GOVERNMENT NOTICE

DEPARTMENT OF DEFENCE

No. R. 634 **28 May 2004**

NATIONAL CONVENTIONAL ARMS CONTROL REGULATIONS

The Minister of Defence has, in terms of section 27 of the National Conventional Arms Control Act, 2002 (Act No. 41 of 2002), and with the concurrence of the National Conventional Arms Control Committee, made the regulations in the Schedule.

Government Notice No. R. 1171 of 2 August 1996 is hereby withdrawn.

SCHEDULE

Definitions

1. In these Regulations any expression to which a meaning has been assigned in the Act, shall bear such meaning, and, unless inconsistent with the context-

"apostille stamp" means the validation stamp that is only recognised in countries that are State Parties to The Hague Convention of 1961 and is a special seal applied by the State Parties' authorities to authenticate a document.

"dual-use goods" means the list of conventional arms contained in the Annexure to these regulations.

"munitions list" means the list of conventional arms contained in the Annexure to these regulations.

"**the Act**" means the National Conventional Arms Control Act, 2002 (Act No. 41 of 2002).

Application for permit

2. (1) A person registered in terms of section 13 of the Act as a trader in conventional arms may apply for-

(a) an armaments development and manufacturing permit;

(b) a marketing permit;

(c) a contracting permit;

(d) an export permit;

(e) an import permit;

(f) a conveyance permit.

(2) Conventional arms, incorporating both dual-use goods and munitions, for which a permit must be obtained are listed in the Annexure to these Regulations. All services as defined in the Act also require a permit.

Purposes for which permits may be issued

3. (1) An armaments development and manufacturing permit is required by registered trader to-

(a) develop and manufacture conventional arms;

(b) own or operate conventional arms; and

(c) render brokering services or services related to conventional arms.

(2) A marketing permit is required by a holder of an armaments development and manufacturing permit to-

(a) identify the specific conventional arms listed in the munitions list in which it may trade;

(b) identify services relating to conventional arms in which it may trade; and

(c) enable it to market the conventional arms contemplated in paragraph (a) and the services contemplated in paragraph (b) on the international market.

(3) A contracting permit is required to enable the holder of an armaments development and manufacturing permit to enter into an agreement with a person resident in a foreign country -

(a) to trade in specified conventional arms; and

(b) to render specified brokering services or services relating to conventional arms.

(4)(a) An export permit is required by the holder of an armaments development and manufacturing permit for-

(i) each consignment of conventional arms which is exported from the Republic for the purpose of transferring ownership of the said arms;

(ii) each consignment of conventional arms which is exported for the purpose of integration, repair, demonstration or evaluation without transfer of ownership; and

(iii) services which are exported relating to conventional arms.

(b) Notwithstanding the stipulations contained in 3(4)(a) under special circumstances a single export permit may be issued to cover several consignments.

(5)(a) An import permit is required by the holder of an armaments development and manufacturing permit for-

(i) each consignment of conventional arms as listed in the munitions list which is imported into the Republic for the purpose of transferring ownership of the said arms; and

(ii) each consignment of conventional arms as listed in the munitions list which is imported for the purpose of integration, repair, demonstration or evaluation without transfer of ownership.

(b) Notwithstanding the stipulations contained in 3(5)(a) under special circumstances a single import permit may be issued to cover several consignments.

(6) A conveyance permit is required to enable the holder of an armaments development and manufacturing permit to convey conventional arms owned by a person resident in a foreign country through or over the territory of the Republic of South Africa. Such an application must include a diplomatic note from the government of the country who owns the conventional arms that are to be conveyed through the Republic requesting authorisation for such conveyance.

Conditions for issuing of permits

4. (1) A permit may, subject to the Act, be issued if the conventional arms concerned are not prohibited under international agreements dealing with conventional arms including the-

(a) Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons which may be deemed to be Excessively Injurious or to have Indiscriminate Effects and its annexed Protocols; or

(b) Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Mines and on their Destruction;

(2) An export permit may not be issued for any conventional arms of a calibre of 12.7mm (.50 inch) or smaller, including the ammunition for such arms, that is surplus to State or parastatal stock and have been designated by the Committee for destruction.

Keeping of records

5. A person trading in conventional arms must keep full records and permits of all trade activities relating to his conventional arms trade.

Matters contained in end-user certificate

6. (1) An end-user certificate must contain a certificate by the Department of Foreign Affairs that the end-user certificate is a legal and valid document that has been properly sealed and signed.

(2) An end-user certificate containing an apostille stamp does not require a certificate contemplated in sub-regulation (1).

Applications in terms of Fire Arms Control Act

7. Any application for the export of firearms and ammunition submitted in terms of the Firearms Control Act, 2000 (Act No. 60 of 2000) where the quantity of the firearms exceeds 10 per type and the quantity of ammunition per calibre exceeds 20 000 must be submitted to the Committee by the National Commissioner of the South African Police Service.

WA-LIST (03) 1
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LIST OF DUAL-USE GOODS, TECHNOLOGIES AND MUNITIONS

(The Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies)

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These Lists reflect the agreements recorded in Appendix 5 to the Initial Elements, dated 19 December 1995, and all amendments, including those approved by the Plenary Meeting (10 to 12 December 2003).

DUAL-USE LIST

Note *Terms in "quotations" are defined terms. Refer to 'Definitions of Terms used in these Lists' annexed to this List.*

GENERAL TECHNOLOGY NOTE

The export of "technology" which is "required" for the "development", "production" or "use" of items controlled in the Dual-Use List is controlled according to the provisions in each Category. This "technology" remains under control even when applicable to any uncontrolled item.

Controls do not apply to that "technology" which is the minimum necessary for the installation, operation, maintenance (checking) and repair of those items which are not controlled or whose export has been authorised.

Note *This does not release such "technology" controlled in entries 1.E.2.e. & 1.E.2.f. and 8.E.2.a. & 8.E.2.b.*

Controls do not apply to "technology" "in the public domain", to "basic scientific research" or to the minimum necessary information for patent applications.

GENERAL SOFTWARE NOTE

The Lists do not control "software" which is either:

1. Generally available to the public by being:

    a. Sold from stock at retail selling points without restriction, by means of:
        1. Over-the-counter transactions;
        2. Mail order transactions;
        3. Electronic transactions; or
        4. Telephone call transactions; and

    b. Designed for installation by the user without further substantial support by the supplier; or

    Note *Entry 1 of the General Software Note does not release "software" controlled by Category 5 - Part 2 ("Information Security").*

2. "In the public domain".

DUAL-USE LIST - CATEGORY 1 - ADVANCED MATERIALS

1. A. SYSTEMS, EQUIPMENT AND COMPONENTS

1. A. 1. Components made from fluorinated compounds, as follows:

a. Seals, gaskets, sealants or fuel bladders specially designed for "aircraft" or aerospace use made from more than 50 % by weight of any of the materials controlled by 1.C.9.b. or 1.C.9.c.;

b. Piezoelectric polymers and copolymers made from vinylidene fluoride materials controlled by 1.C.9.a.:
   1. In sheet or film form; and
   2. With a thickness exceeding 200 μm;

c. Seals, gaskets, valve seats, bladders or diaphragms made from fluoroelastomers containing at least one vinylether group as a constitutional unit, specially designed for "aircraft", aerospace or missile use.

1. A. 2. "Composite" structures or laminates, having any of the following:

a. An organic "matrix" and made from materials controlled by 1.C.10.c., 1.C.10.d. or 1.C.10.e.; or

   Note *1.A.2.a does not control finished or semi-finished items specially designed for purely civilian applications as follows:*
   a. Sporting goods;
   b. Automotive industry;
   c. Machine tool industry;
   d. Medical applications.

b. A metal or carbon "matrix" and made from:
   1. Carbon "fibrous or filamentary materials" with:
      a. A specific modulus exceeding 10.15×10^6 m; and
      b. A specific tensile strength exceeding 17.7×10^4 m; or
   2. Materials controlled by 1.C.10.c.

   Note *1.A.2.b. does not control finished or semi-finished items specially designed for purely civilian applications as follows:*
   a. Sporting goods;
   b. Automotive industry;
   c. Machine tool industry;
   d. Medical applications.

DUAL-USE LIST - CATEGORY 1 - ADVANCED MATERIALS

1. A. 2. b. *Technical Notes*

1. Specific modulus: Young's modulus in pascals, equivalent to N/m^2 divided by specific weight in N/m^3, measured at a temperature of (296 ± 2) K ((23 ± 2)°C) and a relative humidity of (50 ± 5)%.

2. Specific tensile strength: ultimate tensile strength in pascals, equivalent to N/m^2 divided by specific weight in N/m^3, measured at a temperature of (296 ± 2) K((23 ± 2)°C) and a relative humidity of (50 ± 5)%.

Note *1.A.2. does not control composite structures or laminates made from epoxy resin impregnated carbon "fibrous or filamentary materials" for the repair of aircraft structures or laminates, provided the size does not exceed 1 m^2.*

1. A. 3. Manufactures of non-fluorinated polymeric substances controlled by 1.C.8.a.3. in film, sheet, tape or ribbon form:

a. With a thickness exceeding 0.254 mm; or

b. Coated or laminated with carbon, graphite, metals or magnetic substances.

Note *1.A.3. does not control manufactures when coated or laminated with copper and designed for the production of electronic printed circuit boards.*

1. A. 4. Protective and detection equipment and components not specially designed for military use, as follows:

a. Gas masks, filter canisters and decontamination equipment therefor designed or modified for defence against biological agents or radioactive materials "adapted for use in war" or chemical warfare (CW) agents and specially designed components therefor;

b. Protective suits, gloves and shoes specially designed or modified for defence against biological agents or radioactive materials "adapted for use in war" or chemical warfare (CW) agents;

c. Nuclear, biological and chemical (NBC) detection systems specially designed or modified for detection or identification of biological agents or radioactive materials "adapted for use in war" or chemical warfare (CW) agents and specially designed components therefor.

Note *1.A.4. does not control :*

a. Personal radiation monitoring dosimeters;

b. Equipment limited by design or function to protect against hazards specific to civil industries, such as mining, quarrying, agriculture, pharmaceuticals, medical, veterinary, environmental, waste management, or to the food industry.

DUAL-USE LIST - CATEGORY 1 - ADVANCED MATERIALS

1. A. 5. Body armour, and specially designed components therefor, not manufactured to military standards or specifications, nor to their equivalents in performance.

N.B. *For "fibrous or filamentary materials" used in the manufacture of body amour, see entry 1.C.10.*

Note 1 *1.A.5. does not control body armour or protective garments when accompanying their user for the user's own personal protection.*

Note 2 *1.A.5. does not control body armour designed to provide frontal protection only from both fragment and blast from non-military explosive devices.*

1. B. TEST, INSPECTION AND PRODUCTION EQUIPMENT

1. B. 1. Equipment for the production of fibres, prepregs, preforms or "composites" controlled by 1.A.2. or 1.C.10., as follows, and specially designed components and accessories therefor:

a. Filament winding machines of which the motions for positioning, wrapping and winding fibres are coordinated and programmed in three or more axes, specially designed for the manufacture of "composite" structures or laminates from "fibrous or filamentary materials";

b. Tape-laying or tow-placement machines of which the motions for positioning and laying tape, tows or sheets are coordinated and programmed in two or more axes, specially designed for the manufacture of "composite" airframe or missile structures;

c. Multidirectional, multidimensional weaving machines or interlacing machines, including adapters and modification kits, for weaving, interlacing or braiding fibres to manufacture "composite" structures;
Technical Note
For the purposes of 1.B.1.c. the technique of interlacing includes knitting.

Note *1.B.1.c. does not control textile machinery not modified for the above end-uses.*

d. Equipment specially designed or adapted for the production of reinforcement fibres, as follows:
1. Equipment for converting polymeric fibres (such as polyacrylonitrile, rayon, pitch or polycarbosilane) into carbon fibres or silicon carbide fibres, including special equipment to strain the fibre during heating;
2. Equipment for the chemical vapour deposition of elements or compounds on heated filamentary substrates to manufacture silicon carbide fibres;
3. Equipment for the wet-spinning of refractory ceramics (such as aluminium oxide);
4. Equipment for converting aluminium containing precursor fibres into alumina fibres by heat treatment;

DUAL-USE LIST - CATEGORY 1 - ADVANCED MATERIALS

1. B. 1. e. Equipment for producing prepregs controlled by 1.C.10.e. by the hot melt method;

f. Non-destructive inspection equipment capable of inspecting defects three dimensionally, using ultrasonic or X-ray tomography and specially designed for "composite" materials.

1. B. 2. Equipment for producing metal alloys, metal alloy powder or alloyed materials, specially designed to avoid contamination and specially designed for use in one of the processes specified in Item 1.C.2.c.2.

1. B. 3. Tools, dies, moulds or fixtures, for "superplastic forming" or "diffusion bonding" titanium or aluminium or their alloys, specially designed for the manufacture of:
a. Airframe or aerospace structures;
b. "Aircraft" or aerospace engines; or
c. Specially designed components for those structures or engines.

1. C. MATERIALS

Technical Note

Metals and alloys
Unless provision to the contrary is made, the words 'metals' and 'alloys' cover crude and semi-fabricated forms, as follows:

Crude forms
Anodes, balls, bars (including notched bars and wire bars), billets, blocks, blooms, brickets, cakes, cathodes, crystals, cubes, dice, grains, granules, ingots, lumps, pellets, pigs, powder, rondelles, shot, slabs, slugs, sponge, sticks;

Semi-fabricated forms (whether or not coated, plated, drilled or punched):
a. Wrought or worked materials fabricated by rolling, drawing, extruding, forging, impact extruding, pressing, graining, atomising, and grinding, i.e.: angles, channels, circles, discs, dust, flakes, foils and leaf, forging, plate, powder, pressings and stampings, ribbons, rings, rods (including bare welding rods, wire rods, and rolled wire), sections, shapes, sheets, strip, pipe and tubes (including tube rounds, squares, and hollows), drawn or extruded wire;
b. Cast material produced by casting in sand, die, metal, plaster or other types of moulds, including high pressure castings, sintered forms, and forms made by powder metallurgy.

The object of the control should not be defeated by the export of non-listed forms alleged to be finished products but representing in reality crude forms or semi-fabricated forms.

DUAL-USE LIST - CATEGORY 1 - ADVANCED MATERIALS

1. C. 1. Materials specially designed for use as absorbers of electromagnetic waves, or intrinsically conductive polymers, as follows:

a. Materials for absorbing frequencies exceeding 2×10^8 Hz but less than 3×10^{12} Hz;

Note 1 *1.C.1.a. does not control:*

a. Hair type absorbers, constructed of natural or synthetic fibres, with non-magnetic loading to provide absorption;

b. Absorbers having no magnetic loss and whose incident surface is non-planar in shape, including pyramids, cones, wedges and convoluted surfaces;

c. Planar absorbers, having all of the following characteristics:

1. Made from any of the following:

a. Plastic foam materials (flexible or non-flexible) with carbon-loading, or organic materials, including binders, providing more than 5% echo compared with metal over a bandwidth exceeding ±15% of the centre frequency of the incident energy, and not capable of withstanding temperatures exceeding 450 K (177° C); or

b. Ceramic materials providing more than 20% echo compared with metal over a bandwidth exceeding ±15% of the centre frequency of the incident energy, and not capable of withstanding temperatures exceeding 800 K (527°C);

Technical Note

Absorption test samples for 1.C.1.a. Note 1.c.1. should be a square at least 5 wavelengths of the centre frequency on a side and positioned in the far field of the radiating element.

2. Tensile strength less than 7×10^6 N/m^2; and

3. Compressive strength less than 14×10^6 N/m^2;

d. Planar absorbers made of sintered ferrite, having:

1. A specific gravity exceeding 4.4; and

2. A maximum operating temperature of 540 K (267°C).

Note 2 *Nothing in Note 1 releases magnetic materials to provide absorption when contained in paint.*

1. C. 1. b. Materials for absorbing frequencies exceeding 1.5×10^{14} Hz but less than 3.7×10^{14} Hz and not transparent to visible light;

DUAL-USE LIST - CATEGORY 1 - ADVANCED MATERIALS

1. C. 1. c. Intrinsically conductive polymeric materials with a bulk electrical conductivity exceeding 10,000 S/m (Siemens per metre) or a sheet (surface) resistivity of less than 100 ohms/square, based on any of the following polymers:
   1. Polyaniline;
   2. Polypyrrole;
   3. Polythiophene;
   4. Poly phenylene-vinylene; or
   5. Poly thienylene-vinylene.

   Technical Note

   Bulk electrical conductivity and sheet (surface) resistivity should be determined using ASTM D-257 or national equivalents.

1. C. 2. Metal alloys, metal alloy powder and alloyed materials, as follows:

   Note *1.C.2. does not control metal alloys, metal alloy powder and alloyed materials for coating substrates.*

   Technical Notes

   1. *The metal alloys in 1.C.2. are those containing a higher percentage by weight of the stated metal than of any other element.*
   2. *Stress-rupture life should be measured in accordance with ASTM standard E-139 or national equivalents.*
   3. *Low cycle fatigue life should be measured in accordance with ASTM Standard E-606 'Recommended Practice for Constant-Amplitude Low-Cycle Fatigue Testing' or national equivalents. Testing should be axial with an average stress ratio equal to 1 and a stress-concentration factor (K_t) equal to 1. The average stress is defined as maximum stress minus minimum stress divided by maximum stress.*

1. C. 2. a. Aluminides, as follows:
   1. Nickel aluminides containing a minimum of 15 weight percent aluminium, a maximum of 38 weight percent aluminium and at least one additional alloying element;
   2. Titanium aluminides containing 10 weight percent or more aluminium and at least one additional alloying element;

   b. Metal alloys, as follows, made from material controlled by 1.C.2.c.:
      1. Nickel alloys with:
         a. A stress-rupture life of 10,000 hours or longer at 923 K (650°C) at a stress of 676 MPa; or
         b. A low cycle fatigue life of 10,000 cycles or more at 823 K (550° C) at a maximum stress of 1,095 MPa;
      2. Niobium alloys with:
         a. A stress-rupture life of 10,000 hours or longer at 1,073 K (800°C) at a stress of 400 MPa; or
         b. A low cycle fatigue life of 10,000 cycles or more at 973 K (700°C) at a maximum stress of 700 MPa;

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1. C. 2. b. 3. Titanium alloys with:
   a. A stress-rupture life of 10,000 hours or longer at 723 K (450°C) at a stress of 200 MPa; or
   b. A low cycle fatigue life of 10,000 cycles or more at 723 K (450°C) at a maximum stress of 400 MPa;
4. Aluminium alloys with a tensile strength of:
   a. 240 MPa or more at 473 K (200°C); or
   b. 415 MPa or more at 298 K (25°C);
5. Magnesium alloys with:
   a. A tensile strength of 345 MPa or more; and
   b. A corrosion rate of less than 1 mm/year in 3% sodium chloride aqueous solution measured in accordance with ASTM standard G-31 or national equivalents;

1. C. 2. c. Metal alloy powder or particulate material, having all of the following characteristics:
1. Made from any of the following composition systems:
Technical Note
X in the following equals one or more alloying elements.
   a. Nickel alloys (Ni-Al-X, Ni-X-Al) qualified for turbine engine parts or components, i.e. with less than 3 non-metallic particles (introduced during the manufacturing process) larger than 100 µm in 10^9 alloy particles;
   b. Niobium alloys (Nb-Al-X or Nb-X-Al, Nb-Si-X or Nb-X-Si, Nb-Ti-X or Nb-X-Ti);
   c. Titanium alloys (Ti-Al-X or Ti-X-Al);
   d. Aluminium alloys (Al-Mg-X or Al-X-Mg, Al-Zn-X or Al-X-Zn, Al-Fe-X or Al-X-Fe); or
   e. Magnesium alloys (Mg-Al-X or Mg-X-Al); and
2. Made in a controlled environment by any of the following processes:
   a. "Vacuum atomisation";
   b. "Gas atomisation";
   c. "Rotary atomisation";
   d. "Splat quenching";
   e. "Melt spinning" and "comminution";
   f. "Melt extraction" and "comminution"; or
   g. "Mechanical alloying";
3. Capable of forming materials controlled by 1.C.2.a. or 1.C.2.b.;

1. C. 2. d. Alloyed materials, having all of the following characteristics:
1. Made from any of the composition systems specified in 1.C.2.c.1.;
2. In the form of uncomminuted flakes, ribbons or thin rods; and
3. Produced in a controlled environment by any of the following:
   a. "Splat quenching";
   b. "Melt spinning" or;

DUAL-USE LIST - CATEGORY 1 - ADVANCED MATERIALS

c. "Melt extraction";

1. C. 3. Magnetic metals, of all types and of whatever form, having any of the following characteristics:

a. Initial relative permeability of 120,000 or more and a thickness of 0.05 mm or less;
Technical Note
Measurement of initial permeability must be performed on fully annealed materials.

b. Magnetostrictive alloys, having any of the following characteristics:
1. A saturation magnetostriction of more than 5×10^{-4}; or
2. A magnetomechanical coupling factor (k) of more than 0.8; or

c. Amorphous or nanocrystalline alloy strips, having all of the following characteristics:
1. A composition having a minimum of 75 weight percent of iron, cobalt or nickel;
2. A saturation magnetic induction (B_S) of 1.6 T or more; and
3. Any of the following:
a. A strip thickness of 0.02 mm or less; or
b. An electrical resistivity of 2×10^{-4} ohm cm or more.

Technical Note
'Nanocrystalline' materials in 1.C.3.c. are those materials having a crystal grain size of 50 nm or less, as determined by X-ray diffraction.

1. C. 4. Uranium titanium alloys or tungsten alloys with a "matrix" based on iron, nickel or copper, having all of the following:
a. A density exceeding 17.5 g/cm^3;
b. An elastic limit exceeding 880 MPa;
c. An ultimate tensile strength exceeding 1,270 MPa; and
d. An elongation exceeding 8%.

1. C. 5. "Superconductive" "composite" conductors in lengths exceeding 100 m or with a mass exceeding 100 g, as follows:
a. Multifilamentary "superconductive" "composite" conductors containing one or more niobium-titanium filaments:
1. Embedded in a "matrix" other than a copper or copper-based mixed "matrix"; or
2. Having a cross-section area less than 0.28×10^{-4} mm^2 (6 µm in diameter for circular filaments);

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1. C. 5. b. "Superconductive" "composite" conductors consisting of one or more "superconductive" filaments other than niobium-titanium, having all of the following:
   1. A "critical temperature" at zero magnetic induction exceeding 9.85 K (-263.31°C) but less than 24 K (-249.16°C);
   2. A cross-section area less than 0.28×10^{-4} mm^2; and
   3. Remaining in the "superconductive" state at a temperature of 4.2 K (-268.96°C) when exposed to a magnetic field corresponding to a magnetic induction of 12 T.

1. C. 6. Fluids and lubricating materials, as follows:
   a. Hydraulic fluids containing, as their principal ingredients, any of the following compounds or materials:
      1. Synthetic silahydrocarbon oils, having all of the following:
         Technical Note
         For the purpose of 1.C.6.a.1., silahydrocarbon oils contain exclusively silicon, hydrogen and carbon.
         a. A flash point exceeding 477 K (204°C);
         b. A pour point at 239 K (-34°C) or less;
         c. A viscosity index of 75 or more; and
         d. A thermal stability at 616 K (343°C); or
      2. Chlorofluorocarbons, having all of the following:
         Technical Note
         For the purpose of 1.C.6.a.2., chlorofluorocarbons contain exclusively carbon, fluorine and chlorine.
         a. No flash point;
         b. An autogenous ignition temperature exceeding 977 K (704°C);
         c. A pour point at 219 K (-54°C) or less;
         d. A viscosity index of 80 or more; and
         e. A boiling point at 473 K (200°C) or higher;
   b. Lubricating materials containing, as their principal ingredients, any of the following compounds or materials:
      1. Phenylene or alkylphenylene ethers or thio-ethers, or their mixtures, containing more than two ether or thio-ether functions or mixtures thereof; or
      2. Fluorinated silicone fluids with a kinematic viscosity of less than 5,000 mm^2/s (5,000 centistokes) measured at 298 K (25°C);
   c. Damping or flotation fluids with a purity exceeding 99.8%, containing less than 25 particles of 200 µm or larger in size per 100 ml and made from at least 85% of any of the following compounds or materials:
      1. Dibromotetrafluoroethane;
      2. Polychlorotrifluoroethylene (oily and waxy modifications only); or
      3. Polybromotrifluoroethylene;

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1. C. 6. d. Fluorocarbon electronic cooling fluids, having all of the following characteristics:
   1. Containing 85% by weight or more of any of the following, or mixtures thereof:
      a. Monomeric forms of perfluoropolyalkylether-triazines or perfluoroaliphatic-ethers;
      b. Perfluoroalkylamines;
      c. Perfluorocycloalkanes; or
      d. Perfluoroalkanes;
   2. Density at 298 K (25°C) of 1.5 g/ml or more;
   3. In a liquid state at 273 K (0°C); and
   4. Containing 60% or more by weight of fluorine.

Technical Note

For the purpose of 1.C.6.:

a. Flash point is determined using the Cleveland Open Cup Method described in ASTM D-92 or national equivalents;

b. Pour point is determined using the method described in ASTM D-97 or national equivalents;

c. Viscosity index is determined using the method described in ASTM D-2270 or national equivalents;

d. Thermal stability is determined by the following test procedure or national equivalents:

Twenty ml of the fluid under test is placed in a 46 ml type 317 stainless steel chamber containing one each of 12.5 mm (nominal) diameter balls of M-10 tool steel, 52100 steel and naval bronze (60% Cu, 39% Zn, 0.75% Sn);

The chamber is purged with nitrogen, sealed at atmospheric pressure and the temperature raised to and maintained at 644 ± 6 K (371 ± 6°C) for six hours;

The specimen will be considered thermally stable if, on completion of the above procedure, all of the following conditions are met:

1. The loss in weight of each ball is less than 10 mg/mm^2 of ball surface;

2. The change in original viscosity as determined at 311 K (38°C) is less than 25%; and

3. The total acid or base number is less than 0.40;

e. Autogenous ignition temperature is determined using the method described in ASTM E-659 or national equivalents.

DUAL-USE LIST - CATEGORY 1 - ADVANCED MATERIALS

1. C. 7. Ceramic base materials, non-"composite" ceramic materials, ceramic-"matrix" "composite" materials and precursor materials, as follows:

a. Base materials of single or complex borides of titanium having total metallic impurities, excluding intentional additions, of less than 5,000 ppm, an average particle size equal to or less than 5 μm and no more than 10% of the particles larger than 10 μm;

b. Non-"composite" ceramic materials in crude or semi-fabricated form, composed of borides of titanium with a density of 98% or more of the theoretical density;
Note *1.C.7.b. does not control abrasives.*

c. Ceramic-ceramic "composite" materials with a glass or oxide-"matrix" and reinforced with fibres having all of the following:
1. Made from any of the following materials:
a. Si-N;
b. Si-C;
c. Si-Al-O-N; or
d. Si-O-N; and
2. Having a specific tensile strength exceeding 12.7×10^3m;

d. Ceramic-ceramic "composite" materials, with or without a continuous metallic phase, incorporating particles, whiskers or fibres, where carbides or nitrides of silicon, zirconium or boron form the "matrix";

e. Precursor materials (i.e., special purpose polymeric or metallo-organic materials) for producing any phase or phases of the materials controlled by 1.C.7.c., as follows:
1. Polydiorganosilanes (for producing silicon carbide);
2. Polysilazanes (for producing silicon nitride);
3. Polycarbosilazanes (for producing ceramics with silicon, carbon and nitrogen components);

f. Ceramic-ceramic "composite" materials with an oxide or glass "matrix" reinforced with continuous fibres from any of the following systems:
1. Al_2O_3; or
2. Si-C-N.
Note *1.C.7.f. does not control "composites" containing fibres from these systems with a fibre tensile strength of less than 700 MPa at 1,273 K (1,000° C) or fibre tensile creep resistance of more than 1% creep strain at 100 MPa load and 1,273 K (1,000° C) for 100 hours.*

DUAL-USE LIST - CATEGORY 1 - ADVANCED MATERIALS

1. C. 8. Non-fluorinated polymeric substances, as follows:

a. 1. Bismaleimides;
2. Aromatic polyamide-imides;
3. Aromatic polyimides;
4. Aromatic polyetherimides having a glass transition temperature (T_g) exceeding 513 K (240° C) determined using the dry method described in ASTM D 3418;

Note *1.C.8.a. does not control non-fusible compression moulding powders or moulded forms.*

b. Thermoplastic liquid crystal copolymers having a heat distortion temperature exceeding 523 K (250°C) measured according to ASTM D-648, method A, or national equivalents, with a load of 1.82 N/mm^2 and composed of:
1. Any of the following:
a. Phenylene, biphenylene or naphthalene; or
b. Methyl, tertiary-butyl or phenyl substituted phenylene, biphenylene or naphthalene; and
2. Any of the following acids:
a. Terephthalic acid;
b. 6-hydroxy-2 naphthoic acid; or
c. 4-hydroxybenzoic acid;

c. Polyarylene ether ketones, as follows:
1. Polyether ether ketone (PEEK);
2. Polyether ketone ketone (PEKK);
3. Polyether ketone (PEK);
4. Polyether ketone ether ketone ketone (PEKEKK);

d. Polyarylene ketones;

e. Polyarylene sulphides, where the arylene group is biphenylene, triphenylene or combinations thereof;

f. Polybiphenylenethersulphone.

Technical Note
The glass transition temperature (Tg) for 1.C.8. materials is determined using the method described in ASTM D 3418 using the dry method.

1. C. 9. Unprocessed fluorinated compounds, as follows:

a. Copolymers of vinylidene fluoride having 75% or more beta crystalline structure without stretching;
b. Fluorinated polyimides containing 10% by weight or more of combined fluorine;
c. Fluorinated phosphazene elastomers containing 30% by weight or more of combined fluorine.

DUAL-USE LIST - CATEGORY 1 - ADVANCED MATERIALS

1. C. 10. "Fibrous or filamentary materials" which may be used in organic "matrix", metallic "matrix" or carbon "matrix" "composite" structures or laminates, as follows:

a. Organic "fibrous or filamentary materials", having all of the following:
   1. A specific modulus exceeding 12.7×10^6 m; and
   2. A specific tensile strength exceeding 23.5×10^4 m;

   Note *1.C.10.a. does not control polyethylene.*

b. Carbon "fibrous or filamentary materials", having all of the following:
   1. A specific modulus exceeding 12.7×10^6 m; and
   2. A specific tensile strength exceeding 23.5×10^4 m;

   Technical Note
   Properties for materials described in 1.C.10.b. should be determined using SACMA recommended methods SRM 12 to 17, or national equivalent tow tests, such as Japanese Industrial Standard JIS-R-7601, Paragraph 6.6.2., and based on lot average.

   Note *1.C.10.b. does not control fabric made from "fibrous or filamentary materials" for the repair of aircraft structures or laminates, in which the size of individual sheets does not exceed 50 cm x 90 cm.*

c. Inorganic "fibrous or filamentary materials", having all of the following:
   1. A specific modulus exceeding 2.54×10^6 m; and
   2. A melting, softening, decomposition or sublimation point exceeding 1,922 K (1,649°C) in an inert environment;

   Note *1.C.10.c. does not control:*
      1. *Discontinuous, multiphase, polycrystalline alumina fibres in chopped fibre or random mat form, containing 3 weight percent or more silica, with a specific modulus of less than 10×10^6 m;*
      2. *Molybdenum and molybdenum alloy fibres;*
      3. *Boron fibres;*
      4. *Discontinuous ceramic fibres with a melting, softening, decomposition or sublimation point lower than 2,043 K (1,770°C) in an inert environment.*

d. "Fibrous or filamentary materials":
   1. Composed of any of the following:
      a. Polyetherimides controlled by 1.C.8.a; or
      b. Materials controlled by 1.C.8.b. to 1.C.8.f.; or
   2. Composed of materials controlled by 1.C.10.d.1.a. or 1.C.10.d.1.b. and "commingled" with other fibres controlled by 1.C.10.a., 1.C.10.b. or 1.C.10.c.;

DUAL-USE LIST - CATEGORY 1 - ADVANCED MATERIALS

1. C. 10. e. Resin-impregnated or pitch-impregnated fibres (prepregs), metal or carbon-coated fibres (preforms) or "carbon fibre preforms", as follows:
   1. Made from "fibrous or filamentary materials" controlled by 1.C.10.a., 1.C.10.b. or 1.C.10.c.;
   2. Made from organic or carbon "fibrous or filamentary materials":
      a. With a specific tensile strength exceeding 17.7×10^4 m;
      b. With a specific modulus exceeding 10.15×10^6 m;
      c. Not controlled by 1.C.10.a. or 1.C.10.b.; and
      d. When impregnated with materials controlled by 1.C.8. or 1.C.9.b., having a glass transition temperature (T_g) exceeding 383 K (110°C) or with phenolic or epoxy resins, having a glass transition temperature (T_g) equal to or exceeding 418 K (145°C).

Notes *1.C.10.e. does not control:*
   1. *Epoxy resin "matrix" impregnated carbon "fibrous or filamentary materials" (prepregs) for the repair of aircraft structures or laminates, in which the size of individual sheets of prepreg does not exceed 50 cm x 90 cm;*
   2. *Prepregs when impregnated with phenolic or epoxy resins having a glass transition temperature (Tg) less than 433 K (160°C) and a cure temperature lower than the glass transition temperature.*

Technical Note
The glass transition temperature (Tg) for 1.C.10.e. materials is determined using the method described in ASTM D 3418 using the dry method. The glass transition temperature for phenolic and epoxy resins is determined using the method described in ASTM D 4065 at a frequency of 1Hz and a heating rate of 2 K (°C) per minute using the dry method.

Technical Notes
1. *Specific modulus: Young's modulus in pascals, equivalent to N/m^2 divided by specific weight in N/m^3, measured at a temperature of (296 ± 2) K ((23 ± 2)°C) and a relative humidity of (50 ± 5)%.*
2. *Specific tensile strength: ultimate tensile strength in pascals, equivalent to N/m^2 divided by specific weight in N/m^3, measured at a temperature of (296 ± 2) K ((23 ± 2)°C) and a relative humidity of (50 ± 5)%.*

1. C. 11. Metals and compounds, as follows:
   a. Metals in particle sizes of less than 60 µm whether spherical, atomised, spheroidal, flaked or ground, manufactured from material consisting of 99% or more of zirconium, magnesium and alloys of these;
   Technical Note
   The natural content of hafnium in the zirconium (typically 2% to 7%) is counted with the zirconium.

   Note *The metals or alloys listed in 1.C.11.a. are controlled whether or not the metals or alloys are encapsulated in aluminium, magnesium, zirconium or beryllium.*

DUAL-USE LIST - CATEGORY 1 - ADVANCED MATERIALS

1. C. 11. b. Boron or boron carbide of 85% purity or higher and a particle size of 60 μm or less;

Note *The metals or alloys listed in 1.C.11.b. are controlled whether or not the metals or alloys are encapsulated in aluminium, magnesium, zirconium or beryllium.*

c. Guanidine nitrate;

d. Nitroguanidine (NQ) (CAS 556-88-7).

1. C. 12. Materials as follows:

Technical Note

These materials are typically used for nuclear heat sources.

a. Plutonium in any form with a plutonium isotopic assay of plutonium-238 of more than 50% by weight;

Note *1.C.12.a. does not control:*

1. Shipments with a plutonium content of 1 g or less;

2. Shipments of 3 "effective grams" or less when contained in a sensing component in instruments.

b. "Previously separated" neptunium-237 in any form.

Note *1.C.12.b. does not control shipments with a neptunium-237 content of 1 g or less.*

1. D. SOFTWARE

1. D. 1. "Software" specially designed or modified for the "development", "production" or "use" of equipment controlled by 1.B.

1. D. 2. "Software" for the "development" of organic "matrix", metal "matrix" or carbon "matrix" laminates or "composites".

1. E. TECHNOLOGY

1. E. 1. "Technology" according to the General Technology Note for the "development" or "production" of equipment or materials controlled by 1.A.1.b., 1.A.1.c., 1.A.2. to 1.A.5., 1.B. or 1.C.

1. E. 2. Other "technology", as follows:

a. "Technology" for the "development" or "production" of polybenzothiazoles or polybenzoxazoles;

b. "Technology" for the "development" or "production" of fluoroelastomer compounds containing at least one vinylether monomer;

DUAL-USE LIST - CATEGORY 1 - ADVANCED MATERIALS

1. E. 2. c. "Technology" for the design or "production" of the following base materials or non-"composite" ceramic materials:

1. Base materials having all of the following characteristics:

a. Any of the following compositions:

1. Single or complex oxides of zirconium and complex oxides of silicon or aluminium;
2. Single nitrides of boron (cubic crystalline forms);
3. Single or complex carbides of silicon or boron; or
4. Single or complex nitrides of silicon;

b. Total metallic impurities, excluding intentional additions, of less than:

1. 1,000 ppm for single oxides or carbides; or
2. 5,000 ppm for complex compounds or single nitrides;

and

c. Being any of the following:

1. Zirconia with an average particle size equal to or less than 1 μm and no more than 10% of the particles larger than 5 μm;
2. Other base materials with an average particle size equal to or less than 5 μm and no more than 10% of the particles larger than 10 μm; or
3. Having all of the following:
   a. Platelets with a length to thickness ratio exceeding 5;
   b. Whiskers with a length to diameter ratio exceeding 10 for diameters less than 2 μm; and
   c. Continuous or chopped fibres less than 10 μm in diameter;

2. Non-"composite" ceramic materials composed of the materials described in 1.E.2.c.1.;

Note *1.E.2.c.2. does not control technology for the design or production of abrasives.*

1. E. 2. d. "Technology" for the "production" of aromatic polyamide fibres;

e. "Technology" for the installation, maintenance or repair of materials controlled by 1.C.1.;

f. "Technology" for the repair of "composite" structures, laminates or materials controlled by 1.A.2., 1.C.7.c. or 1.C.7.d.

Note *1.E.2.f. does not control "technology" for the repair of "civil aircraft" structures using carbon "fibrous or filamentary materials" and epoxy resins, contained in aircraft manufacturers' manuals.*

DUAL-USE LIST - CATEGORY 2 - MATERIALS PROCESSING

2. A. SYSTEMS, EQUIPMENT AND COMPONENTS

N.B. For quiet running bearings, see Item 9 on the Munitions List. *

2. A. 1. Anti-friction bearings and bearing systems, as follows, and components therefor:

Note 2.A.1. does not control balls with tolerances specified by the manufacturer in accordance with ISO 3290 as grade 5 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 ANSI/ABMA Std 20 Tolerance Class ABEC-7 or RBEC-7, or other national equivalents), or better, and having both rings and rolling elements (ISO 5593) made from monel or beryllium;

Note 2.A.1.a. does not control tapered roller bearings.

b. Other ball bearings and solid roller bearings having all tolerances specified by the manufacturer in accordance with ISO 492 Tolerance Class 2 (or ANSI/ABMA Std 20 Tolerance Class ABEC-9 or RBEC-9, or other national equivalents), or better;

Note 2.A.1.b. does not control tapered roller bearings.

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.

2. B. 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 2.B, the number of axes which can be co-ordinated simultaneously for "contouring control" is the number of axes which affect relative movement between any one workpiece and a tool, cutting head or grinding wheel which is cutting or removing material from the workpiece. This does not include any additional axes which affect other relative movement within the machine. Such axes include:
   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.

* France, the Russian Federation and Ukraine view this list as a reference list drawn up to help in the selection of dual-use goods which could contribute to the indigenous development, production or enhancement of conventional munitions capabilities.

DUAL-USE LIST - CATEGORY 2 - MATERIALS PROCESSING

Technical Notes contd.

3. *Axis nomenclature shall be in accordance with International Standard ISO 841, 'Numerical Control Machines - Axis and Motion Nomenclature'.*
4. *For the purposes of this Category a "tilting spindle" is counted as a rotary axis.*
5. *Stated positioning accuracy levels derived from measurements made according to ISO 230/2 (1997) or national equivalents may be used for each machine tool model instead of individual machine tests. Stated positioning accuracy means the accuracy value provided to national licensing authorities as representative of the accuracy of a machine model.*

Determination of Stated Values

a. *Select five machines of a model to be evaluated;*
b. *Measure the linear axis accuracies according to ISO 230/2 (1997);*
c. *Determine the A-values for each axis of each machine. The method of calculating the A-value is described in the ISO standard;*
d. *Determine the mean value of the A-value of each axis. This mean value $\bar{A}$ becomes the stated value of each axis for the model ($\bar{A}x$ $\bar{A}y$...);*
e. *Since the Category 2 list refers to each linear axis there will be as many stated values as there are linear axes;*
f. *If any axis of a machine model not controlled by 2.B.1.a. to 2.B.1.c. has a stated accuracy $\bar{A}$ of 5 microns for grinding machines and 6.5 microns for milling and turning machines or better, the builder should be required to reaffirm the accuracy level once every eighteen months.*

2. B. 1. 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", and specially designed components as follows:

Note 1 *2.B.1. does not control special purpose machine tools limited to the manufacture of gears. For such machines, see Item 2.B.3.*

Note 2 *2.B.1. does not control special purpose machine tools limited to the manufacture of any of the following parts:*
a. *Crank shafts or cam shafts;*
b. *Tools or cutters;*
c. *Extruder worms;*
d. *Engraved or facetted jewellery parts;*

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 2.B.1.a., b. or c.*

2. B. 1. a. Machine tools for turning, having all of the following characteristics:

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1. Positioning accuracy with "all compensations available" equal to or less (better) than 4.5 µm according to ISO 230/2 (1997) or national equivalents along any linear axis; and
2. Two or more axes which can be coordinated simultaneously for "contouring control";

Note *2.B.1.a. does not control turning machines specially designed for the production of contact lenses.*

2. B. 1. b. Machine tools for milling, having any of the following characteristics:
   1. Having all of the following:
      a. Positioning accuracy with "all compensations available" equal to or less (better) than 4.5 µm according to ISO 230/2 (1997) or national equivalents along any linear axis; and
      b. Three linear axes plus one rotary axis which can be coordinated simultaneously for "contouring control";
   2. Five or more axes which can be coordinated simultaneously for "contouring control"; or
   3. A positioning accuracy for jig boring machines, with "all compensations available", equal to or less (better) than 3.0 µm according to ISO 230/2 (1997) or national equivalents along any linear axis;
   4. Fly cutting machines, having all of the following characteristics:
      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.

2. B. 1. c. Machine tools for grinding, having any of the following characteristics:
   1. Having all of the following:
      a. Positioning accuracy with "all compensations available" equal to or less (better) than 3.0 µm according to ISO 230/2 (1997) or national equivalents along any linear axis; and
      b. Three or more axes which can be coordinated simultaneously for "contouring control"; or
   2. Five or more axes which can be coordinated simultaneously for "contouring control";

Notes *2.B.1.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 the following characteristics:*

DUAL-USE LIST - CATEGORY 2 - MATERIALS PROCESSING

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. Surface grinders.

2. B. 1. 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";

2. B. 1. e. Machine tools for removing metals, ceramics or "composites" having all of the following characteristics:
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. Having two or more rotary axes which:
a. Can be coordinated simultaneously for "contouring control"; and
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.

2. B. 2. Numerically controlled machine tools using a magnetorheological finishing (MRF) process.

Technical Note
For the purposes of 2.B.2., 'MRF' is a material removal process using an abrasive magnetic fluid whose viscosity is controlled by a magnetic field.

2. B. 3. "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).

2. B. 4. Hot "isostatic presses", having all of the following, and specially designed components and accessories therefor:
a. A controlled thermal environment within the closed cavity and a chamber cavity with an inside diameter of 406 mm or more; and
b. 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.

Technical Note

DUAL-USE LIST - CATEGORY 2 - MATERIALS PROCESSING

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 Items 1.B.3., 9.B.9. and ML18. of the Munitions List. *

2. B. 5. Equipment specially designed for the deposition, processing and in-process control of inorganic overlays, coatings and surface modifications, as follows, for non-electronic substrates, by processes shown in the Table and associated Notes following 2.E.3.f., and specially designed automated handling, positioning, manipulation and control components therefor:

a. "Stored programme controlled" chemical vapour deposition (CVD) production equipment having all of the following:
   1. 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. 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. "Stored programme controlled" ion implantation production equipment having beam currents of 5 mA or more;

c. "Stored programme controlled" electron beam physical vapour deposition (EB-PVD) production equipment incorporating power systems rated for over 80 kW, 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. "Stored programme controlled" plasma spraying production equipment having any of the following characteristics:
   1. Operating at reduced pressure controlled atmosphere (equal to or less than 10 kPa measured above and within 300 mm of the gun nozzle exit) in a vacuum chamber capable of evacuation down to 0.01 Pa prior to the spraying process; or
   2. Incorporating *in situ* coating thickness control;

* France, the Russian Federation and Ukraine view this list as a reference list drawn up to help in the selection of dual-use goods which could contribute to the indigenous development, production or enhancement of conventional munitions capabilities.

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

2. B. 5. g. "Stored programme controlled" ion plating production equipment allowing for the *in situ* measurement of any of the following:
1. Coating thickness on the substrate and rate control; or
2. Optical characteristics.

Note *2.B.5.a., 2.B.5.b., 2.B.5.e., 2.B.5.f. and 2.B.5.g. do not control chemical vapour deposition, cathodic arc, sputter deposition, ion plating or ion implantation equipment specially designed for cutting or machining tools.*

2. B. 6. Dimensional inspection or measuring systems and equipment, as follows:

a. Computer controlled, "numerically controlled" or "stored programme controlled" co-ordinate measuring machines (CMM), having a three dimensional (volumetric) maximum permissible error of indication (MPEE) 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), tested according to ISO 10360-2 (2001);

b. Linear and angular displacement measuring instruments, as follows:
1. Linear displacement measuring instruments having any of the following:
Technical Note
For the purpose of 2.B.6.b.1., 'linear displacement' means the change of distance between the measuring probe and the measured object.

a. Non-contact type measuring systems with a "resolution" equal to or less (better) than 0.2 µm within a measuring range up to 0.2 mm;
b. Linear voltage differential transformer systems having all of the following characteristics:
1. "Linearity" equal to or less (better) than 0.1% within a measuring range up to 5 mm; and
2. Drift equal to or less (better) than 0.1% per day at a standard ambient test room temperature ±1 K; or

c. Measuring systems having all of the following:
1. Containing a "laser"; and
2. Maintaining, for at least 12 hours, over a temperature range of ±1 K around a standard temperature and at a standard pressure, all of the following:
a. A "resolution" over their full scale of 0.1 µm or less (better); and

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

Note *2.B.6.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.*

2. B. 6. b. 2. Angular displacement measuring instruments having an "angular position deviation" equal to or less (better) than 0.00025°;

Note *2.B.6.b.2. does not control optical instruments, such as autocollimators, using collimated light (e.g., laser light) to detect angular displacement of a mirror.*

2. B. 6. 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).

Note *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. B. 7. "Robots" having any of the following characteristics and specially designed controllers and "end-effectors" therefor:

a. Capable in real time of full three-dimensional image processing or full three-dimensional scene analysis to generate or modify "programmes" or to generate or modify numerical programme data;
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 5×10^3 Gy (Si) without operational degradation; or

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

2. B. 8. Assemblies or units, specially designed for machine tools, or dimensional inspection or measuring systems and equipment, as follows:

a. Linear position feedback units (e.g., inductive type devices, graduated scales, infrared systems or "laser" systems) having an overall "accuracy" less (better) than $(800 + (600 \times L \times 10^{-3}))$ nm (L equals the effective length in mm);
N.B. *For "laser" systems see also Note to 2.B.6.b.1.*

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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 2.B.6.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 specified in 2.B.

2. B. 9. 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:
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.

Technical Note
Machines combining the function of spin-forming and flow-forming are for the purpose of 2.B.9. regarded as flow-forming machines.

2. C. MATERIALS - None

2. D. SOFTWARE

1. "Software", other than that controlled by 2.D.2., specially designed or modified for the "development", "production" or "use" of equipment controlled by 2.A. or 2.B.

2. "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 4 axes for "contouring control".

Note1 2.D.2. does not control "software" specially designed or modified for the operation of machine tools not controlled by Category 2.

Note 2 2.D.2. does not control "software" for items controlled by 2.B.2. See 2.D.1. for control of "software" for items controlled by 2.B.2.

2. E. TECHNOLOGY

2. E. 1. "Technology" according to the General Technology Note for the "development" of equipment or "software" controlled by 2.A., 2.B. or 2.D.

2. E. 2. "Technology" according to the General Technology Note for the "production" of equipment controlled by 2.A. or 2.B.

2. E. 3. Other "technology", as follows:

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DUAL-USE LIST - CATEGORY 2 - MATERIALS PROCESSING

a. "Technology" for the "development" of interactive graphics as an integrated part in "numerical control" units for preparation or modification of part programmes;

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. E. 3. b. 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;
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;

2. E. 3. 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 programmes) 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.

DUAL-USE LIST - CATEGORY 2 - MATERIALS PROCESSING

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 Vapour 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)'.*

DUAL-USE LIST - CATEGORY 2 - MATERIALS PROCESSING

TABLE - DEPOSITION TECHNIQUES

1. Coating Process (1)*	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)

* The numbers in parenthesis refer to the Notes following this Table.

DUAL-USE LIST - CATEGORY 2 - MATERIALS PROCESSING

TABLE - DEPOSITION TECHNIQUES

1. Coating Process (1)	2. Substrate	3. Resultant Coating
B. 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)
	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

DUAL-USE LIST - CATEGORY 2 - MATERIALS PROCESSING

TABLE - DEPOSITION TECHNIQUES

1. Coating Process (1)	2. Substrate	3. Resultant Coating
B.2. Ion assisted resistive heating Physical Vapour 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 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

DUAL-USE LIST - CATEGORY 2 - MATERIALS PROCESSING

TABLE - DEPOSITION TECHNIQUES

1. Coating Process (1)	2. Substrate	3. Resultant Coating
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)
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)
	Refractory metals and alloys (8)	Aluminides Silicides Carbides

DUAL-USE LIST - CATEGORY 2 - MATERIALS PROCESSING

TABLE - DEPOSITION TECHNIQUES

1. Coating Process (1)	2. Substrate	3. Resultant Coating
D. (continued)	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)
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)

DUAL-USE LIST - CATEGORY 2 - MATERIALS PROCESSING

TABLE - DEPOSITION TECHNIQUES

1. Coating Process (1)	2. Substrate	3. Resultant Coating
F. (continued)	Titanium alloys (13)	Borides Nitrides Oxides Silicides Aluminides Alloyed aluminides (2) Carbides
	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

DUAL-USE LIST - CATEGORY 2 - MATERIALS PROCESSING

TABLE - DEPOSITION TECHNIQUES

1. Coating Process (1)	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