies having a mass greater than 3 kg;

2. Capable of balancing rotors/assemblies at speeds greater than 12 500 rpm;

3. Capable of correcting unbalance in two planes or more; and

4. Capable of balancing to a residual specific unbalance of 0,2 g mm per kg of rotor mass;

Note: 2B119.a. does not control balancing machines designed or modified for dental or other medical equipment.

b. Indicator heads designed or modified for use with machines specified in 2B119.a.

Technical Note:
Indicator heads are sometimes known as balancing instrumentation.

2B120 Motion simulators or rate tables having all of the following characteristics:

a. Two or more axes;

b. Designed or modified to incorporate slip rings or integrated non-contact devices capable of transferring electrical power, signal information, or both; and

c. Having any of the following characteristics:

1. For any single axis having all of the following:

a. Capable of rates of 400 degrees/s or more, or 30 degrees/s or less; and

b. A rate resolution equal to or less than 6 degrees/s and an accuracy equal to or less than 0,6 degrees/s;

2. Having a worst-case rate stability equal to or better (less) than plus or minus 0,05% averaged over 10 degrees or more; or

3. A positioning "accuracy" equal to or less (better) than 5 arc second.

Note 1: 2B120 does not control rotary tables designed or modified for machine tools or for medical equipment. For controls on machine tool rotary tables see 2B008.

Note 2: Motion simulators or rate tables specified in 2B120 remain controlled whether or not slip rings or integrated non-contact devices are fitted at time of export.

2B121 Positioning tables (equipment capable of precise rotary positioning in any axes), other than those specified in 2B120, having all of the following characteristics:

a. Two or more axes; and
b. A positioning "accuracy" equal to or less (better) than 5 arc second.

Note: 2B121 does not control rotary tables designed or modified for machine tools or for medical equipment. For controls on machine tool rotary tables see 2B008.

2B122 Centrifuges capable of imparting accelerations greater than 100 g and designed or modified to incorporate slip rings or integrated non-contact devices capable of transferring electrical power, signal information, or both.

Note: Centrifuges specified in 2B122 remain controlled whether or not slip rings or integrated non-contact devices are fitted at time of export.

2B201 Machine tools and any combination thereof, other than those specified in 2B001, as follows, for removing or cutting metals, ceramics or "composites", which, according to the manufacturer's technical specification, can be equipped with electronic devices for simultaneous "contouring control" in two or more axes:

Technical Note:
Stated positioning accuracy levels derived under the following procedures from measurements made according to ISO 230-2:1988[1] or national equivalents may be used for each machine tool model if provided to, and accepted by, national authorities instead of individual machine tests. Determination of stated positioning accuracy:

a. Select five machines of a model to be evaluated;

b. Measure the linear axis accuracies according to ISO 230-2:1988[1];

c. Determine the accuracy values (A) for each axis of each machine. The method of calculating the accuracy value is described in the ISO 230-2:1988[1] standard;

d. Determine the average accuracy value of each axis. This average value becomes the stated positioning accuracy of each axis for the model (Âx Ây...);

e. Since Item 2B201 refers to each linear axis, there will be as many stated positioning accuracy values as there are linear axes;

[1] Manufacturers calculating positioning accuracy in accordance with ISO 230-2:1997 or 2006 should consult the competent authorities of the Member State in which they are established.

2B201 continued

f. If any axis of a machine tool not specified in 2B201.a., 2B201.b. or 2B201.c. has a stated positioning accuracy of 6 µm or better (less) for grinding machines, and 8 µm or better (less) for milling and turning machines, both according to ISO 230-2:1988[1], then the builder should be required to reaffirm the accuracy level once every eighteen months.

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

1. Positioning accuracies with "all compensations available" equal to or less (better) than 6 µm according to ISO 230-2:1988[1] or national equivalents along any linear axis;

2. Two or more contouring rotary axes; or

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

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

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

b. Overall positioning accuracy on the x-axis more (worse) than 30 µm.

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

1. Positioning accuracies with "all compensations available" equal to or less (better) than 4 µm according to ISO 230-2:1988[1] or national equivalents along any linear axis;

2. Two or more contouring rotary axes; or

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

2B201.b. continued

Note: 2B201.b. does not control grinding machines as follows:

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

1. Limited to a maximum workpiece capacity of 150 mm outside diameter or length; and

2. Axes limited to x, z and c;

b. Jig grinders that do not have a z-axis or a w-axis with an overall positioning accuracy less (better) than 4 µm according to ISO 230-2:1988[1] or national equivalents.

c. Machine tools for turning, that have positioning accuracies with "all compensations available" better (less) than 6 µm according to ISO 230-2:1988[1] along any linear axis (overall positioning) for machines capable of machining diameters greater than 35 mm;

Note: 2B201.c. does not control bar machines (Swissturn), limited to machining only bar feed thru, 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.

Note 1: 2B201 does not control special purpose machine tools limited to the manufacture of any of the following parts:

a. Gears;

b. Crankshafts or camshafts;

c. Tools or cutters;

d. Extruder worms.

Note 2: A machine tool having at least two of the three turning, milling or grinding capabilities (e.g., a turning machine with milling capability), must be evaluated against each applicable entry 2B201.a., b. or c.

Note 3: 2B201.a.3. and 2B201.b.3. include machines based on a parallel linear kinematic design (e.g., hexapods) that have 5 or more axes none of which is a rotary axis.

2B204 "Isostatic presses", other than those specified in 2B004 or 2B104, and related equipment, as follows:

a. "Isostatic presses" having both of the following characteristics:

1. Capable of achieving a maximum working pressure of 69 MPa or greater; and

2. A chamber cavity with an inside diameter in excess of 152 mm;

b. Dies, moulds and controls, specially designed for "isostatic presses" specified in 2B204.a.

Technical Note:
In 2B204 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.

2B206 Dimensional inspection machines, instruments or systems, other than those specified in 2B006, as follows:

a. Computer controlled or numerically controlled coordinate measuring machines (CMM) having either of the following characteristics:

1. Having only two axes and having a maximum permissible error of length measurement along any axis (one dimensional), identified as any combination of $E_{0x,MPE}$, $E_{0y,MPE}$, or $E_{0z,MPE}$, equal to or less (better) than (1,25 + L/1 000) µm (where L is the measured length in mm) at any point within the operating range of the machine (i.e., within the length of the axis), according to ISO 10360-2(2009); or

2B206.a. continued

2. Three or more axes and having a three dimensional (volumetric) maximum permissible error of length measurement ($E_{0,MPE}$) equal to or less (better) than (1,7 + L/800) µm (where L is the measured length in mm) at any point within the operating range of the machine (i.e., within the length of the axis), according to ISO 10360-2(2009);

Technical Note:
The $E_{0,MPE}$ of the most accurate configuration of the CMM specified according to ISO 10360-2:2009 by the manufacturer (e.g., best of the following: probe, stylus, length, motion parameters, environments) and with all compensations available shall be compared to the 1,7 + L/800 µm threshold.

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

1. "Measurement uncertainty" along any linear axis equal to or less (better) than 3,5 µm per 5 mm; and

2. "Angular position deviation" equal to or less than 0,02°;

c. 'Linear displacement' measuring systems having all of the following characteristics:

Technical Note:
For the purpose of 2B206.c. 'linear displacement' means the change of distance between the measuring probe and the measured object.

1. Containing a "laser"; and

2. Capable of maintaining, for at least 12 hours, at a temperature of ± 1 K (± 1°C); around a standard temperature and standard pressure, all of the following:

a. A "resolution" over their full scale of 0,1 µm or better; and

b. With a "measurement uncertainty" equal to or better (less) than (0,2 + L/2 000) µm (L is the measured length in mm).

Note: 2B206.c. 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.

d. Linear variable differential transformer (LVDT) systems having both of the following characteristics:

Technical Note:
For the purpose of 2B206.d. 'linear displacement' means the change of distance between the measuring probe and the measured object.

1. Having any of the following:

a. "Linearity" equal to or less (better) than 0.1% measured from 0 to the full operating range, for LVDTs with an operating range up to 5 mm; or

b. "Linearity" equal to or less (better) than 0.1% measured from 0 to 5 mm for LVDTs with an operating range greater than 5 mm; and

2. Drift equal to or better (less) than 0.1% per day at a standard ambient test room temperature ±1 K (± 1°C).

Note 1: *Machine tools that 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.*

Note 2: *A machine specified in 2B206 is controlled if it exceeds the control threshold anywhere within its operating range.*

Technical Notes:
All parameters of measurement values in 2B206 represent plus/minus i.e., not total band.

2B207 "Robots", "end-effectors" and control units, other than those specified in 2B007, as follows:

a. "Robots" or "end-effectors" specially designed to comply with national safety standards applicable to handling high explosives (for example, meeting electrical code ratings for high explosives);

b. Control units specially designed for any of the "robots" or "end-effectors" specified in 2B207.a.

2B209 Flow forming machines, spin forming machines capable of flow forming functions, other than those specified in 2B009 or 2B109, and mandrels, as follows:

a. Machines having both of the following characteristics:

1. Three or more rollers (active or guiding); and

2. Which, 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 and 400 mm.

Note: 2B209.a. 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.

2B219 Centrifugal multiplane balancing machines, fixed or portable, horizontal or vertical, as follows:

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

1. Swing or journal diameter greater than 75 mm;

2. Mass capability of from 0,9 to 23 kg ; and

3. Capable of balancing speed of revolution greater than 5 000 r.p.m.;

2B219 continued

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

1. Journal diameter greater than 75 mm;

2. Mass capability of from 0,9 to 23 kg;

3. A minimum achievable residual specific unbalance equal to or less than 10 g mm/kg per plane; and

4. Belt drive type.

2B225 Remote manipulators that can be used to provide remote actions in radiochemical separation operations or hot cells, having either of the following characteristics:

a. A capability of penetrating 0,6 m or more of hot cell wall (through-the-wall operation); or

b. 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).

Technical Note:
Remote manipulators provide translation of human operator actions to a remote operating arm and terminal fixture. They may be of 'master/slave' type or operated by joystick or keypad.

2B226 Controlled atmosphere (vacuum or inert gas) induction furnaces, other than those specified in 9B001 and 3B001 and power supplies therefor, as follows:

N.B. SEE ALSO 3B001 and 9B001.

a. Furnaces having all of the following characteristics:

1. Capable of operation above 1 123 K (850°C);

2. Induction coils 600 mm or less in diameter; and

3. Designed for power inputs of 5 kW or more;

Note: 2B226.a. does not control furnaces designed for the processing of semiconductor wafers.

b. Power supplies, with a specified power output of 5 kW or more, specially designed for furnaces specified in 2B226.a.

2B227 Vacuum or other controlled atmosphere metallurgical melting and casting furnaces and related equipment as follows:

a. Arc remelt furnaces, arc melt furnaces and arc melt and casting furnaces having both of the following characteristics:

1. Consumable electrode capacities between 1 000 cm^3 and 20 000 cm^3; and

2. Capable of operating with melting temperatures above 1 973 K (1 700°C);

b. Electron beam melting furnaces, plasma atomization furnaces and plasma melting furnaces, having both of the following characteristics:

1. A power of 50 kW or greater; and

2. Capable of operating with melting temperatures above 1 473 K (1 200°C);

c. Computer control and monitoring systems specially configured for any of the furnaces specified in 2B227.a. or 2B227.b.;

d. Plasma torches specially designed for furnaces specified in 2B227.b. having both of the following characteristics:

1. Operating at a power greater than 50 kW; and

2. Capable of operating above 1 473 K (1 200°C);

e. Electron beam guns specially designed for the furnaces specified in 2B227.b. operating at a power greater than 50 kW.

2B228 Rotor fabrication or assembly equipment, rotor straightening equipment, bellows-forming mandrels and dies, as follows:

a. Rotor assembly equipment for assembly of gas centrifuge rotor tube sections, baffles, and end caps;

Note: 2B228.a. includes precision mandrels, clamps, and shrink fit machines.

b. Rotor straightening equipment for alignment of gas centrifuge rotor tube sections to a common axis;

Technical Note:
In 2B228.b. such equipment normally consists 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.

Technical Note:
In 2B228.c. the bellows have all of the following characteristics:

1. Inside diameter between 75 mm and 400 mm;
2. Length equal to or greater than 12,7 mm;
3. Single convolution depth greater than 2 mm; and
4. Made of high-strength aluminium alloys, maraging steel or high strength "fibrous or filamentary materials".

2B230 All types of 'pressure transducers' capable of measuring absolute pressures and having all of the following:

a. Pressure sensing elements made of or protected by aluminium, aluminium alloy, aluminum oxide (alumina or sapphire), nickel, nickel alloy with more than 60% nickel by weight, or fully fluorinated hydrocarbon polymers;

b. Seals, if any, essential for sealing the pressure sensing element, and in direct contact with the process medium, made of or protected by aluminium, aluminium alloy, aluminum oxide (alumina or sapphire), nickel, nickel alloy with more than 60% nickel by weight, or fully fluorinated hydrocarbon polymers; and

c. Having either of the following characteristics:

1. A full scale of less than 13 kPa and an 'accuracy' of better than 1% of full-scale; or

2. A full scale of 13 kPa or greater and an 'accuracy' of better than 130 Pa when measured at 13 kPa.

Technical Notes:

1. In 2B230 'pressure transducer' means a device that converts a pressure measurement into a signal.

2. For the purposes of 2B230, 'accuracy' includes non-linearity, hysteresis and repeatability at ambient temperature.

2B231 Vacuum pumps having all of the following characteristics:

a. Input throat size equal to or greater than 380 mm;

b. Pumping speed equal to or greater than 15 m^3/s; and

c. Capable of producing an ultimate vacuum better than 13 mPa.

Technical Notes:

1. The pumping speed is determined at the measurement point with nitrogen gas or air.

2. The ultimate vacuum is determined at the input of the pump with the input of the pump blocked off.

2B232 High-velocity gun systems (propellant, gas, coil, electromagnetic, and electrothermal types, and other advanced systems) capable of accelerating projectiles to 1,5 km/s or greater.

N.B. SEE ALSO MILTARY GOODS CONTROLS.

2B233 Bellows-sealed scroll-type compressors and bellows-sealed scroll-type vacuum pumps having all of the following:

N.B. SEE ALSO 2B350.i.

a. Capable of an inlet volume flow rate of 50 m^3/h or greater;

b. Capable of a pressure ratio of 2:1 or greater; and

c. Having all surfaces that come in contact with the process gas made from any of the following materials:

1. Aluminium or aluminium alloy;
2. Aluminium oxide;
3. Stainless steel;
4. Nickel or nickel alloy;
5. Phosphor bronze; or
6. Fluoropolymers.

2B350 Chemical manufacturing facilities, equipment and components, as follows:

a. Reaction vessels or reactors, with or without agitators, with total internal (geometric) volume greater than 0,1 m^3 (100 litres) and less than 20 m^3 (20 000 litres), where all surfaces that come in direct contact with the chemical(s) being processed or contained are made from any of the following materials:

N.B. For prefabricated repair assemblies, see 2B350.k.

1. 'Alloys' with more than 25% nickel and 20% chromium by weight;
2. Fluoropolymers (polymeric or elastomeric materials with more than 35% fluorine by weight);
3. Glass (including vitrified or enamelled coating or glass lining);
4. Nickel or 'alloys' with more than 40% nickel by weight;
5. Tantalum or tantalum 'alloys';
6. Titanium or titanium 'alloys';
7. Zirconium or zirconium 'alloys'; or
8. Niobium (columbium) or niobium 'alloys';

2B350 continued

b. Agitators designed for use in reaction vessels or reactors specified in 2B350.a.; and impellers, blades or shafts designed for such agitators, 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:

1. 'Alloys' with more than 25% nickel and 20% chromium by weight;
2. Fluoropolymers (polymeric or elastomeric materials with more than 35% fluorine by weight);
3. Glass (including vitrified or enamelled coatings or glass lining);
4. Nickel or 'alloys' with more than 40% nickel by weight;
5. Tantalum or tantalum 'alloys';
6. Titanium or titanium 'alloys';
7. Zirconium or zirconium 'alloys'; or
8. Niobium (columbium) or niobium 'alloys';

c. Storage tanks, containers or receivers with a total internal (geometric) volume greater than 0,1 m^3 (100 litres) where all surfaces that come in direct contact with the chemical(s) being processed or contained are made from any of the following materials:

N.B. For prefabricated repair assemblies, see 2B350.k.

1. 'Alloys' with more than 25% nickel and 20% chromium by weight;
2. Fluoropolymers (polymeric or elastomeric materials with more than 35% fluorine by weight);
3. Glass (including vitrified or enamelled coatings or glass lining);
4. Nickel or 'alloys' with more than 40% nickel by weight;
5. Tantalum or tantalum 'alloys';
6. Titanium or titanium 'alloys';
7. Zirconium or zirconium 'alloys'; or
8. Niobium (columbium) or niobium 'alloys';

2B350 continued

d. Heat exchangers or condensers with a heat transfer surface area greater than 0,15 m^2, and less than 20 m^2; and tubes, plates, coils or blocks (cores) designed for such heat exchangers or condensers, where all surfaces that come in direct contact with the chemical(s) being processed are made from any of the following materials:

1. 'Alloys' with more than 25% nickel and 20% chromium by weight;
2. Fluoropolymers (polymeric or elastomeric materials with more than 35% fluorine by weight);
3. Glass (including vitrified or enamelled coatings or glass lining);
4. Graphite or 'carbon graphite';
5. Nickel or 'alloys' with more than 40% nickel by weight;
6. Tantalum or tantalum 'alloys';
7. Titanium or titanium 'alloys';
8. Zirconium or zirconium 'alloys';
9. Silicon carbide;
10. Titanium carbide; or
11. Niobium (columbium) or niobium 'alloys';

e. Distillation or absorption columns of internal diameter greater than 0,1 m; and liquid distributors, vapour distributors or liquid collectors designed for such distillation or absorption columns, where all surfaces that come in direct contact with the chemical(s) being processed are made from any of the following materials:

1. 'Alloys' with more than 25% nickel and 20% chromium by weight;
2. Fluoropolymers (polymeric or elastomeric materials with more than 35% fluorine by weight);
3. Glass (including vitrified or enamelled coatings or glass lining);
4. Graphite or 'carbon graphite';
5. Nickel or 'alloys' with more than 40% nickel by weight;
6. Tantalum or tantalum 'alloys';
7. Titanium or titanium 'alloys';
8. Zirconium or zirconium 'alloys'; or
9. Niobium (columbium) or niobium 'alloys';

2B350 continued

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:

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

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

g. Valves and components, as follows:

1. Valves, having both of the following:

a. A 'nominal size' greater than 10 mm (3/8"); and

b. All surfaces that come in direct contact with the chemical(s) being produced, processed, or contained are made from 'corrosion resistant materials';

2. Valves, other than those specified in 2B350.g.1., having all of the following;

a. A 'nominal size' equal to or greater than 25,4 mm (1") and equal to or less than 101,6 mm (4");

b. Casings (valve bodies) or preformed casing liners;

c. A closure element designed to be interchangeable; and

d. All surfaces of the casing (valve body) or preformed case liner that come in direct contact with the chemical(s) being produced, processed, or contained are made from 'corrosion resistant materials';

3. Components, designed for valves specified in 2B350.g.1 or 2B350.g.2., in which all surfaces that come in direct contact with the chemical(s) being produced, processed, or contained are made from 'corrosion resistant materials', as follows:

a. Casings (valve bodies);

b. Preformed casing liners;

2B350.g. continued

Technical Notes:

1. For the purposes of 2B350.g., 'corrosion resistant materials' means any of the following materials:

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

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

c. Fluoropolymers (polymeric or elastomeric materials with more than 35% fluorine by weight);

d. Glass or glass-lined (including vitrified or enamelled coating);

e. Tantalum or tantalum alloys;

f. Titanium or titanium alloys;

g. Zirconium or zirconium alloys;

h. Niobium (columbium) or niobium alloys; or

i. Ceramic materials as follows:

1. Silicon carbide with a purity of 80% or more by weight;

2. Aluminium oxide (alumina) with a purity of 99.9% or more by weight;

3. Zirconium oxide (zirconia).

2. The 'nominal size' is defined as the smaller of the inlet and outlet diameters.

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:

1. 'Alloys' with more than 25% nickel and 20% chromium by weight;
2. Fluoropolymers (polymeric or elastomeric materials with more than 35% fluorine by weight);
3. Glass (including vitrified or enamelled coatings or glass lining);
4. Graphite or 'carbon graphite';
5. Nickel or 'alloys'with more than 40% nickel by weight;
6. Tantalum or tantalum 'alloys';
7. Titanium or titanium 'alloys';
8. Zirconium or zirconium 'alloys'; or
9. Niobium (columbium) or niobium 'alloys';

2B350 continued

i. Multiple-seal and seal-less pumps, with manufacturer's specified maximum flow-rate greater than 0,6 m^3/hour, or vacuum pumps with manufacturer's specified maximum flow-rate greater than 5 m^3/hour (under standard temperature (273 K (0^oC)) and pressure (101,3 kPa) conditions), other than those specified in 2B233; and casings (pump bodies), preformed casing liners, impellers, rotors or jet pump nozzles designed for such pumps, in which all surfaces that come in direct contact with the chemical(s) being processed are made from any of the following materials:

1. 'Alloys' with more than 25% nickel and 20% chromium by weight;
2. Ceramics;
3. Ferrosilicon (high silicon iron alloys);
4. Fluoropolymers (polymeric or elastomeric materials with more than 35% fluorine by weight);
5. Glass (including vitrified or enamelled coatings or glass lining);
6. Graphite or 'carbon graphite';
7. Nickel or 'alloys' with more than 40% nickel by weight;
8. Tantalum or tantalum 'alloys';
9. Titanium or titanium 'alloys';
10. Zirconium or zirconium 'alloys'; or
11. Niobium (columbium) or niobium 'alloys';

Technical Note:
In 2B350.i., the term seal refers to only those seals that come into direct contact with the chemical(s) being processed (or are designed to), and provide a sealing function where a rotary or reciprocating drive shaft passes through a pump body.

2B350 continued

j. Incinerators designed to destroy chemicals specified in entry 1C350, having specially designed waste supply systems, special handling facilities and an average combustion chamber temperature greater than 1 273 K (1 000°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:

1. 'Alloys' with more than 25% nickel and 20% chromium by weight;
2. Ceramics; or
3. Nickel or 'alloys' with more than 40% nickel by weight;

k. Prefabricated repair assemblies having metallic surfaces that come in direct contact with the chemical(s) being processed which are made from tantalum or tantalum alloys as follows, and specially designed components therefor:

1. Designed for mechanical attachment to glass-lined reaction vessels or reactors specified in 2B350.a.; or

2. Designed for mechanical attachment to glass-lined storage tanks, containers or receivers specified in 2B350.c.

Note: For the purposes of 2B350, the materials used for gaskets, packing, seals, screws, washers or other materials performing a sealing function do not determine the status of control, provided that such components are designed to be interchangeable.

Technical Notes:

1. 'Carbon graphite' is a composition consisting of amorphous carbon and graphite, in which the graphite content is eight percent or more by weight.
2. For the listed materials in the above entries, the term 'alloy' when not accompanied by a specific elemental concentration is understood as identifying those alloys where the identified metal is present in a higher percentage by weight than any other element.

2B351 Toxic gas monitors and monitoring systems and their dedicated detecting components, other than those specified in 1A004, as follows; and detectors; sensor devices; and replaceable sensor cartridges therefor:

a. Designed for continuous operation and usable for the detection of chemical warfare agents or chemicals specified in 1C350, at concentrations of less than 0,3 mg/m^3; or
b. Designed for the detection of cholinesterase-inhibiting activity.

2B352 Biological manufacturing and handling equipment, as follows:

a. Containment facilities and related equipment as follows:

1. Complete containment facilities that meet the criteria for P3 or P4 (BL3, BL4, L3, L4) containment as specified in the WHO Laboratory Biosafety Manual (3rd edition Geneva, 2004);

2. Equipment designed for fixed installation in containment facilities specified in 2B352.a., as follows:

a. Double-door pass-through decontamination autoclaves;
b. Breathing air suit decontamination showers;
c. Mechanical-seal or inflatable-seal walkthrough doors;

b. Fermenters and components as follows:

1. Fermenters capable of cultivation of "microorganisms" or of live cells for the production of viruses or toxins, without the propagation of aerosols, having a total internal volume of 20 litres or more;

2. Components designed for fermenters specified in 2B352.b.1. as follows:

a. Cultivation chambers designed to be sterilised or disinfected in situ;
b. Cultivation chamber holding devices;
c. Process control units capable of simultaneously monitoring and controlling two or more fermentation system parameters (e.g., temperature, pH, nutrients, agitation, dissolved oxygen, air flow, foam control);

Technical Note:
For the purposes of 2B352.b. fermenters include bioreactors, single-use (disposable) bioreactors, chemostats and continuous-flow systems.

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

1. Flow rate exceeding 100 litres per hour;
2. Components of polished stainless steel or titanium;
3. One or more sealing joints within the steam containment area; and
4. Capable of in-situ steam sterilisation in a closed state;

Technical Note:
Centrifugal separators include decanters.

2B352 continued

d. Cross (tangential) flow filtration equipment and components as follows:

1. Cross (tangential) flow filtration equipment capable of separation of "microorganisms", viruses, toxins or cell cultures having all of the following characteristics:

a. A total filtration area equal to or greater than 1 m^2; and

b. Having any of the following characteristics:

1. Capable of being sterilised or disinfected in-situ; or
2. Using disposable or single-use filtration components;

Technical Note:
In 2B352.d.1.b. sterilised denotes the elimination of all viable microbes from the equipment through the use of either physical (e.g. steam) or chemical agents. Disinfected denotes the destruction of potential microbial infectivity in the equipment through the use of chemical agents with a germicidal effect. Disinfection and sterilisation are distinct from sanitisation, the latter referring to cleaning procedures designed to lower the microbial content of equipment without necessarily achieving elimination of all microbial infectivity or viability.

Note: 2B352.d. does not control reverse osmosis and hemodialysis equipment, as specified by the manufacturer.

2. Cross (tangential) flow filtration components (e.g. modules, elements, cassettes, cartridges, units or plates) with filtration area equal to or greater than 0,2 m^2 for each component and designed for use in cross (tangential) flow filtration equipment specified in 2B352.d.;

e. Steam, gas or vapour sterilisable freeze-drying equipment with a condenser capacity of 10 kg of ice or more in 24 hours and less than 1 000 kg of ice in 24 hours;

2B352 continued

f. Protective and containment equipment, as follows:

1. Protective full or half suits, or hoods dependent upon a tethered external air supply and operating under positive pressure;

Note: 2B352.f.1. does not control suits designed to be worn with self-contained breathing apparatus.

2. Biocontainment chambers, isolators, or biological safety cabinets having all of the following characteristics, for normal operation:

a. Fully enclosed workspace where the operator is separated from the work by a physical barrier;

b. Able to operate at negative pressure;

c. Means to safely manipulate items in the workspace;

d. Supply and exhaust air to and from the workspace is HEPA filtered;

Note 1: 2B352.f.2. includes Class III biosafety cabinets, as described in the latest edition of the WHO Laboratory Biosafety Manual or constructed in accordance with national standards, regulations or guidance.

Note 2: 2B352.f.2. does not include isolators specially designed for barrier nursing or transportation of infected patients.

g. Aerosol inhalation equipment designed for aerosol challenge testing with "microorganisms", viruses or "toxins" as follows:

1. Whole-body exposure chambers having a capacity of 1 m^3 or more;
2. Nose-only exposure apparatus utilising directed aerosol flow and having capacity for exposure of any of the following:

a. 12 or more rodents; or

b. 2 or more animals other than rodents;

3. Closed animal restraint tubes designed for use with nose-only exposure apparatus utilising directed aerosol flow;

2B352 continued

h. Spray drying equipment capable of drying toxins or pathogenic "microorganisms" having all of the following:

1. A water evaporation capacity of ≥ 0,4 kg/h and ≤ 400 kg/h;
2. The ability to generate a typical mean product particle size of ≤10 μm with existing fittings or by minimal modification of the spray-dryer with atomization nozzles enabling generation of the required particle size; and
3. Capable of being sterilised or disinfected in situ;

i. Nucleic acid assemblers and synthesisers, which are partly or entirely automated, and designed to generate continuous nucleic acids greater than 1,5 kilobases in length with error rates less than 5% in a single run.

2C Materials

None.

2D Software

2D001 "Software", other than that specified in 2D002, as follows:

a. "Software" specially designed or modified for the "development" or "production" of equipment specified in 2A001 or 2B001

b. "Software" specially designed or modified for the "use" of equipment specified in 2A001.c, 2B001 or 2B003 to 2B009.

Note: 2D001 does not control part programming "software" that generates "numerical control" codes for machining various parts.

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 co-ordinating simultaneously more than four axes for "contouring control".

Note 1: *2D002 does not control "software" specially designed or modified for the operation of items not specified in Category 2.*

Note 2: *2D002 does not control "software" for items specified in 2B002. See 2D001 and 2D003 for "software" for items specified in 2B002.*

Note 3: *2D002 does not control "software" that is exported with, and the minimum necessary for the operation of, items not specified in Category 2.*

2D003 "Software", designed or modified for the operation of equipment specified in 2B002, that converts optical design, workpiece measurements and material removal functions into "numerical control" commands to achieve the desired workpiece form.

2D101 "Software" specially designed or modified for the "use" of equipment specified in 2B104, 2B105, 2B109, 2B116, 2B117 or 2B119 to 2B122.

N.B. *SEE ALSO 9D004.*

2D201 "Software" specially designed for the "use" of equipment specified in 2B204, 2B206, 2B207, 2B209, 2B219 or 2B227.

2D202 "Software" specially designed or modified for the "development", "production" or "use" of equipment specified in 2B201.

Note: *2D202 does not control part programming "software" that generates "numerical control" command codes but does not allow direct use of equipment for machining various parts.*

2D351 "Software", other than that specified in 1D003, specially designed for "use" of equipment specified in 2B351.

2E Technology

2E001 "Technology" according to the General Technology Note for the "development" of equipment or "software" specified in 2A, 2B or 2D.

Note: 2E001 includes "technology" for the integration of probe systems into coordinate measurement machines specified in 2B006.a.

2E002 "Technology" according to the General Technology Note for the "production" of equipment specified in 2A or 2B.

2E003 Other "technology", as follows:

a. Not used;

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

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

a. "Superplastic forming";
b. "Diffusion bonding"; or
c. 'Direct-acting hydraulic pressing';

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

a. "Superplastic forming" of aluminium alloys, titanium alloys or "superalloys":

1. Surface preparation;
2. Strain rate;
3. Temperature;
4. Pressure;

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

1. Surface preparation;
2. Temperature;
3. Pressure;

2E003.b.2. continued

c. 'Direct-acting hydraulic pressing'of aluminium alloys or titanium alloys:

1. Pressure;
2. Cycle time;

d. 'Hot isostatic densification' of titanium alloys, aluminium alloys or "superalloys":

1. Temperature;
2. Pressure;
3. Cycle time;

Technical Notes:

1. 'Direct-acting hydraulic pressing' is a deformation process which uses a fluid-filled flexible bladder in direct contact with the workpiece.

2. 'Hot isostatic densification' is a process of pressurising a casting at temperatures exceeding 375 K (102°C) in a closed cavity through various media (gas, liquid, solid particles, etc.) to create equal force in all directions to reduce or eliminate internal voids in the casting

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

d. Not used;

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.

2E003 continued

Note: *The table and Technical Note appear after entry 2E301.*

N.B. *This table should be read to specify the "technology" for 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 Vapour Deposition (CVD) coating process technical data are included for the application of silicides to carbon-carbon, ceramic and metal "matrix" "composites" substrates, but are not included 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).*

2E101 "Technology" according to the General Technology Note for the "use" of equipment or "software" specified in 2B004, 2B009, 2B104, 2B109, 2B116, 2B119 to 2B122 or 2D101.

2E201 "Technology" according to the General Technology Note for the "use" of equipment or "software" specified in 2A225, 2A226, 2B001, 2B006, 2B007.b., 2B007.c., 2B008, 2B009, 2B201, 2B204, 2B206, 2B207, 2B209, 2B225 to 2B233, 2D201 or 2D202.

2E301 "Technology" according to the General Technology Note for the "use" of goods specified in 2B350 to 2B352.

TABLE - DEPOSITION TECHNIQUES

1. Coating Process (1)[2]	2. Substrate	3. Resultant Coating
A. Chemical Vapour 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)

[2] The numbers in parenthesis refer to the Notes following this Table.

1. Coating Process (1)[2]	2. Substrate	3. Resultant Coating
Thermal-Evaporation Physical Vapour Deposition (TE-PVD)		
B.1. Physical Vapour 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)

1. Coating Process (1)[2]	2. Substrate	3. Resultant Coating
	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
B.2. Ion assisted resistive heating Physical Vapour Deposition (PVD) (Ion Plating)	Ceramics (19) and Low-expansion glasses	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)

1. Coating Process (1)[2]	2. Substrate	3. Resultant Coating
B.3. Physical Vapour 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 (17)
B.4. Physical Vapour 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)

1. Coating Process (1)[2]	2. Substrate	3. Resultant Coating
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)
	Aluminium alloys (6)	MCrAlX (5) Modified zirconia (12) Silicides Mixtures thereof (4)

1. Coating Process (1)[2]	2. Substrate	3. Resultant Coating
	Refractory metals and alloys (8)	Aluminides Silicides Carbides
	Corrosion resistant steel (7)	MCrAlX (5) Modified zirconia (12) Mixtures thereof (4)
	Titanium alloys (13)	Carbides Aluminides Silicides Alloyed aluminides (2) Abradable Nickel-Graphite Abradable materials containing 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)

1. Coating Process (1)[2]	2. Substrate	3. Resultant Coating
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) Dielectic layers (15) Diamond-like carbon (17)
	Titanium alloys (13)	Borides Nitrides Oxides Silicides Aluminides Alloyed aluminides (2) Carbides

1. Coating Process (1)[2]	2. Substrate	3. Resultant Coating
	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

1. Coating Process (1)[2]	2. Substrate	3. Resultant Coating
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

TABLE - DEPOSITION TECHNIQUES - NOTES

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% by weight in various proportions and combinations, except:

a. CoCrAlY coatings which contain less than 22% by weight of chromium, less than 7% by weight of aluminium and less than 2% by weight of yttrium;

b. CoCrAlY coatings which contain 22 to 24% by weight of chromium, 10 to 12% by weight of aluminium and 0,5 to 0,7% by weight of yttrium; or

c. NiCrAlY coatings which contain 21 to 23% by weight of chromium, 10 to 12% by weight of aluminium and 0,9 to 1,1% by weight of yttrium.

6. The term 'aluminium 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. Category 2 does not include "technology" for single-step pack cementation of solid airfoils.

11. 'Polymers', as follows: polyimide, polyester, polysulphide, 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 stabilise 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 1×10^{-7} 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" for depositing diamond-like carbon on any of the following is not controlled:

magnetic disk drives and heads, equipment for the manufacture of disposables, valves for faucets, acoustic diaphragms for speakers, engine parts for automobiles, cutting tools, punching-pressing dies, office automation equipment, microphones or medical devices or moulds, for casting or moulding of plastics, manufactured from alloys containing less than 5% beryllium.

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.

TABLE - DEPOSITION TECHNIQUES - TECHNICAL NOTE

Processes specified in Column 1 of the Table are defined as follows:

a. Chemical Vapour 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.

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

N.B.2 Pack denotes a substrate immersed in a powder mixture.

N.B.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 Vapour 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.

   N.B. 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 aluminium, chromium, silicon or combinations thereof);

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

3. An inert powder, most frequently alumina.

The substrate and powder mixture is contained within a retort which is heated to between 1 030 K (757°C) and 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.

N.B.1 Low pressure means less than ambient atmospheric pressure.

N.B.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.

N.B.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 vaporisation of non-metallic coating materials.

N.B.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 vapour deposition or sputter deposition.