Foreign Affairs and International Trade Canada
Affaires étrangères et Commerce international Canada

A Guide To CANADA'S EXPORT CONTROLS

April 2011

Canada

Introduction

The issuance of export permits is administered by the Export Controls Division (TIE) of Foreign Affairs and International Trade Canada (DFAIT). TIE provides assistance to exporters in determining if export permits are required. It also publishes brochures and Notices to Exporters that are freely available on request and on our website www.exportcontrols.gc.ca.

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For information on how to apply for an export permit and additional information on export controls please refer to our website.

To enquire on the status of an export permit application:

Recognized EXCOL users can check the status of an export permit application on-line. Non-recognized users can call (613) 996-2387 or email tie.reception@international.gc.ca and quote your export permit application identification (ref ID) number.

Export Controls Division website: www.exportcontrols.gc.ca

This Guide, at time of publication, encompasses the list of items enumerated on the Export Control List (ECL) that are controlled for export in accordance with Canadian foreign policy, including Canada's participation in multilateral export control regimes and bilateral agreements. Unless otherwise specified, the export controls contained in this Guide apply to all destinations except the United States.

Canada's Export Control List can be found at the Department of Justice website at http://canada.justice.gc.ca/. The most recent versions of each multilateral export control regime's control lists included in the ECL are:

Export Control Regimes	Latest Controls Incorporated into ECL
Wassenaar Arrangement	December 2010
Nuclear Suppliers Group	June 2010
Missile Technology Control Regime	April 2011
Australia Group	November 2010

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GROUP 1 – DUAL-USE LIST

Note 1:

Terms in "quotations" are defined terms. Refer to 'Definitions of Terms used in these Lists' annexed to this List, at the end of Group 2. References to the "Dual-Use List" and "Munitions Lists" within Groups 1 and 2 refer to the "Group 1 – Dual-Use List" and the "Group 2 – Munitions List" respectively.

Note 2:

In some instances chemicals are listed by name and CAS number. The list applies to chemicals of the same structural formula (including hydrates) regardless of name or CAS number. CAS numbers are shown to assist in identifying a particular chemical or mixture, irrespective of nomenclature. CAS numbers cannot be used as unique identifiers because some forms of the listed chemical have different CAS numbers and mixtures containing a listed chemical may also have different CAS numbers.

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 1-1.E.2.e. and 1-1.E.2.f. and 1-8.E.2.a. and 1-8.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".*

CATEGORY 1: SPECIAL MATERIALS AND RELATED EQUIPMENT

1-1.A. SYSTEMS, EQUIPMENT AND COMPONENTS

1-1.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 specified by 1-1.C.9.b. or 1-1.C.9.c.;

b. Piezoelectric polymers and copolymers, made from vinylidene fluoride (CAS 75-38-7) materials, specified by 1-1.C.9.a., having all of the following:

1. In sheet or film form; **and**

2. With a thickness exceeding 200 μm;

c. Seals, gaskets, valve seats, bladders or diaphragms, having all of the following:

1. Made from fluoroelastomers containing at least one vinylether group as a constitutional unit; and

2. Specially designed for "aircraft", aerospace or missile use.

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

a. Consisting of an organic "matrix" and materials specified by 1-1.C.10.c., 1-1.C.10.d. or 1-1.C.10.e.; **or**

b. Consisting of a metal or carbon "matrix", and any of the following:

1. Carbon "fibrous or filamentary materials" having all of the following:

a. A "specific modulus" exceeding 10.15 x 10^6 m; **and**

b. A "specific tensile strength" exceeding 17.7 x 10^4 m; **or**

2. Materials specified by 1-1.C.10.c.

Note 1:

1-1.A.2. does not apply to composite structures or laminates, made from epoxy resin impregnated carbon "fibrous or filamentary materials", for the repair of "civil aircraft" structures or laminates, having all of the following:

a. An area not exceeding 1 m^2;

*b. A length not exceeding 2.5 m; **and***

c. A width exceeding 15 mm.

Note 2:

1-1.A.2. does not apply to semi-finished items, specially designed for purely civilian applications as follows:

a. Sporting goods;

b. Automotive industry;

c. Machine tool industry;

d. Medical applications.

Note 3:

1-1.A.2.b.1. does not apply to semi-finished items containing a maximum of two dimensions of interwoven filaments and specially designed for applications as follows:

a. Metal heat-treatment furnaces for tempering metals;

b. Silicon boule production equipment.

Note 4:

1-A.2. does not apply to finished items specially designed for a specific application.

1-1.A.3. Manufactures of non-"fusible" aromatic polyimides in film, sheet, tape or ribbon form having any of the following:

a. A thickness exceeding 0.254 mm; **or**

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

Note:

1-1.A.3. does not apply to manufactures when coated or laminated with copper and designed for the production of electronic printed circuit boards.

N.B.:

For "fusible" aromatic polyimides in any form, see 1-1.C.8.a.3.

1-1.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 any of the following, and specially designed components therefor:
   1. Biological agents "adapted for use in war";
   2. Radioactive materials "adapted for use in war";
   3. Chemical warfare (CW) agents; **or**
   4. "Riot control agents", including:
      a. α-Bromobenzeneacetonitrile, (Bromobenzyl cyanide) (CA) (CAS 5798-79-8);
      b. [(2-chlorophenyl) methylene] propanedinitrile, (o-Chlorobenzylidenemalononitrile) (CS) (CAS 2698-41-1);
      c. 2-Chloro-1-phenylethanone, Phenylacyl chloride (ω-chloroacetophenone) (CN) (CAS 532-27-4);
      d. Dibenz-(b,f)-1,4-oxazephine, (CR) (CAS 257-07-8);
      e. 10-Chloro-5,10-dihydrophenarsazine, (Phenarsazine chloride), (Adamsite), (DM) (CAS 578-94-9);
      f. N-Nonanoylmorpholine, (MPA) (CAS 5299-64-9);

b. Protective suits, gloves and shoes, specially designed or modified for defence against any of the following:
   1. Biological agents "adapted for use in war";
   2. Radioactive materials "adapted for use in war"; **or**
   3. Chemical warfare (CW) agents;

c. Detection systems, specially designed or modified for detection or identification of any of the following, and specially designed components therefor:
   1. Biological agents "adapted for use in war";

2. Radioactive materials "adapted for use in war"; **or**
3. Chemical warfare (CW) agents.

d. Electronic equipment designed for automatically detecting or identifying the presence of "explosives" residues and utilising 'trace detection' techniques (e.g., surface acoustic wave, ion mobility spectrometry, differential mobility spectrometry, mass spectrometry).

Technical Note:

'Trace detection' is defined as the capability to detect less than 1 ppm vapour, or 1 mg solid or liquid.

Note 1:

1-1.A.4.d. does not apply to equipment specially designed for laboratory use.

Note 2:

1-1.A.4.d. does not apply to non-contact walk-through security portals.

Note:

1-1.A.4. does not apply to:

a. Personal radiation monitoring dosimeters;

b. Equipment limited by design or function to protect against hazards specific to residential safety or civil industries, including:

1. mining;
2. quarrying;
3. agriculture;
4. pharmaceuticals;
5. medical;
6. veterinary;
7. environmental;
8. waste management;
9. food industry.

Technical Notes:

1. 1-1.A.4. includes equipment and components that have been identified, successfully tested to national standards or otherwise proven effective, for the detection of or defence against radioactive materials "adapted for use in war", biological agents "adapted for use in war", chemical warfare agents, 'simulants' or "riot control agents", even if such equipment or components are used in civil industries such as mining, quarrying, agriculture, pharmaceuticals, medical, veterinary, environmental, waste management, or the food industry.

2. 'Simulant': A substance or material that is used in place of toxic agent (chemical or biological) in training, research, testing or evaluation.

1-1.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 armour, see entry 1-1.C.10.

Note 1:

1-1.A.5. does not apply to body armour or protective garments, when accompanying their user for the user's own personal protection.

Note 2:

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

1-1.A.6. Equipment, specially designed or modified for the disposal of improvised explosive devices, as follows, and specially designed components and accessories therefor:

a. Remotely operated vehicles;

b. 'Disruptors';

Technical Note:

'Disruptors' – Devices specially designed for the purpose of preventing the operation of an explosive device by projecting a liquid, solid or frangible projectile.

N.B.:

For equipment specially designed for military use for the disposal of improvised explosive devices, see also 2-4.

Note:

1-1.A.6. does not apply to equipment when accompanying its operator .

1-1.A.7. Equipment and devices, specially designed to initiate charges and devices containing energetic materials, by electrical means, as follows:

a. Explosive detonator firing sets designed to drive explosive detonators specified by 1-1.A.7.b.

b. Electrically driven explosive detonators as follows:

1. Exploding bridge (EB);
2. Exploding bridge wire (EBW);
3. Slapper;
4. Exploding foil initiators (EFI).

Technical Notes:

1. The word initiator or igniter is sometimes used in place of the word detonator.

2. For the purpose of 1-1.A.7.b. the detonators of concern all utilise a small electrical conductor (bridge, bridge wire, or foil) that explosively vaporises when a fast, high-current electrical pulse is passed through it. In non-slapper types, the exploding conductor starts a chemical detonation in a contacting high explosive material such as PETN (pentaerythritoltetranitrate). In slapper detonators, the explosive vaporisation of the electrical conductor drives a flyer or slapper across a gap, and the impact of the slapper on an explosive starts a chemical detonation. The slapper in some designs is driven by magnetic force. The term exploding foil detonator may refer to either an EB or a slapper-type detonator.

N.B.:

For equipment and devices specially designed for military use see Group 2 - Munitions List.

1-1.A.8. Charges, devices and components, as follows:

a. 'Shaped charges' having all of the following:

1. Net Explosive Quantity (NEQ) greater than 90 g; **and**
2. Outer casing diameter equal to or greater than 75 mm;

b. Linear shaped cutting charges having all of the following, and specially designed components therefor:

1. An explosive load greater than 40 g/m; **and**
2. A width of 10 mm or more;

c. Detonating cord with explosive core load greater than 64 g/m;

d. Cutters, other than those specified by 1-1.A.8.b., and severing tools, having a NEQ greater than 3.5 kg.

Note:

The only charges and devices specified in 1-1.A.8. are those containing "explosives" listed in the Annex to Category 1 and mixtures thereof.

Technical Note:

'Shaped charges' are explosive charges shaped to focus the effects of the explosive blast.

1-1.B. TEST, INSPECTION AND PRODUCTION EQUIPMENT

1-1.B.1. Equipment for the production or inspection of "composite" structures or laminates specified by 1-1.A.2. or "fibrous or filamentary materials" specified by 1-1.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 'primary servo positioning' axes, specially designed for the manufacture of "composite" structures or laminates, from "fibrous or filamentary materials";

b. Tape-laying machines, of which the motions for positioning and laying tape or sheets are coordinated and programmed in five or more 'primary servo positioning' 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, specially designed or modified for weaving, interlacing or braiding fibres, for "composite" structures;

Technical Note:

For the purposes of 1-1.B.1.c., the technique of interlacing includes knitting.

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;

e. Equipment for producing prepregs specified by 1-1.C.10.e. by the hot melt method;

f. Non-destructive inspection equipment specially designed for "composite" materials, as follows:

1. X-ray tomography systems for three dimensional defect inspection;

2. Numerically controlled ultrasonic testing machines of which the motions for positioning transmitters or receivers are simultaneously coordinated and programmed in four or more axes to follow the three dimensional contours of the component under inspection;

g. Tow-placement machines, of which the motions for positioning and laying tows or sheets are coordinated and programmed in two or more 'primary servo positioning' axes, specially designed for the manufacture of "composite" airframe or missile structures.

Technical Note:

For the purposes of 1-1.B.1., 'primary servo positioning' axes control, under computer program direction, the position of the end effector (i.e., head) in space relative to the work piece at the correct orientation and direction to achieve the desired process.

1-1.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 by 1-1.C.2.c.2.

1-1.B.3. Tools, dies, moulds or fixtures, for "superplastic forming" or "diffusion bonding" titanium, aluminium or their alloys, specially designed for the manufacture of any of the following:

a. Airframe or aerospace structures;

b. "Aircraft" or aerospace engines; **or**

c. Specially designed components for structures specified by 1-1.B.3.a. or for engines specified by 1-1.B.3.b.

1-1.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.

1-1.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 x 10^8 Hz but less than 3 x 10^{12} Hz;

Note 1:

1-1.C.1.a. does not apply to:

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:

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 1-1.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 x 10^6 N/m^2; ***and***

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

d. Planar absorbers made of sintered ferrite, having all of the following:

1. A specific gravity exceeding 4.4; ***and***

2. A maximum operating temperature of 548 K (275° C).

Note 2:

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

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

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.

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

Note:

1-1.C.2. does not apply to metal alloys, metal alloy powder and alloyed materials, for coating substrates.

Technical Notes:

1. *The metal alloys in 1-1.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.*

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

b. Metal alloys, as follows, made from the powder or particulate material specified by 1-1.C.2.c.:
   1. Nickel alloys having any of the following:
      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 having any of the following:
      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;
   3. Titanium alloys having any of the following:
      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 having any of the following:
      a. A tensile strength of 240 MPa or more at 473 K (200° C); **or**
      b. A tensile strength of 415 MPa or more at 298 K (25° C);
   5. Magnesium alloys having all of the following:
      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;

c. Metal alloy powder or particulate material, having all of the following:

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);

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"; **and**

3. Capable of forming materials specified by 1-1.C.2.a. or 1-1.C.2.b.;

d. Alloyed materials having all of the following:

1. Made from any of the composition systems specified by 1-1.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**

c. "Melt extraction";

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

a. Initial relative permeability of 120,000 or more and a thickness of 0.05 mm or less;

Technical Note:

Measurement of initial relative permeability must be performed on fully annealed materials.

b. Magnetostrictive alloys having any of the following:

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:

1. A composition having a minimum of 75% by weight 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 x 10^{-4} ohm cm or more.

Technical Note:

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

1-1.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%.

1-1.C.5. "Superconductive" "composite" conductors in lengths exceeding 100 m or with a mass exceeding 100 g, as follows:

a. "Superconductive" "composite" conductors containing one or more niobium-titanium 'filaments', having all of the following:
   1. Embedded in a "matrix" other than a copper or copper-based mixed "matrix"; **and**
   2. Having a cross-section area less than 0.28 x 10^{-4} mm^2 (6 μm in diameter for circular 'filaments');
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); **and**
   2. Remaining in the "superconductive" state at a temperature of 4.2 K (-268.96° C) when exposed to a magnetic field oriented in any direction perpendicular to the longitudinal axis of conductor and corresponding to a magnetic induction of 12 T with critical current density exceeding 1,750 A/mm^2 on overall cross-section of the conductor.
c. "Superconductive" "composite" conductors consisting of one or more "superconductive" 'filaments', which remain "superconductive" above 115 K (-158.16°C).

Technical Note:

For the purpose of 1-1.C.5., 'filaments' may be in wire, cylinder, film, tape or ribbon form.

1-1.C.6. Fluids and lubricating materials, as follows:

a. Hydraulic fluids containing, as their principal ingredients, any of the following:
   1. Synthetic 'silahydrocarbon oils' having all of the following:

      Technical Note:

      For the purpose of 1-1.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 1-1.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;

Technical Note:

For the purpose of 1-1.C.6.a., the following determinations apply:

1. *'Flash point' is determined using the Cleveland Open Cup Method described in ASTM D-92 or national equivalents;*
2. *'Pour point' is determined using the method described in ASTM D-97 or national equivalents;*
3. *'Viscosity index' is determined using the method described in ASTM D-2270 or national equivalents;*
4. *'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:

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

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

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

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

b. Lubricating materials containing, as their principal ingredients, any of the following:

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 having all of the following:

1. Purity exceeding 99.8%;

2. Containing less than 25 particles of 200 μm or larger in size per 100 ml; **and**

3. Made from at least 85% of any of the following:
    a. Dibromotetrafluoroethane (CAS 25497-30-7, 124-73-2, 27336-23-8);
    b. Polychlorotrifluoroethylene (oily and waxy modifications only); **or**
    c. Polybromotrifluoroethylene;

d. Fluorocarbon electronic cooling fluids having all of the following:
    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.

1-1.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:

1-1.C.7.b. does not apply to 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 12.7×10^3 m;

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 specified by 1-1.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 (CAS 1344-28-1); **or**
2. Si-C-N.

Note:

1-1.C.7.f. does not apply to "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.

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

a. Imides as follows:

1. Bismaleimides;
2. Aromatic polyamide-imides (PAI) having a 'glass transition temperature (Tg)' exceeding 563 K (290° C);
3. Aromatic polyimides;
4. Aromatic polyetherimides having a 'glass transition temperature (Tg)' exceeding 513 K (240° C);

Note:

1-1.C.8.a. applies to the substances in liquid or solid "fusible" form, including resin, powder, pellet, film, sheet, tape, or ribbon.

N.B.:

For non-"fusible" aromatic polyimides in film, sheet, tape, or ribbon form, see 1-1.A.3.

b. Thermoplastic liquid crystal copolymers having a heat distortion temperature exceeding 523 K (250° C) measured according to ISO 75-2 (2004), method A or national equivalents, with a load of 1.80 N/mm^2 and composed of:

1. Any of the following compounds:
   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 (CAS 100-21-0);
   b. 6-hydroxy-2 naphthoic acid (CAS 16712-64-4); **or**
   c. 4-hydroxybenzoic acid (CAS 99-96-7);

c. Not used since 2006

d. Polyarylene ketones;

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

f. Polybiphenylenethersulphone having a 'glass transition temperature (Tg)' exceeding 513 K (240° C).

Technical Note:

The 'glass transition temperature (Tg)' for 1-1.C.8. materials is determined using the method described in ISO 11357-2 (1999) or national equivalents. In addition, for 1.C.8.a.2. materials, 'glass transition temperature (Tg)' is determined on a PAI test specimen having initially been cured at a minimum temperature of 310° C for a minimum of 15 minutes.

1-1.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.

1-1.C.10. "Fibrous or filamentary materials" as follows:

a. Organic "fibrous or filamentary materials", having all of the following:

1. "Specific modulus" exceeding 12.7 x 10^6 m; **and**

2. "Specific tensile strength" exceeding 23.5 x 10^4 m;

Note:

1-1.C.10.a. does not apply to polyethylene.

b. Carbon "fibrous or filamentary materials", having all of the following:

1. "Specific modulus" exceeding 14.65 x 10^6 m; **and**

2. "Specific tensile strength" exceeding 26.82 x 10^4 m;

Note:

1-1.C.10.b. does not apply to:

a. "Fibrous or filamentary materials", for the repair of "civil aircraft" structures or laminates, having all of the following:

1. An area not exceeding 1 m^2;

*2. A length not exceeding 2.5 m; **and***

3. A width exceeding 15 mm.

b. Mechanically chopped, milled or cut carbon "fibrous or filamentary materials" 25.0 mm or less in length.

Technical Note:

Properties for materials described in 1-1.C.10.b. should be determined using SACMA recommended methods SRM 12 to 17, ISO 10618 (2004) 10.2.1 Method A or national equivalent tow tests and based on lot average.

c. Inorganic "fibrous or filamentary materials", having all of the following:

1. "Specific modulus" exceeding 2.54 x 10^6 m; **and**

2. Melting, softening, decomposition or sublimation point exceeding 1,922 K (1,649° C) in an inert environment;

Note:

1-1.C.10.c. does not apply to:

a. Discontinuous, multiphase, polycrystalline alumina fibres in chopped fibre or random mat form, containing 3% by weight or more silica, with a 'specific modulus' of less than 10 x 10^6 m;

b. Molybdenum and molybdenum alloy fibres;

c. Boron fibres;

d. 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", having any of the following:

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

e. Fully or partially resin-impregnated or pitch-impregnated "fibrous or filamentary materials" (prepregs), metal or carbon-coated "fibrous or filamentary materials" (preforms) or "carbon fibre preforms", having all of the following:
   1. Having any of the following:
      a. Inorganic "fibrous or filamentary materials" specified by 1-1.C.10.c.; **or**
      b. Organic or carbon "fibrous or filamentary materials", having all of the following:
         1. "Specific modulus" exceeding 10.15×10^6 m; **and**
         2. "Specific tensile strength" exceeding 17.7×10^4 m; **and**
   2. Having any of the following:
      a. Resin or pitch specified by 1-1.C.8. or 1-1.C.9.b.;
      b. 'Dynamic Mechanical Analysis glass transition temperature (DMA Tg)' equal to or exceeding 453 K (180° C) and having a phenolic resin; **or**
      c. 'Dynamic Mechanical Analysis glass transition temperature (DMA Tg)' equal to or exceeding 505 K (232° C) and having a resin or pitch, not specified by 1-1.C.8. or 1-1.C.9.b., and not being a phenolic resin.

Note 1:

Metal or carbon-coated "fibrous or filamentary materials" (preforms) or "carbon fibre preforms", not impregnated with resin or pitch, are specified by "fibrous or filamentary materials" in 1-1.C.10.a., 1-1.C.10.b. or 1-1.C.10.c.

Note 2:

1-1.C.10.e. does not apply to:

a. Epoxy resin "matrix" impregnated carbon "fibrous or filamentary materials" (prepregs) for the repair of "civil aircraft" structures or laminates, having all of the following;
   1. An area not exceeding 1 m^2;
   *2. A length not exceeding 2.5 m; **and***
   3. A width exceeding 15 mm.

b. Fully or partially resin-impregnated or pitch-impregnated mechanically chopped, milled or cut carbon "fibrous or filamentary materials" 25.0 mm or less in length when using a resin or pitch other than those specified by 1.C.8. or 1.C.9.b.

Technical Note:

The 'Dynamic Mechanical Analysis glass transition temperature (DMA Tg)' for materials specified by 1.C.10.e. is determined using the method described in ASTM D 7028-07, or equivalent national standard, on a dry test specimen. In the case of thermoset materials, degree of cure of a dry test specimen shall be a minimum of 90% as defined by ASTM E 2160-04 or equivalent national standard.

1-1.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 thereof;

Note:

The metals or alloys specified by 1-1.C.11.a. also refer to metals or alloys encapsulated in aluminium, magnesium, zirconium or beryllium.

Technical Note:

The natural content of hafnium in the zirconium (typically 2% to 7%) is counted with the zirconium.

b. Boron or boron alloys, with a particle size of 60 µm or less as follows:

1. Boron with a purity of 85% by weight or more;
2. Boron alloys with a boron content of 85% by weight or more;

Note:

The metals or alloys specified by 1-1.C.11.b. also refer to metals or alloys encapsulated in aluminium, magnesium, zirconium or beryllium.

c. Guanidine nitrate (CAS 506-93-4);

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

N.B.:

See 2-8.c.5.b. for metal powders mixed with other substances to form a mixture formulated for military purposes.

1-1.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:

1-1.C.12.a. does not apply to:

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

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

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

Note:

1-1.C.12.b. does not apply to shipments with a neptunium-237 content of 1 g or less.

1-1.D. SOFTWARE

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

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

1-1.D.3. "Software" specially designed or modified to enable equipment to perform the functions of equipment specified by 1-1.A.4.c. or 1-1.A.4.d.

1-1.E. TECHNOLOGY

1-1.E.1. "Technology" according to the General Technology Note for the "development" or "production" of equipment or materials specified by 1-1.A.1.b., 1-1.A.1.c., 1-1.A.2. to 1-1.A.5., 1-1.A.6.b., 1-1.A.7., 1-1.B. or 1-1.C.

1-1.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;

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:

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. Any of the following total metallic impurities (excluding intentional additions):

1. Less than 1,000 ppm for single oxides or carbides; **or**

2. Less than 5,000 ppm for complex compounds or single nitrides; **and**

c. Being any of the following:

1. Zirconia (CAS 1314-23-4) 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 specified by 1-1.E.2.c.1.;

Note:

1-1.E.2.c.2. does not apply to technology for the design or production of abrasives.

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

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

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

Note:

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

g. 'Libraries' (parametric technical databases) specially designed or modified to enable equipment to perform the functions of equipment specified by 1-1.A.4.c. or 1-1.A.4.d.

Technical Note:

For the purpose of 1-1.E.2.g., 'library' (parametric technical database) means a collection of technical information, reference to which may enhance the performance of relevant equipment or systems.

LIST – "EXPLOSIVES"

(See 1-1.A.8.)

1. ADNBF (aminodinitrobenzofuroxan or 7-amino-4,6-dinitrobenzofurazane-1-oxide) (CAS 97096-78-1);
2. BNCP (cis-bis (5-nitrotetrazolato) tetra amine-cobalt (III) perchlorate) (CAS 117412-28-9);
3. CL-14 (diamino dinitrobenzofuroxan or 5,7-diamino-4,6-dinitrobenzofurazane-1-oxide) (CAS 117907-74-1);
4. CL-20 (HNIW or Hexanitrohexaazaisowurtzitane) (CAS 135285-90-4); chlathrates of CL-20;
5. CP (2-(5-cyanotetrazolato) penta amine-cobalt (III) perchlorate) (CAS 70247-32-4);
6. DADE (1,1-diamino-2,2-dinitroethylene, FOX7) (CAS 145250-81-3);
7. DATB (diaminotrinitrobenzene) (CAS 1630-08-6);
8. DDFP (1,4-dinitrodifurazanopiperazine);
9. DDPO (2,6-diamino-3,5-dinitropyrazine-1-oxide, PZO) (CAS 194486-77-6);
10. DIPAM (3,3′-diamino-2,2′,4,4′,6,6′-hexanitrobiphenyl or dipicramide) (CAS 17215-44-0);
11. DNGU (DINGU or dinitroglycoluril) (CAS 55510-04-8);
12. Furazans as follows:
    a. DAAOF (diaminoazoxyfurazan);
    b. DAAzF (diaminoazofurazan) (CAS 78644-90-3);
13. HMX and derivatives, as follows:
    a. HMX (Cyclotetramethylenetetranitramine, octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazine, 1,3,5,7-tetranitro-1,3,5,7-tetraza-cyclooctane, octogen or octogene) (CAS 2691-41-0);
    b. difluoroaminated analogs of HMX;
    c. K-55 (2,4,6,8-tetranitro-2,4,6,8-tetraazabicyclo [3,3,0]-octanone-3, tetranitrosemiglycouril or keto-bicyclic HMX) (CAS 130256-72-3);
14. HNAD (hexanitroadamantane) (CAS 143850-71-9);
15. HNS (hexanitrostilbene) (CAS 20062-22-0);
16. Imidazoles as follows:
    a. BNNII (Octahydro-2,5-bis(nitroimino)imidazo [4,5-d]imidazole);
    b. DNI (2,4-dinitroimidazole) (CAS 5213-49-0);
    c. FDIA (1-fluoro-2,4-dinitroimidazole);
    d. NTDNIA (N-(2-nitrotriazolo)-2,4-dinitroimidazole);
    e. PTIA (1-picryl-2,4,5-trinitroimidazole);
17. NTNMH (1-(2-nitrotriazolo)-2-dinitromethylene hydrazine);
18. NTO (ONTA or 3-nitro-1,2,4-triazol-5-one) (CAS 932-64-9);
19. Polynitrocubanes with more than four nitro groups;
20. PYX (2,6-Bis(picrylamino)-3,5-dinitropyridine) (CAS 38082-89-2);
21. RDX and derivatives, as follows:
    a. RDX (cyclotrimethylenetrinitramine, cyclonite, T4, hexahydro-1,3,5-trinitro-1,3,5-triazine, 1,3,5-trinitro-1,3,5-triaza-cyclohexane, hexogen or hexogene) (CAS 121-82-4);

b. Keto-RDX (K-6 or 2,4,6-trinitro-2,4,6-triazacyclohexanone) (CAS 115029-35-1);

22. TAGN (triaminoguanidinenitrate) (CAS 4000-16-2);
23. TATB (triaminotrinitrobenzene) (CAS 3058-38-6);
24. TEDDZ (3,3,7,7-tetrabis(difluoroamine) octahydro-1,5-dinitro-1,5-diazocine);
25. Tetrazoles as follows:
    a. NTAT (nitrotriazol aminotetrazole);
    b. NTNT (1-N-(2-nitrotriazolo)-4-nitrotetrazole);
26. Tetryl (trinitrophenylmethylnitramine) (CAS 479-45-8);
27. TNAD (1,4,5,8-tetranitro-1,4,5,8-tetraazadecalin) (CAS 135877-16-6);
28. TNAZ (1,3,3-trinitroazetidine) (CAS 97645-24-4);
29. TNGU (SORGUYL or tetranitroglycoluril) (CAS 55510-03-7);
30. TNP (1,4,5,8-tetranitro-pyridazino[4,5-d]pyridazine) (CAS 229176-04-9);
31. Triazines as follows:
    a. DNAM (2-oxy-4,6-dinitroamino-s-triazine) (CAS 19899-80-0);
    b. NNHT (2-nitroimino-5-nitro-hexahydro-1,3,5-triazine) (CAS 130400-13-4);
32. Triazoles as follows:
    a. 5-azido-2-nitrotriazole;
    b. ADHTDN (4-amino-3,5-dihydrazino-1,2,4-triazole dinitramide) (CAS 1614-08-0);
    c. ADNT (1-amino-3,5-dinitro-1,2,4-triazole);
    d. BDNTA ([bis-dinitrotriazole]amine);
    e. DBT (3,3′-dinitro-5,5-bi-1,2,4-triazole) (CAS 30003-46-4);
    f. DNBT (dinitrobistriazole) (CAS 70890-46-9);
    g. NTDNA (2-nitrotriazole 5-dinitramide) (CAS 75393-84-9);
    h. NTDNT (1-N-(2-nitrotriazolo) 3,5-dinitrotriazole);
    i. PDNT (1-picryl-3,5-dinitrotriazole);
    j. TACOT (tetranitrobenzotriazolobenzotriazole) (CAS 25243-36-1);
33. “Explosives” not listed elsewhere in this list having a detonation velocity exceeding 8,700 m/s, at maximum density, or a detonation pressure exceeding 34 GPa (340 kbar);
34. Organic “explosives” not listed elsewhere in this list yielding detonation pressures of 25 GPa (250 kbar) or more that will remain stable at temperatures of 523 K (250° C) or higher, for periods of 5 minutes or longer;
35. Nitrocellulose (containing more than 12.5% nitrogen) (CAS 9004-70-0);
36. Nitroglycol (CAS 628-96-6);
37. Pentaerythritol tetranitrate (PETN) (CAS 78-11-5);
38. Picryl chloride (CAS 88-88-0);
39. 2,4,6-Trinitrotoluene (TNT) (CAS 118-96-7);
40. Nitroglycerine (NG) (CAS 55-63-0);
41. Triacetone Triperoxide (TATP) (CAS 17088-37-8);
42. Guanidine nitrate (CAS 506-93-4);
43. Nitroguanidine (NQ) (CAS 556-88-7).

CATEGORY 2: MATERIALS PROCESSING

1-2.A. SYSTEMS, EQUIPMENT AND COMPONENTS

N.B.:

For quiet running bearings, see 2-9. in Group 2 - Munitions List.

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

Note:

1-2.A.1. does not apply to 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 national equivalents), or better, and having both rings and rolling elements (ISO 5593), made from monel or beryllium;

Note:

1-2.A.1.a. does not apply to tapered roller bearings.

b. Not used since 2010

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.

1-2.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 1-2.B., 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 motions 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, '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' derived from measurements made according to ISO 230/2 (1997) or national equivalents may be used for each machine tool model as an alternative to individual machine tests. 'Stated positioning accuracy' means the accuracy value provided to national licensing authorities as representative of the accuracy of a specific machine model.*

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 (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 specified by 1-2.B.1.a. to 1-2.B.1.c. has a stated accuracy $\bar{A}$ of 5 µm for grinding machines and 6.5 µm for milling and turning machines or better, the builder should be required to reaffirm the accuracy level once every eighteen months.

1-2.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:

1-2.B.1. does not apply to special purpose machine tools limited to the manufacture of gears. For such machines, see 1-2.B.3.

Note 2:

1-2.B.1. does not apply to special purpose machine tools limited to the manufacture of any of the following:

a. Crank shafts or cam shafts;

b. Tools or cutters;

*c. Extruder worms; **or***

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

N.B.:

For optical finishing machines, see 1-2.B.2.

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

   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:

1-2.B.1.a. does not apply to 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.

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

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";

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; **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. 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";

Note:

1-2.B.1.c. does not apply to grinding machines 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 positioning accuracy with "all compensations available" less (better) than 3 µm according to ISO 230/2 (1997) or national equivalents.

c. Surface grinders.

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

e. Machine tools for removing metals, ceramics or "composites", 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 5 m and specially designed components therefor.

1-2.B.2. 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'.

Technical Notes:

For the purposes of 1-2.B.2.:

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.*

1-2.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).

1-2.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. 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.

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 1-1.B.3., 1-9.B.9. and 2-18. of Group -2 - Munitions List.

1-2.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 1-2.E.3.f., and specially designed automated handling, positioning, manipulation and control components therefor:

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

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;

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 *in situ* measurement of any of the following:

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

2. Optical characteristics.

Note:

1-2.B.5.a., 1-2.B.5.b., 1-2.B.5.e., 1-2.B.5.f. and 1-2.B.5.g. do not apply to chemical vapour deposition, cathodic arc, sputter deposition, ion plating or ion implantation equipment, specially designed for cutting or machining tools.

1-2.B.6. Dimensional inspection or measuring systems, equipment and "electronic assemblies", as follows:

a. Computer controlled or "numerically 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.

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 1-2.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:

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;

c. Measuring systems having all of the following:

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

2. Maintaining, for at least 12 hours, at a temperature of 20±1° C, all of the following:

a. A "resolution" over their full scale of 0.1 μm or less (better); **and**

b. Capable of achieving a "measurement uncertainty", when compensated for the refractive index of air, equal to or less (better) than (0.2 + L/2,000) μm (L is the measured length in mm); **or**

d. "Electronic assemblies" specially designed to provide feedback capability in systems specified by 1-2.B.6.b.1.c.;

Note:

1-2.B.6.b.1. does not apply to measuring interferometer systems, with an automatic control system that is designed to use no feedback techniques, containing a "laser" to measure slide movement errors of machine-tools, dimensional inspection machines or similar equipment.

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

Note:

1-2.B.6.b.2. does not apply to optical instruments, such as autocollimators, using collimated light (e.g., laser light) to detect angular displacement of a mirror.

c. Equipment for measuring surface irregularities, by measuring optical scatter as a function of angle, with a sensitivity of 0.5 nm or less (better).

Note:

1-2.B.6. includes machine tools, other than those specified by 1-2.B.1., that can be used as measuring machines if they meet or exceed the criteria specified for the measuring machine function.

1-2.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 potentially explosive munitions environments;

Note:

1-2.B.7.b. does not apply to "robots" specially designed for paint-spraying booths.

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.

1-2.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 x L/1,000)) nm (L equals the effective length in mm);

N.B.:

For "laser" systems see also 1-2.B.6.b.1.c. and 1-2.B.6.b.1.d.

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 1-2.B.6.b.2.

c. "Compound rotary tables" and "tilting spindles", capable of upgrading, according to the manufacturer's specifications, machine tools to or above the levels specified by 1-2.B.

1-2.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:

For the purpose of 1-2.B.9., machines combining the function of spin-forming and flow-forming are regarded as flow-forming machines.

1-2.C. MATERIALS

None

1-2.D. SOFTWARE

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

1-2.D.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:

1-2.D.2. does not apply to "software" specially designed or modified for the operation of machine tools not specified by Category 2.

Note 2:

1-2.D.2. does not apply to "software" for items specified by 1-2.B.2. See 1-2.D.1. for "software" for items specified by 1-2.B.2.

1-2.E. TECHNOLOGY

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

1-2.E.2. "Technology" according to the General Technology Note for the "production" of equipment specified by 1-2.A. or 1-2.B.

1-2.E.3. Other "technology", as follows:

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. 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;

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.

N.B.:

This Table should be read to specify 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 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)'.

TABLE - DEPOSITION TECHNIQUES

Coating Process (1)*	Substrate	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)
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)

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

Coating Process (1)*	Substrate	Resultant Coating
B.1. (con't)	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 Molybdenum 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 (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)

Coating Process (1)*	Substrate	Resultant Coating
B.3. (con't)	Beryllium and Beryllium alloys	Dielectric layers (15)
	Sensor window materials (9)	Dielectric layers (15) Diamond-like carbon
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
	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

Coating Process (1)*	Substrate	Resultant Coating
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 (19) 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
	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)

Coating Process (1)*	Substrate	Resultant Coating
F. (con't)	Refractory metals and alloys (8)	Aluminides Silicides Oxides Carbides
G. Ion Implantation	High temperature bearing steels	Additions of Chromium Tantalum or Niobium (Columbium)
	Titanium alloys (13)	Borides Nitrides
	Beryllium and Beryllium alloys	Borides
	Cemented tungsten carbide (16)	Carbides Nitrides

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 weight percent 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 to1.1% 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. "Technology" for single-step pack cementation of solid airfoils is not specified by Category 2.
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 included.
13. 'Titanium alloys' refers only to aerospace alloys having an ultimate tensile strength of 900 MPa or more measured at 293 K (20° C).
14. 'Low-expansion glasses' refers to glasses which have a coefficient of thermal expansion of $1 \times 10^{-7}\ K^{-1}$ or less measured at 293 K (20° C).
15. 'Dielectric layers' are coatings constructed of multi-layers of insulator materials in which the interference properties of a design composed of materials of various refractive indices are used to reflect, transmit or absorb various wavelength bands. Dielectric layers refers to more than four dielectric layers or dielectric/metal "composite" layers.
16. 'Cemented tungsten carbide' does not include cutting and forming tool materials consisting of tungsten carbide/(cobalt, nickel), titanium carbide/(cobalt, nickel), chromium carbide/nickel-chromium and chromium carbide/nickel.
17. "Technology" specially designed to deposit diamond-like carbon on any of the following is not included: 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, 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 NOTES

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.

TABLE - DEPOSITION TECHNIQUES - STATEMENT OF UNDERSTANDING

It is understood that the following technical information, accompanying the table of deposition techniques, is for use as appropriate.

1. "Technology" for pretreatments of the substrates listed in the Table, as follows:
    a. Chemical stripping and cleaning bath cycle parameters, as follows:
        1. Bath composition
            a. For the removal of old or defective coatings, corrosion product or foreign deposits;
            b. For preparation of virgin substrates;
        2. Time in bath;
        3. Temperature of bath;
        4. Number and sequences of wash cycles;
    b. Visual and macroscopic criteria for acceptance of the cleaned part;
    c. Heat treatment cycle parameters, as follows:
        1. Atmosphere parameters, as follows:
            a. Composition of the atmosphere;
            b. Pressure of the atmosphere;
        2. Temperature for heat treatment;
        3. Time of heat treatment;

d. Substrate surface preparation parameters, as follows:
    1. Grit blasting parameters, as follows:
        a. Grit composition;
        b. Grit size and shape;
        c. Grit velocity;
    2. Time and sequence of cleaning cycle after grit blast;
    3. Surface finish parameters;
    4. Application of binders to promote adhesion;
e. Masking technique parameters, as follows:
    1. Material of mask;
    2. Location of mask;

2. "Technology" for *in situ* quality assurance techniques for evaluation of the coating processes listed in the Table, as follows:
    a. Atmosphere parameters, as follows:
        1. Composition of the atmosphere;
        2. Pressure of the atmosphere;
    b. Time parameters;
    c. Temperature parameters;
    d. Thickness parameters;
    e. Index of refraction parameters;
    f. Control of composition;
3. "Technology" for post deposition treatments of the coated substrates listed in the Table, as follows:
    a. Shot peening parameters, as follows:
        1. Shot composition;
        2. Shot size;
        3. Shot velocity;
    b. Post shot peening cleaning parameters;
    c. Heat treatment cycle parameters, as follows:
        1. Atmosphere parameters, as follows:
            a. Composition of the atmosphere;
            b. Pressure of the atmosphere;
        2. Time-temperature cycles;
    d. Post heat treatment visual and macroscopic criteria for acceptance of the coated substrates;
4. "Technology" for quality assurance techniques for the evaluation of the coated substrates listed in the Table, as follows:
    a. Statistical sampling criteria;
    b. Microscopic criteria for:
        1. Magnification;
        2. Coating thickness uniformity;
        3. Coating integrity;

4. Coating composition;
5. Coating and substrates bonding;
6. Microstructural uniformity;

c. Criteria for optical properties assessment (measured as a function of wavelength):
1. Reflectance;
2. Transmission;
3. Absorption;
4. Scatter;

5. "Technology" and parameters related to specific coating and surface modification processes listed in the Table, as follows:

a. For Chemical Vapour Deposition (CVD):
1. Coating source composition and formulation;
2. Carrier gas composition;
3. Substrate temperature;
4. Time-temperature-pressure cycles;
5. Gas control and part manipulation;

b. For Thermal Evaporation - Physical Vapour Deposition (PVD):
1. Ingot or coating material source composition;
2. Substrate temperature;
3. Reactive gas composition;
4. Ingot feed rate or material vaporisation rate;
5. Time-temperature-pressure cycles;
6. Beam and part manipulation;
7. "Laser" parameters, as follows:
a. Wave length;
b. Power density;
c. Pulse length;
d. Repetition ratio;
e. Source;

c. For Pack Cementation:
1. Pack composition and formulation;
2. Carrier gas composition;
3. Time-temperature-pressure cycles;

d. For Plasma Spraying:
1. Powder composition, preparation and size distributions;
2. Feed gas composition and parameters;
3. Substrate temperature;
4. Gun power parameters;
5. Spray distance;
6. Spray angle;
7. Cover gas composition, pressure and flow rates;

8. Gun control and part manipulation;

e. For Sputter Deposition:
   1. Target composition and fabrication;
   2. Geometrical positioning of part and target;
   3. Reactive gas composition;
   4. Electrical bias;
   5. Time-temperature-pressure cycles;
   6. Triode power;
   7. Part manipulation;

f. For Ion Implantation:
   1. Beam control and part manipulation;
   2. Ion source design details;
   3. Control techniques for ion beam and deposition rate parameters;
   4. Time-temperature-pressure cycles;

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

CATEGORY 3: ELECTRONICS

1-3.A. SYSTEMS, EQUIPMENT AND COMPONENTS

Note 1:

The status of equipment and components described in 1-3.A., other than those described in 1-3.A.1.a.3. to 1-3.A.1.a.10. or 1-3.A.1.a.12., which are specially designed for or which have the same functional characteristics as other equipment is determined by the status of the other equipment.

Note 2:

The status of integrated circuits described in 1-3.A.1.a.3. to 1-3.A.1.a.9. or 1-3.A.1.a.12. which are unalterably programmed or designed for a specific function for another equipment is determined by the status of the other equipment.

N.B.:

When the manufacturer or applicant cannot determine the status of the other equipment, the status of the integrated circuits is determined in 1-3.A.1.a.3. to 1-3.A.1.a.9. and 1-3.A.1.a.12.

1-3.A.1. Electronic components and specially designed components therefor, as follows:

1-3.A.1.a. General purpose integrated circuits, as follows:

Note 1:

The status of wafers (finished or unfinished), in which the function has been determined, is to be evaluated against the parameters of 1-3.A.1.a.

Note 2:

Integrated circuits include the following types:

-"Monolithic integrated circuits";

-"Hybrid integrated circuits";

- "Multichip integrated circuits";

-"Film type integrated circuits", including silicon-on-sapphire integrated circuits;

-"Optical integrated circuits".

1. Integrated circuits designed or rated as radiation hardened to withstand any of the following:
   a. A total dose of 5×10^3 Gy (Si) or higher;
   b. A dose rate upset of 5×10^6 Gy (Si)/s or higher; **or**
   c. A fluence (integrated flux) of neutrons (1 MeV equivalent) of 5×10^{13} n/cm^2 or higher on silicon, or its equivalent for other materials;

   Note:

   1-3.A.1.a.1.c. does not apply to Metal Insulator Semiconductors (MIS).

2. "Microprocessor microcircuits", "microcomputer microcircuits", microcontroller microcircuits, storage integrated circuits manufactured from a compound semiconductor, analogue-to-digital converters, digital-to-analogue converters, electro-optical or "optical integrated circuits" designed for "signal processing", field programmable logic devices, custom integrated circuits for which either the function is unknown or the status of the equipment in which the integrated circuit will be used is unknown, Fast Fourier Transform (FFT) processors, electrical erasable programmable read-only memories (EEPROMs), flash memories or static random-access memories (SRAMs), having any of the following:
   a. Rated for operation at an ambient temperature above 398 K (+125° C);
   b. Rated for operation at an ambient temperature below 218 K (-55° C); **or**
   c. Rated for operation over the entire ambient temperature range from 218 K (-55° C) to 398 K (+125° C);

   Note:

   1-3.A.1.a.2. does not apply to integrated circuits for civil automobile or railway train applications.

3. "Microprocessor microcircuits", "microcomputer microcircuits" and microcontroller microcircuits, manufactured from a compound semiconductor and operating at a clock frequency exceeding 40 MHz;

   Note:

   1-3.A.1.a.3. includes digital signal processors, digital array processors and digital coprocessors.

4. Not used since 2010

5. Analogue-to-Digital Converter (ADC) and Digital-to-Analogue Converter (DAC) integrated circuits, as follows:
   a. ADCs having any of the following:
      1. A resolution of 8 bit or more, but less than 10 bit, with an output rate greater than 500 million words per second;
      2. A resolution of 10 bit or more, but less than 12 bit, with an output rate greater than 300 million words per second;
      3. A resolution of 12 bit with an output rate greater than 200 million words per second;
      4. A resolution of more than 12 bit but equal to or less than 14 bit with an output rate greater than 125 million words per second; **or**
      5. A resolution of more than 14 bit with an output rate greater than 20 million words per second;

      Technical Notes:

      1. A resolution of n bit corresponds to a quantisation of 2^n levels.

      2. The number of bits in the output word is equal to the resolution of the ADC.

      3. The output rate is the maximum output rate of the converter, regardless of architecture or oversampling.

      4. For 'multiple channel ADCs', the outputs are not aggregated and the output rate is the maximum output rate of any single channel.

5. *For 'interleaved ADCs' or for 'multiple channel ADCs' that are specified to have an interleaved mode of operation, the outputs are aggregated and the output rate is the maximum combined total output rate of all of the outputs.*
6. *Vendors may also refer to the output rate as sampling rate, conversion rate or throughput rate. It is often specified in megahertz (MHz) or mega samples per second (MSPS).*
7. *For the purpose of measuring output rate, one output word per second is equivalent to one Hertz or one sample per second.*
8. *'Multiple channel ADCs' are defined as devices which integrate more than one ADC, designed so that each ADC has a separate analogue input.*
9. *'Interleaved ADCs' are defined as devices which have multiple ADC units that sample the same analogue input at different times such that when the outputs are aggregated, the analogue input has been effectively sampled and converted at a higher sampling rate.*

b. Digital-to-Analogue Converters (DAC) having any of the following:
   1. A resolution of 10 bit or more with an 'adjusted update rate' of 3,500 MSPS or greater; **or**
   2. A resolution of 12 bit or more with an 'adjusted update rate' of equal to or greater than 1,250 MSPS and having any of the following:
      a. A settling time less than 9 ns to 0.024% of full scale from a full scale step; **or**
      b. A 'Spurious Free Dynamic Range' (SFDR) greater than 68 dBc (carrier) when synthesizing a full scale analogue signal of 100 MHz or the highest full scale analogue signal frequency specified below 100 MHz.

Technical Notes:

1. *'Spurious Free Dynamic Range' (SFDR) is defined as the ratio of the RMS value of the carrier frequency (maximum signal component) at the input of the DAC to the RMS value of the next largest noise or harmonic distortion component at its output.*
2. *SFDR is determined directly from the specification table or from the characterisation plots of SFDR versus frequency.*
3. *A signal is defined to be full scale when its amplitude is greater than -3 dBfs (full scale).*
4. *'Adjusted update rate' for DACs:*
   a. *For conventional (non-interpolating) DACs, the 'adjusted update rate' is the rate at which the digital signal is converted to an analogue signal and the output analogue values are changed by the DAC. For DACs where the interpolation mode may be bypassed (interpolation factor of one), the DAC should be considered as a conventional (non-interpolating) DAC.*
   b. *For interpolating DACs (oversampling DACs), the 'adjusted update rate' is defined as the DAC update rate divided by the smallest interpolating factor. For interpolating DACs, the 'adjusted update rate' may be referred to by different terms including:*
      - *input data rate*
      - *input word rate*
      - *input sample rate*

- *maximum total input bus rate*
- *maximum DAC clock rate for DAC clock input*

6. Electro-optical and "optical integrated circuits", designed for "signal processing" and having all of the following:
   a. One or more than one internal "laser" diode;
   b. One or more than one internal light detecting element; **and**
   c. Optical waveguides;
7. 'Field programmable logic devices' having any of the following:
   a. A maximum number of digital input/outputs greater than 200; **or**
   b. A system gate count of greater than 230,000;

   Note:

   1-3.A.1.a.7.includes:

   - Simple Programmable Logic Devices (SPLDs)

   - Complex Programmable Logic Devices (CPLDs)

   - Field Programmable Gate Arrays (FPGAs)

   - Field Programmable Logic Arrays (FPLAs)

   - Field Programmable Interconnects (FPICs)

   Technical Notes:

   1. *'Field programmable logic devices' are also known as field programmable gate or field programmable logic arrays.*
   2. *Maximum number of digital input/outputs in 1-3.A.1.a.7.a. is also referred to as maximum user input/outputs or maximum available input/outputs, whether the integrated circuit is packaged or bare die.*
8. Not used since 1999
9. Neural network integrated circuits;
10. Custom integrated circuits for which the function is unknown, or the status of the equipment in which the integrated circuits will be used is unknown to the manufacturer, having any of the following:
    a. More than 1,500 terminals;
    b. A typical "basic gate propagation delay time" of less than 0.02 ns; **or**
    c. An operating frequency exceeding 3 GHz;
11. Digital integrated circuits, other than those described in 1-3.A.1.a.3. to 1-3.A.1.a.10. and 1-3.A.1.a.12., based upon any compound semiconductor and having any of the following:
    a. An equivalent gate count of more than 3,000 (2 input gates); **or**
    b. A toggle frequency exceeding 1.2 GHz;
12. Fast Fourier Transform (FFT) processors having a rated execution time for an N-point complex FFT of less than $(N \log_2 N)/20{,}480$ ms, where N is the number of points;

    Technical Note:

    When N is equal to 1,024 points, the formula in 1-3.A.1.a.12. gives an execution time of 500 μs.

1-3.A.1.b. Microwave or millimetre wave components, as follows:

1. Electronic vacuum tubes and cathodes, as follows:

Note 1:

1-3.A.1.b.1. does not apply to tubes designed or rated for operation in any frequency bands and having all of the following:

a. Does not exceed 31.8 GHz; ***and***

b. Is "allocated by the ITU" for radio-communications services, but not for radio-determination.

Note 2:

1-3.A.1.b.1. does not apply to non-"space-qualified" tubes having all of the following:

a. An average output power equal to or less than 50 W; ***and***

b. Designed or rated for operation in any frequency band and having all of the following:

1. Exceeds 31.8 GHz but does not exceed 43.5 GHz; ***and***

2. Is "allocated by the ITU" for radio-communications services, but not for radio-determination;

a. Travelling wave tubes, pulsed or continuous wave, as follows:

1. Tubes operating at frequencies exceeding 31.8 GHz;

2. Tubes having a cathode heater element with a turn on time to rated RF power of less than 3 seconds;

3. Coupled cavity tubes, or derivatives thereof, with a "fractional bandwidth" of more than 7% or a peak power exceeding 2.5 kW;

4. Helix tubes, or derivatives thereof, having any of the following:

a. An "instantaneous bandwidth" of more than one octave, and average power (expressed in kW) times frequency (expressed in GHz) of more than 0.5;

b. An "instantaneous bandwidth" of one octave or less, and average power (expressed in kW) times frequency (expressed in GHz) of more than 1; **or**

c. Being "space-qualified";

b. Crossed-field amplifier tubes with a gain of more than 17 dB;

c. Impregnated cathodes designed for electronic tubes producing a continuous emission current density at rated operating conditions exceeding 5 A/cm^2;

2. Microwave "Monolithic Integrated Circuits" (MMIC) power amplifiers having any of the following:

a. Rated for operation at frequencies exceeding 3.2 GHz up to and including 6.8 GHz and with an average output power greater than 4W (36 dBm) with a "fractional bandwidth" greater than 15%;

b. Rated for operation at frequencies exceeding 6.8 GHz up to and including 16 GHz and with an average output power greater than 1W (30 dBm) with a "fractional bandwidth" greater than 10%;

c. Rated for operation at frequencies exceeding 16 GHz up to and including 31.8 GHz and with an average output power greater than 0.8W (29 dBm) with a "fractional bandwidth" greater than 10%;

d. Rated for operation at frequencies exceeding 31.8 GHz up to and including 37.5 GHz and with an average output power greater than 0.1 nW;

e. Rated for operation at frequencies exceeding 37.5 GHz up to and including 43.5 GHz and with an average output power greater than 0.25W (24 dBm) with a "fractional bandwidth" greater than 10%; **or**

f. Rated for operation at frequencies exceeding 43.5 GHz and with an average output power greater than 0.1 nW;

Note 1:

Not used since 2010

Note 2:

The status of the MMIC whose rated operating frequency includes frequencies listed in more than one frequency range, as defined by 1-3.A.1.b.2.a. through 1-3.A.1.b.2.f., is determined by the lowest average output power threshold.

Note 3:

Notes 1 and 2 in 1-3.A. mean that 1-3.A.1.b.2. does not apply to MMICs if they are specially designed for other applications, e.g., telecommunications, radar, automobiles.

3. Discrete microwave transistors having any of the following:

   a. Rated for operation at frequencies exceeding 3.2 GHz up to and including 6.8 GHz and having an average output power greater than 60W (47.8 dBm);

   b. Rated for operation at frequencies exceeding 6.8 GHz up to and including 31.8 GHz and having an average output power greater than 20W (43 dBm);

   c. Rated for operation at frequencies exceeding 31.8 GHz up to and including 37.5 GHz and having an average output power greater than 0.5W (27 dBm);

   d. Rated for operation at frequencies exceeding 37.5 GHz up to and including 43.5 GHz and having an average output power greater than 1W (30 dBm); **or**

   e. Rated for operation at frequencies exceeding 43.5 GHz and having an average output power greater than 0.1 nW;

   Note:

   The status of a transistor whose rated operating frequency includes frequencies listed in more than one frequency range, as defined by 1-3.A.1.b.3.a. through 1-3.A.1.b.3.e., is determined by the lowest average output power threshold.

4. Microwave solid state amplifiers and microwave assemblies/modules containing microwave solid state amplifiers, having any of the following:

   a. Rated for operation at frequencies exceeding 3.2 GHz up to and including 6.8 GHz and with an average output power greater than 60W (47.8 dBm) with a "fractional bandwidth" greater than 15%;

   b. Rated for operation at frequencies exceeding 6.8 GHz up to and including 31.8 GHz and with an average output power greater than 15W (42 dBm) with a "fractional bandwidth" greater than 10%;

c. Rated for operation at frequencies exceeding 31.8 GHz up to and including 37.5 GHz and with an average output power greater than 0.1 nW;

d. Rated for operation at frequencies exceeding 37.5 GHz up to and including 43.5 GHz and with an average output power greater than 1W (30 dBm) with a "fractional bandwidth" greater than 10%;

e. Rated for operation at frequencies exceeding 43.5 GHz and with an average output power greater than 0.1 nW; **or**

f. Rated for operation at frequencies above 3.2 GHz and having all of the following:

1. An average output power (in watts), P, greater than 150 divided by the maximum operating frequency (in GHz) squared [$P>150\ W*GHz^2/f_{GHz}^2$];

2. A "fractional bandwidth" of 5% or greater; **and**

3. Any two sides perpendicular to one another with length d (in cm) equal to or less than 15 divided by the lowest operating frequency in GHz [$d \leq 15 cm*GHz/f_{GHz}$];

Technical Note:

3.2 GHz should be used as the lowest operating frequency (f_{GHz}) in the formula in 1-3.A.1.b.4.f.3., for amplifiers that have a rated operation range extending downward to 3.2 GHz and below [$d \leq 15 cm*GHz/3.2\ GHz$].

N.B.:

MMIC power amplifiers should be evaluated against the criteria in 1-3.A.1.b.2.

Note 1:

Not used since 2010

Note 2:

The status of an item whose rated operating frequency includes frequencies listed in more than one frequency range, as defined by 1-3.A.1.b.4.a. through 1-3.A.1.b.4.e., is determined by the lowest average output power threshold.

5. Electronically or magnetically tunable band-pass or band-stop filters, having more than 5 tunable resonators capable of tuning across a 1.5:1 frequency band (f_{max}/f_{min}) in less than 10 µs and having any of the following:

a. A band-pass bandwidth of more than 0.5% of centre frequency; **or**

b. A band-stop bandwidth of less than 0.5% of centre frequency;

6. Not used since 2003

7. Converters and harmonic mixers, designed to extend the frequency range of equipment described in 1-3.A.2.c., 1-3.A.2.d., 1-3.A.2.e. or 1-3.A.2.f. beyond the limits stated therein;

8. Microwave power amplifiers containing tubes specified by 1-3.A.1.b.1. and having all of the following:

a. Operating frequencies above 3 GHz;

b. An average output power to mass ratio exceeding 80 W/kg; **and**

c. A volume of less than 400 cm^3;

Note:

1-3.A.1.b.8. does not apply to equipment designed or rated for operation in any frequency band which is "allocated by the ITU" for radio-communications services, but not for radio-determination.

9. Microwave power modules (MPM) consisting of, at least, a travelling wave tube, a microwave "monolithic integrated circuit" and an integrated electronic power conditioner and having all of the following:
   a. A 'turn-on time' from off to fully operational in less than 10 seconds;
   b. A volume less than the maximum rated power in Watts multiplied by 10 cm^3/W; **and**
   c. An "instantaneous bandwidth" greater than 1 octave ($f_{max.} > 2f_{min.}$) and having any of the following:
      1. For frequencies equal to or less than 18 GHz, an RF output power greater than 100 W; **or**
      2. A frequency greater than 18 GHz;

   Technical Notes:

   1. To calculate the volume in 1-3.A.1.b.9.b., the following example is provided: for a maximum rated power of 20 W, the volume would be: 20 W x 10 cm^3/W = 200 cm^3.

   2. The 'turn-on time' in 1-3.A.1.b.9.a. refers to the time from fully-off to fully operational, i.e., it includes the warm-up time of the MPM.

10. Oscillators or oscillator assemblies, designed to operate with all of the following:
    a. A single sideband (SSB) phase noise, in dBc/Hz, better than $-(126+20 \log_{10}F-20 \log_{10}f)$ for 10 Hz <F<10 kHz; **and**
    b. A single sideband (SSB) phase noise, in dBc/Hz, better than $-(114+20 \log_{10}F-20 \log_{10}f)$ for 10 kHz ≤ F < 500 kHz.

    Technical Note:

    In 1-3.A.1.b.10., F is the offset from the operating frequency in Hz and f is the operating frequency in MHz.

11. "Frequency synthesizer" "electronic assemblies" having a "frequency switching time" as specified by any of the following:
    a. Less than 312 ps;
    b. Less than 100 µs for any frequency change exceeding 1.6 GHz within the synthesized frequency range exceeding 3.2 GHz but not exceeding 10.6 GHz;
    c. Less than 250 µs for any frequency change exceeding 550 MHz within the synthesized frequency range exceeding 10.6 GHz but not exceeding 31.8 GHz;
    d. Less than 500 µs for any frequency change exceeding 550 MHz within the synthesized frequency range exceeding 31.8 GHz but not exceeding 43.5 GHz; **or**
    e. Less than 1 ms within the synthesized frequency range exceeding 43.5 GHz.

N.B.:

For general purpose "signal analysers", signal generators, network analysers and microwave test receivers, see 1-3.A.2.c., 1-3.A.2.d., 1-3.A.2.e. and 1-3.A.2.f., respectively.

1-3.A.1.c. Acoustic wave devices as follows and specially designed components therefor:

1. Surface acoustic wave and surface skimming (shallow bulk) acoustic wave devices, having any of the following:
   a. A carrier frequency exceeding 6 GHz;
   b. A carrier frequency exceeding 1 GHz, but not exceeding 6 GHz and having any of the following:
      1. A 'frequency side-lobe rejection' exceeding 65 dB;
      2. A product of the maximum delay time and the bandwidth (time in μs and bandwidth in MHz) of more than 100;
      3. A bandwidth greater than 250 MHz; **or**
      4. A dispersive delay of more than 10 μs; **or**
   c. A carrier frequency of 1 GHz or less and having any of the following:
      1. A product of the maximum delay time and the bandwidth (time in μs and bandwidth in MHz) of more than 100;
      2. A dispersive delay of more than 10 μs; **or**
      3. A 'frequency side-lobe rejection' exceeding 65 dB and a bandwidth greater than 100 MHz;

   Technical Note:

   'Frequency side-lobe rejection' is the maximum rejection value specified in data sheet.

2. Bulk (volume) acoustic wave devices which permit the direct processing of signals at frequencies exceeding 6 GHz;
3. Acoustic-optic "signal processing" devices employing interaction between acoustic waves (bulk wave or surface wave) and light waves which permit the direct processing of signals or images, including spectral analysis, correlation or convolution;

Note:

1-3.A.1.c. does not apply to acoustic wave devices that are limited to a single band pass, low pass, high pass or notch filtering, or resonating function.

1-3.A.1.d. Electronic devices and circuits containing components, manufactured from "superconductive" materials, specially designed for operation at temperatures below the "critical temperature" of at least one of the "superconductive" constituents and having any of the following:

1. Current switching for digital circuits using "superconductive" gates with a product of delay time per gate (in seconds) and power dissipation per gate (in watts) of less than 10^{-14} J; **or**
2. Frequency selection at all frequencies using resonant circuits with Q-values exceeding 10,000;

1-3.A.1.e. High energy devices as follows:

1. 'Cells' as follows:
   a. 'Primary cells' having an 'energy density' exceeding 550 Wh/kg at 20° C;
   b. 'Secondary cells' having an 'energy density' exceeding 250 Wh/kg at 20° C;

   Technical Notes:

   1. For the purpose of 1-3.A.1.e.1., 'energy density' (Wh/kg) is calculated from the nominal voltage multiplied by the nominal capacity in ampere-hours (Ah) divided by the mass in kilograms. If the nominal capacity is not stated, energy density is calculated from the nominal voltage squared then multiplied by the discharge duration in hours divided by the discharge load in Ohms and the mass in kilograms.

   2. For the purpose of 1-3.A.1.e.1., a 'cell' is defined as an electrochemical device, which has positive and negative electrodes, an electrolyte, and is a source of electrical energy. It is the basic building block of a battery.

   3. For the purpose of 1-3.A.1.e.1.a., a 'primary cell' is a 'cell' that is not designed to be charged by any other source.

   4. For the purpose of 1-3.A.1.e.1.b., a 'secondary cell' is a 'cell' that is designed to be charged by an external electrical source.

   Note:

   1-3.A.1.e. does not apply to batteries, including single-cell batteries.

2. High energy storage capacitors as follows:
   a. Capacitors with a repetition rate of less than 10 Hz (single shot capacitors) and having all of the following:
      1. A voltage rating equal to or more than 5 kV;
      2. An energy density equal to or more than 250 J/kg; **and**
      3. A total energy equal to or more than 25 kJ;
   b. Capacitors with a repetition rate of 10 Hz or more (repetition rated capacitors) and having all of the following:
      1. A voltage rating equal to or more than 5 kV;
      2. An energy density equal to or more than 50 J/kg;
      3. A total energy equal to or more than 100 J; **and**
      4. A charge/discharge cycle life equal to or more than 10,000;
3. "Superconductive" electromagnets and solenoids, specially designed to be fully charged or discharged in less than one second and having all of the following:

   Note:

   1-3.A.1.e.3. does not apply to "superconductive" electromagnets or solenoids specially designed for Magnetic Resonance Imaging (MRI) medical equipment.

   a. Energy delivered during the discharge exceeding 10 kJ in the first second;
   b. Inner diameter of the current carrying windings of more than 250 mm; **and**
   c. Rated for a magnetic induction of more than 8 T or "overall current density" in the winding of more than 300 A/mm^2;

4. Solar cells, cell-interconnect-coverglass (CIC) assemblies, solar panels, and solar arrays, which are "space-qualified", having a minimum average efficiency exceeding 20% at an operating temperature of 301 K (28° C) under simulated 'AM0' illumination with an irradiance of 1,367 Watts per square meter (W/m^2);

Technical Note:

'AM0', or 'Air Mass Zero', refers to the spectral irradiance of sun light in the earth's outer atmosphere when the distance between the earth and sun is one astronomical unit (AU).

1-3.A.1.f. Rotary input type absolute position encoders having an accuracy equal to or less (better) than ± 1.0 second of arc;

1-3.A.1.g. Solid-state pulsed power switching thyristor devices and 'thyristor modules', using either electrically, optically, or electron radiation controlled switch methods and having any of the following:

1. A maximum turn-on current rate of rise (di/dt) greater than 30,000 A/µs and off-state voltage greater than 1,100 V; **or**
2. A maximum turn-on current rate of rise (di/dt) greater than 2,000 A/µs and having all of the following:
   a. An off-state peak voltage equal to or greater than 3,000 V; **and**
   b. A peak (surge) current equal to or greater than 3,000 A.

Note 1:

1-3.A.1.g. includes:

- Silicon Controlled Rectifiers (SCRs)

- Electrical Triggering Thyristors (ETTs)

- Light Triggering Thyristors (LTTs)

- Integrated Gate Commutated Thyristors (IGCTs)

- Gate Turn-off Thyristors (GTOs)

- MOS Controlled Thyristors (MCTs)

- Solidtrons

Note 2:

1-3.A.1.g. does not apply to thyristor devices and 'thyristor modules' incorporated into equipment designed for civil railway or "civil aircraft" applications.

Technical Note:

For the purposes of 1-3.A.1.g., a 'thyristor module' contains one or more thyristor devices.

1-3.A.1.h. Solid-state power semiconductor switches, diodes, or 'modules', having all of the following:

1. Rated for a maximum operating junction temperature greater than 488 K (215° C);
2. Repetitive peak off-state voltage (blocking voltage) exceeding 300 V; **and**
3. Continuous current greater than 1 A.

Note 1:

Repetitive peak off-state voltage in 1-3.A.1.h. includes drain to source voltage, collector to emitter voltage, repetitive peak reverse voltage and peak repetitive off-state blocking voltage.

Note 2:

1-3.A.1.h. includes:

- Junction Field Effect Transistors (JFETs)

- Vertical Junction Field Effect Transistors (VJFETs)

- Metal Oxide Semiconductor Field Effect Transistors (MOSFETs)

- Double Diffused Metal Oxide Semiconductor Field Effect Transistor (DMOSFET)

- Insulated Gate Bipolar Transistor (IGBT)

- High Electron Mobility Transistors (HEMTs)

- Bipolar Junction Transistors (BJTs)

- Thyristors and Silicon Controlled Rectifiers (SCRs)

- Gate Turn-Off Thyristors (GTOs)

- Emitter Turn-Off Thyristors (ETOs)

- PiN Diodes

- Schottky Diodes

Note 3:

1-3.A.1.h. does not apply to switches, diodes, or 'modules' incorporated into equipment designed for civil automobile, civil railway, or "civil aircraft" applications.

Technical Note:

For the purposes of 1-3.A.1.h., 'modules' contain one or more solid-state power semiconductor switches or diodes.

1-3.A.2. General purpose electronic equipment and accessories therefor, as follows:

1-3.A.2.a. Recording equipment as follows and specially designed test tape therefor:

1. Analogue instrumentation magnetic tape recorders, including those permitting the recording of digital signals (e.g., using a high density digital recording (HDDR) module), having any of the following:
   a. A bandwidth exceeding 4 MHz per electronic channel or track;
   b. A bandwidth exceeding 2 MHz per electronic channel or track and having more than 42 tracks; **or**
   c. A time displacement (base) error, measured in accordance with applicable IRIG or EIA documents, of less than ± 0.1 μs;

   Note:

   Analogue magnetic tape recorders specially designed for civilian video purposes are not considered to be instrumentation tape recorders.

2. Digital video magnetic tape recorders having a maximum digital interface transfer rate exceeding 360 Mbit/s;

   Note:

   1-3.A.2.a.2. does not apply to digital video magnetic tape recorders specially designed for television recording using a signal format, which may include a compressed signal format, standardised or recommended by the ITU, the IEC, the SMPTE, the EBU, the ETSI or the IEEE for civil television applications.

3. Digital instrumentation magnetic tape data recorders employing helical scan techniques or fixed head techniques and having any of the following:
   a. A maximum digital interface transfer rate exceeding 175 Mbit/s; **or**
   b. Being "space-qualified";

   Note:

   1-3.A.2.a.3. does not apply to analogue magnetic tape recorders equipped with HDDR conversion electronics and configured to record only digital data.
4. Equipment having a maximum digital interface transfer rate exceeding 175 Mbit/s and designed to convert digital video magnetic tape recorders for use as digital instrumentation data recorders;
5. Waveform digitisers and transient recorders, having all of the following:
   a. Digitising rates equal to or more than 200 million samples per second and a resolution of 10 bits or more; **and**
   b. A 'continuous throughput' of 2 Gbit/s or more;

   Technical Notes:

   1. *For those instruments with a parallel bus architecture, the 'continuous throughput' rate is the highest word rate multiplied by the number of bits in a word.*
   2. *'Continuous throughput' is the fastest data rate the instrument can output to mass storage without the loss of any information whilst sustaining the sampling rate and analogue-to-digital conversion.*
6. Digital instrumentation data recorders using magnetic disk storage technique and having all of the following:
   a. Digitizing rate equal to or more than 100 million samples per second and a resolution of 8 bit or more; **and**
   b. A 'continuous throughput' of 1 Gbit/s or more;

1-3.A.2.b. Not used since 2009

1-3.A.2.c. Radio-frequency "signal analysers" as follows:

1. "Signal analysers" having a 3 dB resolution bandwidth (RBW) exceeding 10 MHz anywhere within the frequency range exceeding 31.8 GHz but not exceeding 37.5 GHz;
2. "Signal analysers" having Displayed Average Noise Level (DANL) less (better) than –150 dBm/Hz anywhere within the frequency range exceeding 43.5 GHz but not exceeding 70 GHz;
3. "Signal analysers" having a frequency exceeding 70 GHz;
4. "Dynamic signal analysers" having a "real-time bandwidth" exceeding 40 MHz;

   Note:

   1-3.A.2.c.4. does not apply to those "dynamic signal analysers" using only constant percentage bandwidth filters (also known as octave or fractional octave filters).

1-3.A.2.d. Frequency synthesized signal generators producing output frequencies, the accuracy and short term and long term stability of which are controlled, derived from or disciplined by the internal master reference oscillator and having any of the following:

1. Specified to generate a 'pulse duration' of less than 100 ns anywhere within the synthesized frequency range exceeding 31.8 GHz but not exceeding 70 GHz;
2. An output power exceeding 100 mW (20 dBm) anywhere within the synthesized frequency range exceeding 43.5 GHz but not exceeding 70 GHz;
3. A "frequency switching time" as specified by any of the following:
   a. Less than 312 ps;
   b. Less than 100 µs for any frequency change exceeding 1.6 GHz within the synthesized frequency range exceeding 3.2 GHz but not exceeding 10.6 GHz;
   c. Less than 250 µs for any frequency change exceeding 550 MHz within the synthesized frequency range exceeding 10.6 GHz but not exceeding 31.8 GHz;
   d. Less than 500 µs for any frequency change exceeding 550 MHz within the synthesized frequency range exceeding 31.8 GHz but not exceeding 43.5 GHz;
   e. Less than 1 ms for any frequency change exceeding 550 MHz within the synthesized frequency range exceeding 43.5 GHz but not exceeding 56 GHz; **or**
   f. Less than 1 ms for any frequency change exceeding 2.2 GHz within the synthesized frequency range exceeding 56 GHz but not exceeding 70 GHz;
4. At synthesised frequencies exceeding 3.2 GHz but not exceeding 70 GHz, and having all of the following:
   a. A single sideband (SSB) phase noise, in dBc/Hz, better than $-(126+20 \log_{10}F-20 \log_{10}f)$ for 10 Hz <F<10 kHz; **and**
   b. A single sideband (SSB) phase noise, in dBc/Hz, better than $-(114+20 \log_{10}F-20 \log_{10}f)$ for 10 kHz $\leq$ F < 500 kHz; **or**

   Technical Note:

   In 1-3.A.2.d.4., F is the offset from the operating frequency in Hz and f is the operating frequency in Mhz.
5. A maximum synthesized frequency exceeding 70 GHz;

Note 1:

For the purpose of 1-3.A.2.d., frequency synthesized signal generators include arbitrary waveform and function generators.

Note 2:

1-3.A.2.d. does not apply to equipment in which the output frequency is either produced by the addition or subtraction of two or more crystal oscillator frequencies, or by an addition or subtraction followed by a multiplication of the result.

Technical Notes:

1. *Arbitrary waveform and function generators are normally specified by sample rate (e.g., GSample/s), which is converted to the RF domain by the Nyquist factor of two. Thus, a 1 GSample/s arbitrary waveform has a direct output capability of 500 MHz. Or, when oversampling is used, the maximum direct output capability is proportionately lower.*

2. For the purposes of 1-3.A.2.d.1., 'pulse duration' is defined as the time interval between the leading edge of the pulse achieving 90% of the peak and the trailing edge of the pulse achieving 10% of the peak.

1-3.A.2.e. Network analysers having any of the following:

1. Maximum operating frequency exceeding 43.5 GHz and output power exceeding 31.62 mW (15 dBm); **or**
2. Maximum operating frequency exceeding 70 GHz;

1-3.A.2.f. Microwave test receivers having all of the following:

1. A maximum operating frequency exceeding 43.5 GHz; **and**
2. Being capable of measuring amplitude and phase simultaneously;

1-3.A.2.g. Atomic frequency standards being any of the following:

1. "Space-qualified";
2. Non-rubidium and having a long-term stability less (better) than 1×10^{-11}/month; **or**
3. Non-"space-qualified" and having all of the following:
   a. Being a rubidium standard;
   b. Long-term stability less (better) than 1×10^{-11}/month; **and**
   c. Total power consumption of less than 1 Watt.

1-3.A.3. Spray cooling thermal management systems employing closed loop fluid handling and reconditioning equipment in a sealed enclosure where a dielectric fluid is sprayed onto electronic components using specially designed spray nozzles that are designed to maintain electronic components within their operating temperature range, and specially designed components therefor.

1-3.B. TEST, INSPECTION AND PRODUCTION EQUIPMENT

1-3.B.1. Equipment for the manufacturing of semiconductor devices or materials, as follows and specially designed components and accessories therefor:

a. Equipment designed for epitaxial growth as follows:
   1. Equipment capable of producing a layer of any material other than silicon with a thickness uniform to less than ± 2.5% across a distance of 75 mm or more;

      Note:

      1-3.B.1.a.1. includes atomic layer epitaxy (ALE) equipment.
   2. Metal Organic Chemical Vapour Deposition (MOCVD) reactors specially designed for compound semiconductor crystal growth by the chemical reaction between materials specified by 1-3.C.3. or 1-3.C.4.;
   3. Molecular beam epitaxial growth equipment using gas or solid sources;

b. Equipment designed for ion implantation and having any of the following:
   1. A beam energy (accelerating voltage) exceeding 1 MeV;
   2. Being specially designed and optimised to operate at a beam energy (accelerating voltage) of less than 2 keV;
   3. Direct write capability; **or**

4. A beam energy of 65 keV or more and a beam current of 45 mA or more for high energy oxygen implant into a heated semiconductor material "substrate";

c. Anisotropic plasma dry etching equipment having all of the following:
   1. Designed or optimized to produce critical dimensions of 65 nm or less; **and**
   2. Within-wafer non-uniformity equal to or less than 10% 3σ measured with an edge exclusion of 2 mm or less;

d. Plasma enhanced Chemical Vapor Deposition (CVD) equipment as follows:
   1. Equipment with cassette-to-cassette operation and load-locks, and designed according to the manufacturer's specifications or optimised for use in the production of semiconductor devices with critical dimensions of 65 nm or less;
   2. Equipment specially designed for equipment specified by 1-3.B.1.e. and designed according to the manufacturer's specifications or optimised for use in the production of semiconductor devices with critical dimensions of 65 nm or less;

e. Automatic loading multi-chamber central wafer handling systems having all of the following:
   1. Interfaces for wafer input and output, to which more than two functionally different 'semiconductor process tools' specified by 1-3.B.1.a., 1-3.B.1.b., 1-3.B.1.c. or 1-3.B.1.d. are designed to be connected; **and**
   2. Designed to form an integrated system in a vacuum environment for 'sequential multiple wafer processing';

   Note:

   1-3.B.1.e. does not apply to automatic robotic wafer handling systems specially designed for parallel wafer processing.

   Technical Notes:

   1. *For the purpose of 1-3.B.1.e., 'semiconductor process tools' refers to modular tools that provide physical processes for semiconductor production that are functionally different, such as deposition, etch, implant or thermal processing.*
   2. *For the purpose of 1-3.B.1.e., 'sequential multiple wafer processing' means the capability to process each wafer in different 'semiconductor process tools', such as by transferring each wafer from one tool to a second tool and on to a third tool with the automatic loading multi-chamber central wafer handling systems.*

f. Lithography equipment as follows:
   1. Align and expose step and repeat (direct step on wafer) or step and scan (scanner) equipment for wafer processing using photo-optical or X-ray methods and having any of the following:
      a. A light source wavelength shorter than 245 nm; **or**
      b. Capable of producing a pattern with a 'Minimum Resolvable Feature size' (MRF) of 95 nm or less;

      Technical Note:

      The 'Minimum Resolvable Feature size'(MRF) is calculated by the following formula:

$$MRF = \frac{(\text{an exposure light source wavelength in nm}) \times (\text{Kfactor})}{\text{numerical aperture}}$$

where the K factor = 0.35

2. Imprint lithography equipment capable of producing features of 95 nm or less;

Note:

1-3.B.1.f.2. includes:

-Micro contact printing tools

-Hot embossing tools

-Nano-imprint lithography tools

-Step and flash imprint lithography (S-FIL) tools

3. Equipment specially designed for mask making or semiconductor device processing using direct writing methods, having all of the following:
   a. Using deflected focussed electron beam, ion beam or "laser" beam; **and**
   b. Having any of the following:
      1. A spot size smaller than 0.2 µm;
      2. Being capable of producing a pattern with a feature size of less than 1 µm; **or**
      3. An overlay accuracy of better than ± 0.20 µm (3 sigma);

g. Masks and reticles, designed for integrated circuits specified by 1-3.A.1.;

h. Multi-layer masks with a phase shift layer;

Note:

1-3.B.1.h. does not apply to multi-layer masks with a phase shift layer designed for the fabrication of memory devices not specified by 1-3.A.1.

i. Imprint lithography templates designed for integrated circuits specified by 1-3.A.1.

1-3.B.2. Test equipment specially designed for testing finished or unfinished semiconductor devices as follows and specially designed components and accessories therefor:

a. For testing S-parameters of transistor devices at frequencies exceeding 31.8 GHz;

b. Not used since 2004

c. For testing microwave integrated circuits specified by 1-3.A.1.b.2.

1-3.C. MATERIALS

1-3.C.1. Hetero-epitaxial materials consisting of a "substrate" having stacked epitaxially grown multiple layers of any of the following:

a. Silicon (Si);

b. Germanium (Ge);

c. Silicon Carbide (SiC); **or**

d. "III/V compounds" of gallium or indium.

1-3.C.2. Resist materials as follows and "substrates" coated with the following resists:

a. Positive resists designed for semiconductor lithography specially adjusted (optimised) for use at wavelengths below 245 nm;

b. All resists designed for use with electron beams or ion beams, with a sensitivity of 0.01 μcoulomb/mm^2 or better;

c. All resists designed for use with X-rays, with a sensitivity of 2.5 mJ/mm^2 or better;

d. All resists optimised for surface imaging technologies, including silylated resists;

e. All resists designed or optimised for use with imprint lithography equipment specified by 1-3.B.1.f.2. that use either a thermal or photo-curable process.

Technical Note:

Silylation techniques are defined as processes incorporating oxidation of the resist surface to enhance performance for both wet and dry developing.

1-3.C.3. Organo-inorganic compounds as follows:

a. Organo-metallic compounds of aluminium, gallium or indium, having a purity (metal basis) better than 99.999%;

b. Organo-arsenic, organo-antimony and organo-phosphorus compounds, having a purity (inorganic element basis) better than 99.999%.

Note:

1-3.C.3. only applies to compounds whose metallic, partly metallic or non-metallic element is directly linked to carbon in the organic part of the molecule.

1-3.C.4. Hydrides of phosphorus, arsenic or antimony, having a purity better than 99.999%, even diluted in inert gases or hydrogen.

Note:

1-3.C.4. does not apply to hydrides containing 20% molar or more of inert gases or hydrogen.

1-3.C.5. Silicon carbide (SiC), gallium nitride (GaN), aluminium nitride (AlN) or aluminium gallium nitride (AlGaN) "substrates", or ingots, boules, or other preforms of those materials, having resistivities greater than 10,000 ohm-cm at 20° C.

1-3.C.6. "Substrates" specified in 1-3.C.5. with at least one epitaxial layer of silicon carbide, gallium nitride, aluminium nitride or aluminium gallium nitride.

1-3.D. SOFTWARE

1-3.D.1. "Software" specially designed for the "development" or "production" of equipment specified by 1-3.A.1.b. to 1-3.A.2.g. or 1-3.B.

1-3.D.2. "Software" specially designed for the "use" of equipment specified by 1-3.B.1.a. to 1-3.B.1.f. or 1-3.B.2.

1-3.D.3. 'Physics-based' simulation "software" specially designed for the "development" of lithographic, etching or deposition processes for translating masking patterns into specific topographical patterns in conductors, dielectrics or semiconductor materials.

Technical Note:

'Physics-based' in 1-3.D.3. means using computations to determine a sequence of physical cause and effect events based on physical properties (e.g., temperature, pressure, diffusion constants and semiconductor materials properties).

Note:

Libraries, design attributes or associated data for the design of semiconductor devices or integrated circuits are considered as "technology".

1-3.D.4. "Software" specially designed for the "development" of equipment specified by 1-3.A.3.

1-3.E. TECHNOLOGY

1-3.E.1. "Technology" according to the General Technology Note for the "development" or "production" of equipment or materials specified by 1-3.A., 1-3.B. or 1-3.C.;

Note 1:

1-3.E.1. does not apply to "technology" for the "production" of equipment or components specified by 1-3.A.3.

Note 2:

1-3.E.1. does not apply to "technology" for the "development" or "production" of integrated circuits specified by 1-3.A.1.a.3. to 1-3.A.1.a.12., having all of the following:

a. Using "technology" at or above 0.130 µm or more; ***and***

b. Incorporating multi-layer structures with three or fewer metal layers.

1-3.E.2. "Technology" according to the General Technology Note other than that specified by 1-3.E.1. for the "development" or "production" of a "microprocessor microcircuit", "microcomputer microcircuit" or microcontroller microcircuit core, having an arithmetic logic unit with an access width of 32 bits or more and any of the following features or characteristics:

a. A 'vector processor unit' designed to perform more than two calculations on floating-point vectors (one-dimensional arrays of 32-bit or larger numbers) simultaneously;

Technical Note:

A 'vector processor unit' is a processor element with built-in instructions that perform multiple calculations on floating-point vectors (one-dimensional arrays of 32-bit or larger numbers) simultaneously, having at least one vector arithmetic logic unit.

b. Designed to perform more than two 64-bit or larger floating-point operation results per cycle; **or**

c. Designed to perform more than four 16-bit fixed-point multiply-accumulate results per cycle (e.g., digital manipulation of analogue information that has been previously converted into digital form, also known as digital "signal processing").

Note:

1-3.E.2.c. does not apply to "technology" for multimedia extensions.

Note 1:

1-3.E.2. does not apply to "technology" for the "development" or "production" of micro-processor cores, having all of the following:

a. Using "technology" at or above 0.130 µm; ***and***

b. Incorporating multi-layer structures with five or fewer metal layers.

Note 2:

1-3.E.2. includes "technology" for digital signal processors and digital array processors.

1-3.E.3. Other "technology" for the "development" or "production" of the following:

a. Vacuum microelectronic devices;

b. Hetero-structure semiconductor devices such as high electron mobility transistors (HEMT), hetero-bipolar transistors (HBT), quantum well and super lattice devices;

Note:

1-3.E.3.b. does not apply to "technology" for high electron mobility transistors (HEMT) operating at frequencies lower than 31.8 GHz and hetero-junction bipolar transistors (HBT) operating at frequencies lower than 31.8 GHz.

c. "Superconductive" electronic devices;

d. Substrates of films of diamond for electronic components;

e. Substrates of silicon-on-insulator (SOI) for integrated circuits in which the insulator is silicon dioxide;

f. Substrates of silicon carbide for electronic components;

g. Electronic vacuum tubes operating at frequencies of 31.8 GHz or higher.

CATEGORY 4: COMPUTERS

Note 1:

Computers, related equipment and "software" performing telecommunications or "local area network" functions must also be evaluated against the performance characteristics of Category 5, Part 1 (Telecommunications).

Note 2:

Control units which directly interconnect the buses or channels of central processing units, "main storage" or disk controllers are not regarded as telecommunications equipment described in Category 5, Part 1 (Telecommunications).

N.B.:

For the status of "software" specially designed for packet switching, see Category 5.D.1. (Telecommunications).

Note 3:

Computers, related equipment and "software" performing cryptographic, cryptanalytic, certifiable multi-level security or certifiable user isolation functions, or which limit electromagnetic compatibility (EMC), must also be evaluated against the performance characteristics in Category 5, Part 2 ("Information Security").

1-4.A. SYSTEMS, EQUIPMENT AND COMPONENTS

1-4.A.1. Electronic computers and related equipment, having any of the following and "electronic assemblies" and specially designed components therefor:

a. Specially designed to have any of the following:

1. Rated for operation at an ambient temperature below 228 K (-45° C) or above 358 K (85° C); **or**

Note:

1-4.A.1.a.1. does not apply to computers specially designed for civil automobile, railway train or "civil aircraft" applications.

2. Radiation hardened to exceed any of the following specifications:

a. Total Dose 5×10^3 Gy (Si);

b. Dose Rate Upset 5×10^6 Gy (Si)/s; **or**

c. Single Event Upset 1×10^{-8} Error/bit/day.

Note:

1-4.A.1.a.2. does not apply to computers specially designed for "civil aircraft" applications

b. Not used since 2009

N.B.:

See Category 5, Part 2 for electronic computers and related equipment performing or incorporating "information security" functions.

1-4.A.2. Not used since 2003

1-4.A.3. "Digital computers", "electronic assemblies", and related equipment therefor, as follows and specially designed components therefor:

Note 1:

1-4.A.3. includes the following:

- 'Vector processors';

- Array processors;

- Digital signal processors;

- Logic processors;

- Equipment designed for "image enhancement";

- Equipment designed for "signal processing".

Note 2:

The status of the "digital computers" and related equipment described in 1-4.A.3. is determined by the status of other equipment or systems provided:

a. The "digital computers" or related equipment are essential for the operation of the other equipment or systems;

b. The "digital computers" or related equipment are not a "principal element" of the other equipment or systems; and

N.B. 1:

The status of "signal processing" or "image enhancement" equipment specially designed for other equipment with functions limited to those required for the other equipment is determined by the status of the other equipment even if it exceeds the "principal element" criterion.

N.B. 2:

For the status of "digital computers" or related equipment for telecommunications equipment, see Category 5, Part 1 (Telecommunications).

c. The "technology" for the "digital computers" and related equipment is determined by 1-4.E.

1-4.A.3.a. Designed or modified for "fault tolerance";

Note:

For the purposes of 1-4.A.3.a., "digital computers" and related equipment are not considered to be designed or modified for "fault tolerance" if they utilise any of the following:

1. Error detection or correction algorithms in "main storage";

2. The interconnection of two "digital computers" so that, if the active central processing unit fails, an idling but mirroring central processing unit can continue the system's functioning;

3. The interconnection of two central processing units by data channels or by using shared storage to permit one central processing unit to perform other work until the second central processing unit fails, at which time the first central processing unit takes over in order to continue the system's functioning; ***or***

4. The synchronisation of two central processing units by "software" so that one central processing unit recognises when the other central processing unit fails and recovers tasks from the failing unit.

b. "Digital computers" having an 'Adjusted Peak Performance' ('APP') exceeding 1.5 Weighted TeraFLOPS (WT);

c. "Electronic assemblies" specially designed or modified for enhancing performance by aggregation of processors so that the 'APP' of the aggregation exceeds the limit specified by 1-4.A.3.b.;

Note 1:

1-4.A.3.c. applies only to "electronic assemblies" and programmable interconnections not exceeding the limit specified by 1-4.A.3.b. when shipped as unintegrated "electronic assemblies". It does not apply to "electronic assemblies" inherently limited by nature of their design for use as related equipment specified by 1-4.A.3.e.

Note 2:

1-4.A.3.c. does not apply to "electronic assemblies" specially designed for a product or family of products whose maximum configuration does not exceed the limit specified by 1-4.A.3.b.

d. Not used since 2001

e. Equipment performing analogue-to-digital conversions exceeding the limits specified by 1-3.A.1.a.5.;

f. Not used since 1998

g. Equipment specially designed for aggregating the performance of "digital computers" by providing external interconnections which allow communications at unidirectional data rates exceeding 2.0 Gbyte/s per link.

Note:

1-4.A.3.g. does not apply to internal interconnection equipment (e.g. backplanes, buses), passive interconnection equipment, "network access controllers" or "communications channel controllers".

1-4.A.4. Computers as follows and specially designed related equipment, "electronic assemblies" and components therefor:

a. "Systolic array computers";

b. "Neural computers";

c. "Optical computers".

1-4.B. TEST, INSPECTION AND PRODUCTION EQUIPMENT

None

1-4.C. MATERIALS

None

1-4.D. SOFTWARE

Note:

The status of "software" for the "development", "production", or "use" of equipment described in other Categories is dealt with in the appropriate Category.

1-4.D.1. "Software" as follows:

a. "Software" specially designed or modified for the "development", "production" or "use" of equipment or "software" specified by 1-4.A. or 1-4.D.

b. "Software", other than that specified by 1-4.D.1.a., specially designed or modified for the "development" or "production" of equipment as follows:

1. "Digital computers" having an 'Adjusted Peak Performance' ('APP') exceeding 0.25 Weighted TeraFLOPS (WT);

2. "Electronic assemblies" specially designed or modified for enhancing performance by aggregation of processors so that the 'APP' of the aggregation exceeds the limit in 1-4.D.1.b.1.

1-4.D.2. "Software" specially designed or modified to support "technology" specified by 1-4.E.

1-4.D.3. Not used since 2009

N.B.:

See Category 5, Part 2 for "software" performing or incorporating "information security" functions.

1-4.E. TECHNOLOGY

1-4.E.1. "Technology" as follows:

a. "Technology" according to the General Technology Note, for the "development", "production" or "use" of equipment or "software" specified by 1-4.A. or 1-4.D.

b. "Technology", other than that specified by 1-4.E.1.a., specially designed or modified for the "development" or "production" of equipment as follows:

1. "Digital computers" having an 'Adjusted Peak Performance' ('APP') exceeding 0.25 Weighted TeraFLOPS (WT);

2. "Electronic assemblies" specially designed or modified for enhancing performance by aggregation of processors so that the 'APP' of the aggregation exceeds the limit in 1-4.E.1.b.1.

TECHNICAL NOTE ON 'ADJUSTED PEAK PERFORMANCE' ('APP')

'APP' is an adjusted peak rate at which "digital computers" perform 64-bit or larger floating point additions and multiplications.

Abbreviations used in this Technical Note

n number of processors in the "digital computer"

i processor number (i,...n)

t_i processor cycle time ($t_i = 1/F_i$)

F_i processor frequency

R_i peak floating point calculating rate

W_i architecture adjustment factor

'APP' is expressed in Weighted TeraFLOPS (WT), in units of 10^{12} adjusted floating point operations per second.

OUTLINE OF 'APP' CALCULATION METHOD

1. For each processor i, determine the peak number of 64-bit or larger floating point operations, FPO_i, performed per cycle for each processor in the "digital computer".

Note: In determining FPO, include only 64-bit or larger floating point additions and/or multiplications. All floating point operations must be expressed in operations per processor cycle; operations requiring multiple cycles may be expressed in fractional

results per cycle. For processors not capable of performing calculations on floating point operands of 64-bit or more, the effective calculating rate R is zero.

2. Calculate the floating point rate R for each processor: $R_i = FPO_i/t_i$.

3. Calculate 'APP' as 'APP' = $W_1 \times R_1 + W_2 \times R_2 + \ldots + W_n \times R_n$.

4. For 'vector processors', $W_i = 0.9$. For non-'vector processors', $W_i = 0.3$.

Note 1: For processors that perform compound operations in a cycle, such as addition and multiplication, each operation is counted.

Note 2: For a pipelined processor the effective calculating rate R is the faster of the pipelined rate, once the pipeline is full, or the non-pipelined rate.

Note 3: The calculating rate R of each contributing processor is to be calculated at its maximum value theoretically possible before the 'APP' of the combination is derived. Simultaneous operations are assumed to exist when the computer manufacturer claims concurrent, parallel, or simultaneous operation or execution in a manual or brochure for the computer.

Note 4: Do not include processors that are limited to input/output and peripheral functions (e.g., disk drive, communication and video display) when calculating 'APP'.

Note 5: 'APP' values are not to be calculated for processor combinations (inter)connected by "Local Area Networks", Wide Area Networks, I/O shared connections/devices, I/O controllers and any communication interconnection implemented by "software".

Note 6: 'APP' values must be calculated for 1) processor combinations containing processors specially designed to enhance performance by aggregation, operating simultaneously and sharing memory; or 2) multiple memory/processor combinations operating simultaneously utilizing specially designed hardware.

Note 7: A 'vector processor' is defined as a processor with built-in instructions that perform multiple calculations on floating-point vectors (one-dimensional arrays of 64-bit or larger numbers) simultaneously, having at least 2 vector functional units and at least 8 vector registers of at least 64 elements each.

CATEGORY 5 - PART 1: TELECOMMUNICATIONS

Note 1:

The status of components, test and "production" equipment and "software" therefor which are specially designed for telecommunications equipment or systems is determined in Category 5, Part 1.

N.B. 1:

For "lasers" specially designed for telecommunications equipment or systems, see 1-6.A.5.

N.B. 2:

See also Category 5, Part 2 for equipment, components and "software" performing or incorporating "information security" functions.

Note 2:

"Digital computers", related equipment or "software", when essential for the operation and support of telecommunications equipment described in this Category, are regarded as specially designed components, provided they are the standard models customarily supplied by the manufacturer. This includes operation, administration, maintenance, engineering or billing computer systems.

1-5.A.1. SYSTEMS, EQUIPMENT AND COMPONENTS

1-5.A.1. Telecommunications systems, equipment, components and accessories, as follows:

a. Any type of telecommunications equipment having any of the following characteristics, functions or features:

1. Specially designed to withstand transitory electronic effects or electromagnetic pulse effects, both arising from a nuclear explosion;
2. Specially hardened to withstand gamma, neutron or ion radiation; **or**
3. Specially designed to operate outside the temperature range from 218 K (-55° C) to 397 K (124° C);

Note:

1-5.A.1.a.3. applies only to electronic equipment.

Note:

1-5.A.1.a.2. and 1-5.A.1.a.3. do not apply to equipment designed or modified for use on board satellites.

b. Telecommunication systems and equipment, and specially designed components and accessories therefor, having any of the following characteristics, functions or features:

1. Being underwater untethered communications systems having any of the following:
   a. An acoustic carrier frequency outside the range from 20 kHz to 60 kHz;
   b. Using an electromagnetic carrier frequency below 30 kHz;
   c. Using electronic beam steering techniques; **or**

d. Using "lasers" or light-emitting diodes (LEDs) with an output wavelength greater than 400 nm and less than 700 nm, in a "local area network".

2. Being radio equipment operating in the 1.5 MHz to 87.5 MHz band and having all of the following:
   a. Automatically predicting and selecting frequencies and "total digital transfer rates" per channel to optimise the transmission; **and**
   b. Incorporating a linear power amplifier configuration having a capability to support multiple signals simultaneously at an output power of 1 kW or more in the frequency range of 1.5 MHz or more but less than 30 MHz, or 250 W or more in the frequency range of 30 MHz or more but not exceeding 87.5 MHz, over an "instantaneous bandwidth" of one octave or more and with an output harmonic and distortion content of better than -80 dB;
3. Being radio equipment employing "spread spectrum" techniques, including "frequency hopping" techniques, not specified by 1-5.A.1.b.4. and having any of the following:
   a. User programmable spreading codes; **or**
   b. A total transmitted bandwidth which is 100 or more times the bandwidth of any one information channel and in excess of 50 kHz;

      Note:

      1-5.A.1.b.3.b. does not apply to radio equipment specially designed for use with civil cellular radio-communications systems.

   Note:

   1-5.A.1.b.3. does not apply to equipment designed to operate at an output power of 1 W or less.
4. Being radio equipment employing ultra-wideband modulation techniques having user programmable channelizing codes, scrambling codes or network identification codes and having any of the following:
   a. A bandwidth exceeding 500 MHz; **or**
   b. A "fractional bandwidth" of 20% or more;
5. Being digitally controlled radio receivers having all of the following:
   a. More than 1,000 channels;
   b. A "frequency switching time" of less than 1 ms;
   c. Automatic searching or scanning of a part of the electromagnetic spectrum; **and**
   d. Identification of the received 'signals or the type of transmitter; **or**

   Note:

   1-5.A.1.b.5. does not apply to radio equipment specially designed for use with civil cellular radio-communications systems.
6. Employing functions of digital "signal processing" to provide 'voice coding' output at rates of less than 2,400 bit/s.

   Technical Notes:

   1. For variable rate 'voice coding', 1-5.A.1.b.6. applies to the 'voice coding' output of continuous speech.

2. *For the purpose of 1-5.A.1.b.6., 'voice coding' is defined as the technique to take samples of human voice and then convert these samples into a digital signal, taking into account specific characteristics of human speech.*

c. Optical fibres of more than 500 m in length and specified by the manufacturer as being capable of withstanding a 'proof test' tensile stress of 2 x 10^9 N/m^2 or more;

N. B.:

For underwater umbilical cables, see 1-8.A.2.a.3.

Technical Note:

'Proof Test': on-line or off-line production screen testing that dynamically applies a prescribed tensile stress over a 0.5 to 3 m length of fibre at a running rate of 2 to 5 m/s while passing between capstans approximately 150 mm in diameter. The ambient temperature is a nominal 293 K (20° C) and relative humidity 40%. Equivalent national standards may be used for executing the proof test.

d. "Electronically steerable phased array antennae" operating above 31.8 GHz;

Note:

1-5.A.1.d. does not apply to "electronically steerable phased array antennae" for landing systems with instruments meeting ICAO standards covering Microwave Landing Systems (MLS).

e. Radio direction finding equipment operating at frequencies above 30 MHz and having all of the following, and specially designed components therefor:

1. "Instantaneous bandwidth" of 10 MHz or more; **and**
2. Capable of finding a Line Of Bearing (LOB) to non-cooperating radio transmitters with a signal duration of less than 1 ms;

f. Jamming equipment specially designed or modified to intentionally and selectively interfere with, deny, inhibit, degrade or seduce mobile telecommunication services and perform any of the following, and specially designed components therefor:

1. Simulate the functions of Radio Access Network (RAN) equipment;
2. Detect and exploit specific characteristics of the mobile telecommunications protocol employed (e.g., GSM); **or**
3. Exploit specific characteristics of the mobile telecommunications protocol employed (e.g., GSM);

N.B.:

For GNSS jamming equipment see Group 2 - Munitions List.

g. Passive Coherent Location (PCL) systems or equipment, specially designed for detecting and tracking moving objects by measuring reflections of ambient radio frequency emissions, supplied by non-radar transmitters;

Technical Note:

Non-radar transmitters may include commercial radio, television or cellular telecommunications base stations.

Note:

1-5.A.1.g. does not apply to any of the following:

*a. Radio-astronomical equipment; **or***

b. Systems or equipment, that require any radio transmission from the target.

h. Radio Frequency (RF) transmitting equipment designed or modified for prematurely activating or preventing the initiation of Improvised Explosive Devices (IEDs).

N.B.:

See also 1-5.A.1.f and Group 2 - Munitions List.

1-5.B.1. TEST, INSPECTION AND PRODUCTION EQUIPMENT

1-5.B.1. Telecommunication test, inspection and production equipment, components and accessories, as follows:

a. Equipment and specially designed components or accessories therefor, specially designed for the "development", "production" or "use" of equipment, functions or features, specified by 1-5.A.1.;

Note:

1-5.B.1.a. does not apply to optical fibre characterization equipment.

b. Equipment and specially designed components or accessories therefor, specially designed for the "development" of any of the following telecommunication transmission or switching equipment:

1. Not used since 2009
2. Equipment employing a "laser" and having any of the following:
   a. A transmission wavelength exceeding 1,750 nm;
   b. Performing "optical amplification" using praseodymium-doped fluoride fibre amplifiers (PDFFA);
   c. Employing coherent optical transmission or coherent optical detection techniques (also called optical heterodyne or homodyne techniques); **or**
   d. Employing analogue techniques and having a bandwidth exceeding 2.5 GHz;

   Note:

   1-5.B.1.b.2.d. does not apply to equipment specially designed for the "development" of commercial TV systems.
3. Not used since 2009
4. Radio equipment employing Quadrature-Amplitude-Modulation (QAM) techniques above level 256; **or**
5. Equipment employing "common channel signalling" operating in non-associated mode of operation.

1-5.C.1. MATERIALS

None

1-5.D.1. SOFTWARE

1-5.D.1. "Software" as follows:

a. "Software" specially designed or modified for the "development", "production" or "use" of equipment, functions or features, specified by 1-5.A.1.;

b. "Software" specially designed or modified to support "technology" specified by 1-5.E.1.;

c. Specific "software" specially designed or modified to provide characteristics, functions or features of equipment, specified by 1-5.A.1. or 1-5.B.1.;

d. "Software" specially designed or modified for the "development" of any of the following telecommunication transmission or switching equipment:

1. Not used since 2009

2. Equipment employing a "laser" and having any of the following:

a. A transmission wavelength exceeding 1,750 nm; **or**

b. Employing analogue techniques and having a bandwidth exceeding 2.5 GHz; **or**

Note:

1-5.D.1.d.2.b. does not apply to "software" specially designed or modified for the "development" of commercial TV systems.

3. Not used since 2009

4. Radio equipment employing Quadrature-Amplitude-Modulation (QAM) techniques above level 256.

1-5.E.1. TECHNOLOGY

1-5.E.1. "Technology" as follows:

a. "Technology" according to the General Technology Note for the "development", "production" or "use" (excluding operation) of equipment, functions or features specified by 1-5.A.1. or "software" specified by 1-5.D.1.a.;

b. Specific "technology" as follows:

1. "Required" "technology" for the "development" or "production" of telecommunications equipment specially designed to be used on board satellites;

2. "Technology" for the "development" or "use" of "laser" communication techniques with the capability of automatically acquiring and tracking signals and maintaining communications through exoatmosphere or sub-surface (water) media;

3. "Technology" for the "development" of digital cellular radio base station receiving equipment whose reception capabilities that allow multi-band, multi-channel, multi-mode, multi-coding algorithm or multi-protocol operation can be modified by changes in "software";

4. "Technology" for the "development" of "spread spectrum" techniques, including "frequency hopping" techniques;

Note:

1-5.E.1.b.4. does not apply to "technology" for the "development" of civil cellular radio-communications systems.

c. "Technology" according to the General Technology Note for the "development" or "production" of any of the following:

1. Equipment employing digital techniques designed to operate at a "total digital transfer rate" exceeding 50 Gbit/s;

Technical Note:

For telecommunication switching equipment the "total digital transfer rate" is the unidirectional speed of a single interface, measured at the highest speed port or line.

2. Equipment employing a "laser" and having any of the following:
   a. A transmission wavelength exceeding 1,750 nm;
   b. Performing "optical amplification" using Praseodymium-Doped Fluoride Fibre Amplifiers (PDFFA);
   c. Employing coherent optical transmission or coherent optical detection techniques (also called optical heterodyne or homodyne techniques);
   d. Employing wavelength division multiplexing techniques of optical carriers at less than 100 GHz spacing; **or**
   e. Employing analogue techniques and having a bandwidth exceeding 2.5 GHz;

      Note:

      1-5.E.1.c.2.e. does not apply to "technology" for the "development" or "production" of commercial TV systems.

   N.B.:

   For "technology" for the "development" or "production" of non-telecommunications equipment employing a "laser", see 1-6.E.
3. Equipment employing "optical switching" and having a switching time less than 1 ms;
4. Radio equipment having any of the following:
   a. Quadrature-Amplitude-Modulation (QAM) techniques above level 256;
   b. Operating at input or output frequencies exceeding 31.8 GHz; **or**

      Note:

      1-5.E.1.c.4.b. does not apply to "technology" for the "development" or "production" of equipment designed or modified for operation in any frequency band which is "allocated by the ITU" for radio-communications services, but not for radio-determination.
   c. Operating in the 1.5 MHz to 87.5 MHz band and incorporating adaptive techniques providing more than 15 dB suppression of an interfering signal;
5. Equipment employing "common channel signalling" operating in non-associated mode of operation; **or**
6. Mobile equipment having all of the following:
   a. Operating at an optical wavelength greater than or equal to 200 nm and less than or equal to 400 nm; **and**
   b. Operating as a "local area network";

d. "Technology" according to the General Technology Note for the "development" or "production" of Microwave Monolithic Integrated Circuit (MMIC) power amplifiers specially designed for telecommunications and having any of the following:

1. Rated for operation at frequencies exceeding 3.2 GHz up to and including 6.8 GHz and with an average output power greater than 4 W (36 dBm) with a "fractional bandwidth" greater than 15%;
2. Rated for operation at frequencies exceeding 6.8 GHz up to and including 16 GHz and with an average output power greater than 1 W (30 dBm) with a "fractional bandwidth" greater than 10%;
3. Rated for operation at frequencies exceeding 16 GHz up to and including 31.8 GHz and with an average output power greater than 0.8 W (29 dBm) with a "fractional bandwidth" greater than 10%;
4. Rated for operation at frequencies exceeding 31.8 GHz up to and including 37.5 GHz;
5. Rated for operation at frequencies exceeding 37.5 GHz up to and including 43.5 GHz and with an average output power greater than 0.25 W (24 dBm) with a "fractional bandwidth" greater than 10%; **or**
6. Rated for operation at frequencies exceeding 43.5 GHz;

e. "Technology" according to the General Technology Note for the "development" or "production" of electronic devices and circuits, specially designed for telecommunications and containing components manufactured from "superconductive" materials, specially designed for operation at temperatures below the "critical temperature" of at least one of the "superconductive" constituents and having any of the following:

1. Current switching for digital circuits using "superconductive" gates with a product of delay time per gate (in seconds) and power dissipation per gate (in watts) of less than 10^{-14} J; **or**
2. Frequency selection at all frequencies using resonant circuits with Q-values exceeding 10,000.

CATEGORY 5 - PART 2: "INFORMATION SECURITY"

Note 1:

The status of "information security" equipment, "software", systems, application specific "electronic assemblies", modules, integrated circuits, components or functions is determined in Category 5, Part 2 even if they are components or "electronic assemblies" of other equipment.

Note 2:

Category 5 – Part 2 does not apply to products when accompanying their user for the user's personal use.

Note 3: Cryptography Note

1-5.A.2. and 1-5.D.2. do not apply to items that meet all of the following:

a. *Generally available to the public by being sold, without restriction, from stock at retail selling points by means of any of the following:*
    1. *Over-the-counter transactions;*
    2. *Mail order transactions;*
    3. *Electronic transactions;* ***or***
    4. *Telephone call transactions;*
b. *The cryptographic functionality cannot easily be changed by the user;*
c. *Designed for installation by the user without further substantial support by the supplier;* ***and***
d. *Not used since 2000*
e. *When necessary, details of the items are accessible and will be provided, upon request, to the appropriate authority in the exporter's country in order to ascertain compliance with conditions described in paragraphs a. to c. above.*

Note 4:

Category 5–Part 2 does not apply to items incorporating or using "cryptography" and meeting all of the following:

a. *The primary function or set of functions is not any of the following:*
    1. *"Information security";*
    2. *A computer, including operating systems, parts and components therefor;*
    3. *Sending, receiving or storing information (except in support of entertainment, mass commercial broadcasts, digital rights management or medical records management);* ***or***
    4. *Networking (includes operation, administration, management and provisioning);*
b. *The cryptographic functionality is limited to supporting their primary function or set of functions;* ***and***
c. *When necessary, details of the items are accessible and will be provided, upon request, to the appropriate authority in the exporter's country in order to ascertain compliance with conditions described in paragraphs a. and b. above.*

Technical Note:

In Category 5-Part 2, parity bits are not included in the key length.

1-5.A.2. SYSTEMS, EQUIPMENT AND COMPONENTS

1-5.A.2. "Information security" systems, equipment and components therefor, as follows:

a. Systems, equipment, application specific "electronic assemblies", modules and integrated circuits for "information security", as follows, and components therefor specially designed for "information security":

N.B.:

For Global Navigation Satellite Systems (GNSS) receiving equipment containing or employing decryption, see 1-7.A.5.

1. Designed or modified to use "cryptography" employing digital techniques performing any cryptographic function other than authentication or digital signature and having any of the following:

Technical Notes:

1. Authentication and digital signature functions include their associated key management function.

2. Authentication includes all aspects of access control where there is no encryption of files or text except as directly related to the protection of passwords, Personal Identification Numbers (PINs) or similar data to prevent unauthorised access.

3. "Cryptography" does not include "fixed" data compression or coding techniques.

Note:

1-5.A.2.a.1. includes equipment designed or modified to use "cryptography" employing analogue principles when implemented with digital techniques.

a. A "symmetric algorithm" employing a key length in excess of 56 bits; **or**

b. An "asymmetric algorithm" where the security of the algorithm is based on any of the following:

1. Factorisation of integers in excess of 512 bits (e.g., RSA);

2. Computation of discrete logarithms in a multiplicative group of a finite field of size greater than 512 bits (e.g., Diffie-Hellman over Z/pZ); **or**

3. Discrete logarithms in a group other than mentioned in 1-5.A.2.a.1.b.2. in excess of 112 bits (e.g., Diffie-Hellman over an elliptic curve);

2. Designed or modified to perform cryptanalytic functions;

3. Not used since 1998

4. Specially designed or modified to reduce the compromising emanations of information-bearing signals beyond what is necessary for health, safety or electromagnetic interference standards;

5. Designed or modified to use cryptographic techniques to generate the spreading code for "spread spectrum" systems, not specified by 1-5.A.2.a.6., including the hopping code for "frequency hopping" systems;

6. Designed or modified to use cryptographic techniques to generate channelizing codes, scrambling codes or network identification codes, for systems using ultra-wideband modulation techniques and having any of the following:
   a. A bandwidth exceeding 500MHz; **or**
   b. A "fractional bandwidth" of 20% or more;
7. Non-cryptographic information and communications technology (ICT) security systems and devices evaluated to an assurance level exceeding class EAL-6 (evaluation assurance level) of the Common Criteria (CC) or equivalent;
8. Communications cable systems designed or modified using mechanical, electrical or electronic means to detect surreptitious intrusion;
9. Designed or modified to use "quantum cryptography".

Technical Note:

"Quantum cryptography" is also known as Quantum Key Distribution (QKD).

b. Systems, equipment, application specific "electronic assemblies", modules and integrated circuits, designed or modified to enable an item to achieve or exceed the controlled performance levels for functionality specified by 1-5.A.2.a. that would not otherwise be enabled.

Note:

1-5.A.2. does not apply to any of the following:

a. Smart cards and smart card 'readers/writers' as follows:

1. A smart card or an electronically readable personal document (e.g., token coin, e-passport) that meets any of the following:

*a. The cryptographic capability is restricted for use in equipment or systems excluded from 1-5.A.2. by Note 4 in Category 5–Part 2 or entries b. to i. of this Note, and cannot be reprogrammed for any other use; **or***

b. Having all of the following:

1. It is specially designed and limited to allow protection of 'personal data' stored within;

*2. Has been, or can only be, personalized for public or commercial transactions or individual identification; **and***

3. Where the cryptographic capability is not user-accessible;

Technical Note:

'Personal data' includes any data specific to a particular person or entity, such as the amount of money stored and data necessary for authentication.

2. 'Readers/writers' specially designed or modified, and limited, for items specified by a.1. of this Note.

Technical Note:

'Readers/writers' include equipment that communicates with smart cards or electronically readable documents through a network.

b. Not used since 2009

N.B.:

See Note 4 in Category 5-Part 2 for items previously specified in 1-5.A.2. Note b.

c. Not used since 2009

N.B.:

See Note 4 in Category 5-Part 2 for items previously specified in 1-5.A.2. Note c.

d. Cryptographic equipment specially designed and limited for banking use or 'money transactions';

Technical Note:

'Money transactions' in 1-5.A.2. Note d. includes the collection and settlement of fares or credit functions.

e. Portable or mobile radiotelephones for civil use (e.g., for use with commercial civil cellular radio communication systems) that are not capable of transmitting encrypted data directly to another radiotelephone or equipment (other than Radio Access Network (RAN) equipment), nor of passing encrypted data through RAN equipment (e.g., Radio Network Controller (RNC) or Base Station Controller (BSC));

f. Cordless telephone equipment not capable of end-to-end encryption where the maximum effective range of unboosted cordless operation (i.e., a single, unrelayed hop between terminal and home base station) is less than 400 metres according to the manufacturer's specifications;

g. Portable or mobile radiotelephones and similar client wireless devices for civil use, that implement only published or commercial cryptographic standards (except for anti-piracy functions, which may be non-published) and also meet the provisions of paragraphs b. to e. of the Cryptography Note (Note 3 in Category 5, Part 2), that have been customised for a specific civil industry application with features that do not affect the cryptographic functionality of these original non-customised devices;

h. Not used since 2009

N.B.:

See Note 4 in Category 5-Part 2 for items previously specified in 1-5.A.2. Note h.

i. Wireless "personal area network" equipment that implement only published or commercial cryptographic standards and where the cryptographic capability is limited to a nominal operating range not exceeding 30 metres according to the manufacturer's specifications; ***or***

j. Equipment, having no functionality specified by 1-5.A.2.a.2., 1-5.A.2.a.4., 1-5.A.2.a.7., or 1-5.A.2.a.8., where all cryptographic capability specified by 1-5.A.2.a. meets any of the following:

1. It cannot be used; ***or***

2. It can only be made useable by means of "cryptographic activation".

N.B.:

See 1-5.A.2.a. for equipment that has undergone "cryptographic activation".

1-5.B.2. TEST, INSPECTION AND PRODUCTION EQUIPMENT

1-5.B.2. "Information security" test, inspection and "production" equipment, as follows:

a. Equipment specially designed for the "development" or "production" of equipment specified by 1-5.A.2. or 1-5.B.2.b.;

b. Measuring equipment specially designed to evaluate and validate the "information security" functions of equipment specified by 1-5.A.2. or "software" specified by 1-5.D.2.a. or 1-5.D.2.c.

1-5.C.2. MATERIALS

None

1-5.D.2. SOFTWARE

1-5.D.2. "Software" as follows:

a. "Software" specially designed or modified for the "development", "production" or "use" of equipment specified by 1-5.A.2. or "software" specified by 1-5.D.2.c.;

b. "Software" specially designed or modified to support "technology" specified by 1-5.E.2.;

c. Specific "software" as follows:

1. "Software" having the characteristics, or performing or simulating the functions of the equipment, specified by 1-5.A.2.;

2. "Software" to certify "software" specified by 1-5.D.2.c.1.

d. "Software" designed or modified to enable an item to achieve or exceed the controlled performance levels for functionality specified by 1-5.A.2.a. that would not otherwise be enabled.

Note:

1-5.D.2. does not apply to "software" as follows:

a. "Software" required for the "use" of equipment excluded by the Note to 1-5.A.2.;

b. "Software" providing any of the functions of equipment excluded by the Note to 1-5.A.2.

1-5.E.2. TECHNOLOGY

1-5.E.2. "Technology" as follows:

a. "Technology" according to the General Technology Note for the "development", "production" or "use" of equipment specified by 1-5.A.2. or 1-5.B.2. or "software" specified by 1-5.D.2.a. or 1-5.D.2.c.;

b. "Technology" to enable an item to achieve or exceed the controlled performance levels for functionality specified by 1-5.A.2.a. that would not otherwise be enabled.

CATEGORY 6: SENSORS AND "LASERS"

1-6.A. SYSTEMS, EQUIPMENT AND COMPONENTS

1-6.A.1. ACOUSTICS

Acoustic systems, equipment and components, as follows:

1-6.A.1.a. Marine acoustic systems, equipment and specially designed components therefor, as follows:

1-6.A.1.a.1. Active (transmitting or transmitting-and-receiving) systems, equipment and specially designed components therefor, as follows:

Note:

1-6.A.1.a.1. does not apply to equipment as follows:

a. Depth sounders operating vertically below the apparatus, not including a scanning function exceeding ± 20°, and limited to measuring the depth of water, the distance of submerged or buried objects or fish finding;

b. Acoustic beacons, as follows:

1. Acoustic emergency beacons;

2. Pingers specially designed for relocating or returning to an underwater position.

a. Acoustic seabed survey equipment as follows:

1. Surface vessel survey equipment designed for sea bed topographic mapping and having all of the following:

a. Designed to take measurements at an angle exceeding 20° from the vertical;

b. Designed to measure seabed topography at seabed depths exceeding 600 m;

c. 'Sounding resolution' less than 2; **and**

d. 'Enhancement' of the depth accuracy through compensation for all the following:

1. Motion of the acoustic sensor;

2. In-water propagation from sensor to the seabed and back; **and**

3. Sound speed at the sensor;

Technical Notes:

1. 'Sounding resolution' is the swath width (degrees) divided by the maximum number of soundings per swath.

2. 'Enhancement' includes the ability to compensate by external means.

2. Underwater survey equipment designed for seabed topographic mapping and having all of the following:

a. Designed or modified to operate at depths exceeding 300 m; and

b. 'Sounding rate' greater than 3,800;

Technical Note:

'Sounding rate' is the product of the maximum speed (m/s) at which the sensor can operate and the maximum number of soundings per swath.

3. Side Scan Sonar (SSS) or Synthetic Aperture Sonar (SAS), designed for seabed imaging and having all of the following:
   a. Designed or modified to operate at depths exceeding 500 m; **and**
   b. An 'area coverage rate' of greater than 570 m2/s while operating with both an 'along track resolution' and 'across track resolution' of less than 15 cm.

Technical Notes:

1. 'Area coverage rate' (m2/s) is twice the product of the maximum sonar range (m) and the maximum speed (m/s) at which the sensor can operate.

2. 'Along track resolution' (cm), for SSS only, is the product of azimuth (horizontal) beamwidth (degrees) and maximum sonar range (m) and 0.873.

3. 'Across track resolution' (cm) is 75 divided by the signal bandwidth (kHz).

b. Object detection or location systems, having any of the following:
   1. A transmitting frequency below 10 kHz;
   2. Sound pressure level exceeding 224 dB (reference 1 µPa at 1 m) for equipment with an operating frequency in the band from 10 kHz to 24 kHz inclusive;
   3. Sound pressure level exceeding 235 dB (reference 1 µPa at 1 m) for equipment with an operating frequency in the band between 24 kHz and 30 kHz;
   4. Forming beams of less than 1° on any axis and having an operating frequency of less than 100 kHz;
   5. Designed to operate with an unambiguous display range exceeding 5,120 m; **or**
   6. Designed to withstand pressure during normal operation at depths exceeding 1,000 m and having transducers with any of the following:
      a. Dynamic compensation for pressure; **or**
      b. Incorporating other than lead zirconate titanate as the transduction element;

c. Acoustic projectors, including transducers, incorporating piezoelectric, magnetostrictive, electrostrictive, electrodynamic or hydraulic elements operating individually or in a designed combination and having any of the following:

Note 1:

The status of acoustic projectors, including transducers, specially designed for other equipment is determined by the status of the other equipment.

Note 2:

1-6.A.1.a.1.c. does not apply to electronic sources which direct the sound vertically only, or mechanical (e.g., air gun or vapour-shock gun) or chemical (e.g., explosive) sources.

1. An instantaneous radiated 'acoustic power density' exceeding 0.01 $mW/mm^2/Hz$ for devices operating at frequencies below 10 kHz;
2. A continuously radiated 'acoustic power density' exceeding 0.001 $mW/mm^2/Hz$ for devices operating at frequencies below 10 kHz; **or**

Technical Note:

'Acoustic power density' is obtained by dividing the output acoustic power by the product of the area of the radiating surface and the frequency of operation.

3. Side-lobe suppression exceeding 22 dB;

d. Acoustic systems and equipment, designed to determine the position of surface vessels or underwater vehicles and having all of the following, and specially designed components therefor:

1. Detection range exceeding 1,000 m; **and**
2. Positioning accuracy of less than 10 m rms (root mean square) when measured at a range of 1,000 m;

Note:

1-6.A.1.a.1.d. includes:

a. Equipment using coherent "signal processing" between two or more beacons and the hydrophone unit carried by the surface vessel or underwater vehicle;

b. Equipment capable of automatically correcting speed-of-sound propagation errors for calculation of a point.

e. Active individual sonars, specially designed or modified to detect, locate and automatically classify swimmers or divers, having all of the following:

1. Detection range exceeding 530 m;
2. Positioning accuracy of less than 15 m rms (root mean square) when measured at a range of 530 m; **and**
3. Transmitted pulse signal bandwidth exceeding 3 kHz;

N.B.:

For diver detection systems specially designed or modified for military use, see Group 2 - Munitions List.

Note:

For 1-6.A.1.a.1.e., where multiple detection ranges are specified for various environments, the greatest detection range is used.

1-6.A.1.a.2. Passive systems, equipment and specially designed components therefor, as follows:

a. Hydrophones having any of the following:

Note:

The status of hydrophones specially designed for other equipment is determined by the status of the other equipment.

1. Incorporating continuous flexible sensing elements;
2. Incorporating flexible assemblies of discrete sensing elements with either a diameter or length less than 20 mm and with a separation between elements of less than 20 mm;
3. Having any of the following sensing elements:
   a. Optical fibres;
   b. 'Piezoelectric polymer films' other than polyvinylidene-fluoride (PVDF) and its co-polymers {P(VDF-TrFE) and P(VDF-TFE)}; **or**
   c. 'Flexible piezoelectric composites';
4. A 'hydrophone sensitivity' better than -180 dB at any depth with no acceleration compensation;
5. Designed to operate at depths exceeding 35 m with acceleration compensation; **or**
6. Designed for operation at depths exceeding 1,000 m;

Technical Notes:

1. 'Piezoelectric polymer film' sensing elements consist of polarized polymer film that is stretched over and attached to a supporting frame or spool (mandrel).

2. 'Flexible piezoelectric composite' sensing elements consist of piezoelectric ceramic particles or fibres combined with an electrically insulating, acoustically transparent rubber, polymer or epoxy compound, where the compound is an integral part of the sensing elements.

3. 'Hydrophone sensitivity' is defined as twenty times the logarithm to the base 10 of the ratio of rms output voltage to a 1 V rms reference, when the hydrophone sensor, without a pre-amplifier, is placed in a plane wave acoustic field with an rms pressure of 1 µPa. For example, a hydrophone of -160 dB (reference 1 V per µPa) would yield an output voltage of 10^{-8} V in such a field, while one of -180 dB sensitivity would yield only 10^{-9} V output. Thus, -160 dB is better than -180 dB.

b. Towed acoustic hydrophone arrays having any of the following:
   1. Hydrophone group spacing of less than 12.5 m or 'able to be modified' to have hydrophone group spacing of less than 12.5 m;
   2. Designed or 'able to be modified' to operate at depths exceeding 35 m;

      Technical Note:

      'Able to be modified' in 1-6.A.1.a.2.b. means having provisions to allow a change of the wiring or interconnections to alter hydrophone group spacing or operating depth limits. These provisions are: spare wiring exceeding 10% of the number of wires, hydrophone group spacing adjustment blocks or internal depth limiting devices that are adjustable or that control more than one hydrophone group.

   3. Heading sensors specified by 1-6.A.1.a.2.d.;
   4. Longitudinally reinforced array hoses;
   5. An assembled array of less than 40 mm in diameter; **or**

6. Not used since 2007
7. Hydrophone characteristics specified by 1-6.A.1.a.2.a.;

c. Processing equipment, specially designed for towed acoustic hydrophone arrays, having "user accessible programmability" and time or frequency domain processing and correlation, including spectral analysis, digital filtering and beamforming using Fast Fourier or other transforms or processes;

d. Heading sensors having all of the following:
1. An accuracy of better than ± 0.5°; **and**
2. Designed to operate at depths exceeding 35 m or having an adjustable or removable depth sensing device in order to operate at depths exceeding 35 m;

e. Bottom or bay cable systems, having any of the following:
1. Incorporating hydrophones specified by 1-6.A.1.a.2.a.; **or**
2. Incorporating multiplexed hydrophone group signal modules having all of the following characteristics:
a. Designed to operate at depths exceeding 35 m or having an adjustable or removable depth sensing device in order to operate at depths exceeding 35 m; **and**
b. Capable of being operationally interchanged with towed acoustic hydrophone array modules;

f. Processing equipment, specially designed for bottom or bay cable systems, having "user accessible programmability" and time or frequency domain processing and correlation, including spectral analysis, digital filtering and beamforming using Fast Fourier or other transforms or processes;

Note:

1-6.A.1.a.2. also applies to receiving equipment, whether or not related in normal application to separate active equipment, and specially designed components therefor.

1-6.A.1.b. Correlation-velocity and Doppler-velocity sonar log equipment, designed to measure the horizontal speed of the equipment carrier relative to the sea bed, as follows:

1. Correlation-velocity sonar log equipment having any of the following characteristics:
a. Designed to operate at distances between the carrier and the sea bed exceeding 500 m; **or**
b. Having speed accuracy better than 1% of speed;
2. Doppler-velocity sonar log equipment having speed accuracy better than 1% of speed.

Note 1:

1-6.A.1.b. does not apply to depth sounders limited to any of the following:

a. Measuring the depth of water;

*b. Measuring the distance of submerged or buried objects; **or***

c. Fish finding.

Note 2:

1-6.A.1.b. does not apply to equipment specially designed for installation on surface vessels.

1-6.A.1.c. Not used since 2010

N.B.:

For diver deterrent acoustic systems, see 1-8.A.2.r.

1-6.A.2. OPTICAL SENSORS

Optical sensors or equipment and components therefor, as follows:

1-6.A.2.a. Optical detectors as follows:

1-6.A.2.a.1. "Space-qualified" solid-state detectors as follows:

Note:

For the purpose of 1-6.A.2.a.1., solid-state detectors include "focal plane arrays".

a. "Space-qualified" solid-state detectors having all of the following:
   1. A peak response in the wavelength range exceeding 10 nm but not exceeding 300 nm; **and**
   2. A response of less than 0.1% relative to the peak response at a wavelength exceeding 400 nm;

b. "Space-qualified" solid-state detectors having all of the following:
   1. A peak response in the wavelength range exceeding 900 nm but not exceeding 1,200 nm; **and**
   2. A response "time constant" of 95 ns or less;

c. "Space-qualified" solid-state detectors having a peak response in the wavelength range exceeding 1,200 nm but not exceeding 30,000 nm;

d. "Space-qualified" "focal plane arrays" having more than 2,048 elements per array and having a peak response in the wavelength range exceeding 300 nm but not exceeding 900 nm.

1-6.A.2.a.2. Image intensifier tubes and specially designed components therefor, as follows:

Note:

1-6.A.2.a.2. does not apply to non-imaging photomultiplier tubes having an electron sensing device in the vacuum space limited solely to any of the following:

*a. A single metal anode; **or***

b. Metal anodes with a centre to centre spacing greater than 500 µm.

Technical Note:

'Charge multiplication' is a form of electronic image amplification and is defined as the generation of charge carriers as a result of an impact ionization gain process. 'Charge multiplication' sensors may take the form of an image intensifier tube, solid state detector or "focal plane array".

a. Image intensifier tubes having all of the following:
   1. A peak response in the wavelength range exceeding 400 nm but not exceeding 1,050 nm;

2. Electron image amplification using any of the following:
   a. A microchannel plate with a hole pitch (centre-to-centre spacing) of 12 µm or less; **or**
   b. An electron sensing device with a non-binned pixel pitch of 500 µm or less, specially designed or modified to achieve 'charge multiplication' other than by a microchannel plate; **and**
3. Any of the following photocathodes:
   a. Multialkali photocathodes (e.g., S-20 and S-25) having a luminous sensitivity exceeding 350 µA/lm;
   b. GaAs or GaInAs photocathodes; **or**
   c. Other "III/V compound" semiconductor photocathodes having a maximum radiant sensitivity exceeding 10 mA/W;

b. Image intensifier tubes having all of the following:
   1. A peak response in the wavelength range exceeding 1,050 nm but not exceeding 1,800 nm;
   2. Electron image amplification using any of the following:
      a. A microchannel plate with a hole pitch (centre-to-centre spacing) of 12 µm or less; **or**
      b. An electron sensing device with a non-binned pixel pitch of 500 µm or less, specially designed or modified to achieve 'charge multiplication' other than by a microchannel plate; **and**
   3. "III/V compound" semiconductor (e.g., GaAs or GaInAs) photocathodes and transferred electron photocathodes, having a maximum radiant sensitivity exceeding 15 mA/W;

c. Specially designed components as follows:
   1. Microchannel plates having a hole pitch (centre-to-centre spacing) of 12 µm or less;
   2. An electron sensing device with a non-binned pixel pitch of 500 µm or less, specially designed or modified to achieve 'charge multiplication' other than by a microchannel plate;
   3. "III/V compound" semiconductor (e.g., GaAs or GaInAs) photocathodes and transferred electron photocathodes;

   Note:

   1-6.A.2.a.2.c.3. does not apply to compound semiconductor photocathodes designed to achieve a maximum radiant sensitivity of any of the following:

   a. 10 mA/W or less at the peak response in the wavelength range exceeding 400 nm but not exceeding 1,050 nm; ***or***

   b. 15 mA/W or less at the peak response in the wavelength range exceeding 1,050 nm but not exceeding 1,800 nm.

1-6.A.2.a.3. Non-"space-qualified" "focal plane arrays" as follows:

N.B.:

'Microbolometer' non-"space-qualified" "focal plane arrays" are only specified by 1-6.A.2.a.3.f.

Technical Note:

Linear or two-dimensional multi-element detector arrays are referred to as "focal plane arrays".

Note 1:

1-6.A.2.a.3. includes photoconductive arrays and photovoltaic arrays.

Note 2:

1-6.A.2.a.3. does not apply to:

a. Multi-element (not to exceed 16 elements) encapsulated photoconductive cells using either lead sulphide or lead selenide;

b. Pyroelectric detectors using any of the following:

1. Triglycine sulphate and variants;

2. Lead-lanthanum-zirconium titanate and variants;

3. Lithium tantalate;

*4. Polyvinylidene fluoride and variants; **or***

5. Strontium barium niobate and variants.

c. "Focal plane arrays" specially designed or modified to achieve 'charge multiplication' and limited by design to have a maximum radiant sensitivity of 10 mA/W or less for wavelengths exceeding 760 nm, having all of the following:

*1. Incorporating a response limiting mechanism designed not to be removed or modified; **and***

2. Any of the following:

*a. The response limiting mechanism is integral to or combined with the detector element; **or***

b. The "focal plane array" is only operable with the response limiting mechanism in place.

Technical Note:

A response limiting mechanism integral to the detector element is designed not to be removed or modified without rendering the detector inoperable.

a. Non-"space-qualified" "focal plane arrays" having all of the following:

1. Individual elements with a peak response within the wavelength range exceeding 900 nm but not exceeding 1,050 nm; **and**

2. Any of the following:

a. A response "time constant" of less than 0.5 ns; **or**

b. Specially designed or modified to achieve 'charge multiplication' and having a maximum "radiant sensitivity" exceeding 10 mA/W.

b. Non-"space-qualified" "focal plane arrays" having all of the following:

1. Individual elements with a peak response in the wavelength range exceeding 1,050 nm but not exceeding 1,200 nm; **and**

2. Any of the following:

a. A response "time constant" of 95 ns or less; **or**

b. Specially designed or modified to achieve 'charge multiplication' and having a maximum "radiant sensitivity" exceeding 10 mA/W.

c. Non-"space-qualified" non-linear (2-dimensional) "focal plane arrays" having individual elements with a peak response in the wavelength range exceeding 1,200 nm but not exceeding 30,000 nm;

N.B.:

Silicon and other material based 'microbolometer' non-"space-qualified" "focal plane arrays" are only specified by 1-6.A.2.a.3.f.

d. Non-"space-qualified" linear (1-dimensional) "focal plane arrays" having all of the following :

1. Individual elements with a peak response in the wavelength range exceeding 1,200 nm but not exceeding 3,000 nm; **and**
2. Any of the following:
   a. A ratio of 'scan direction' dimension of the detector element to the 'cross-scan direction' dimension of the detector element of less than 3.8; **or**
   b. Signal Processing in the Element (SPRITE);

Note:

1-6.A.2.a.3.d. does not apply to "focal plane arrays" (not to exceed 32 elements) having detector elements limited solely to germanium material.

Technical Note:

For the purposes of 1-6.A.2.a.3.d., 'cross-scan direction' is defined as the axis parallel to the linear array of detector elements and the 'scan direction' is defined as the axis perpendicular to the linear array of detector elements.

e. Non-"space-qualified" linear (1-dimensional) "focal plane arrays" having individual elements with a peak response in the wavelength range exceeding 3,000 nm but not exceeding 30,000 nm;

f. Non-"space-qualified" non-linear (2-dimensional) infrared "focal plane arrays" based on 'microbolometer' material having individual elements with an unfiltered response in the wavelength range equal to or exceeding 8,000 nm but not exceeding 14,000 nm;

Technical Note:

For the purposes of 1-6.A.2.a.3.f., 'microbolometer' is defined as a thermal imaging detector that, as a result of a temperature change in the detector caused by the absorption of infrared radiation, is used to generate any usable signal.

g. Non-"space-qualified" "focal plane arrays" having all of the following:

1. Individual detector elements with a peak response in the wavelength range exceeding 400 nm but not exceeding 900 nm;
2. Specially designed or modified to achieve 'charge multiplication' and having a maximum "radiant sensitivity" exceeding 10 mA/W for wavelengths exceeding 760 nm; **and**
3. Greater than 32 elements.

1-6.A.2.b. "Monospectral imaging sensors" and "multispectral imaging sensors", designed for remote sensing applications and having any of the following:

1. An Instantaneous-Field-Of-View (IFOV) of less than 200 µrad (microradians); **or**

2. Specified for operation in the wavelength range exceeding 400 nm but not exceeding 30,000 nm and having all the following;
   a. Providing output imaging data in digital format; **and**
   b. Having any of the following characteristics:
      1. "Space-qualified"; **or**
      2. Designed for airborne operation, using other than silicon detectors, and having an IFOV of less than 2.5 mrad (milliradians);

Note:

1-6.A.2.b.1. does not apply to "monospectral imaging sensors" with a peak response in the wavelength range exceeding 300 nm but not exceeding 900 nm and only incorporating any of the following non-"space-qualified" detectors or non-"space-qualified" "focal plane arrays":

*a. Charge Coupled Devices (CCD) not designed or modified to achieve 'charge multiplication'; **or***

b. Complementary Metal Oxide Semiconductor (CMOS) devices not designed or modified to achieve 'charge multiplication'.

1-6.A.2.c. 'Direct view' imaging equipment incorporating any of the following:

1. Image intensifier tubes having the characteristics listed in 1-6.A.2.a.2.a. or 1-6.A.2.a.2.b.;
2. "Focal plane arrays" having the characteristics listed in 1-6.A.2.a.3.; **or**
3. Solid state detectors specified by 1-6.A.2.a.1.

Technical Note:

'Direct view' refers to imaging equipment that presents a visual image to a human observer without converting the image into an electronic signal for television display, and that cannot record or store the image photographically, electronically or by any other means.

Note:

1-6.A.2.c. does not apply to equipment as follows, when incorporating other than GaAs or GaInAs photocathodes:

a. Industrial or civilian intrusion alarm, traffic or industrial movement control or counting systems;

b. Medical equipment;

c. Industrial equipment used for inspection, sorting or analysis of the properties of materials;

d. Flame detectors for industrial furnaces;

e. Equipment specially designed for laboratory use.

1-6.A.2.d. Special support components for optical sensors, as follows:

1. "Space-qualified" cryocoolers;
2. Non-"space-qualified" cryocoolers having a cooling source temperature below 218 K (-55° C), as follows:
   a. Closed cycle type with a specified Mean-Time-To-Failure (MTTF) or Mean-Time-Between-Failures (MTBF), exceeding 2,500 hours;
   b. Joule-Thomson (JT) self-regulating minicoolers having bore (outside) diameters of less than 8 mm;

3. Optical sensing fibres specially fabricated either compositionally or structurally, or modified by coating, to be acoustically, thermally, inertially, electromagnetically or nuclear radiation sensitive;

Note:

1-6.A.2.d.3. does not apply to encapsulated optical sensing fibres specially designed for bore hole sensing applications.

1-6.A.2.e. Not used since 2008

1-6.A.3. CAMERAS

Cameras, systems or equipment, and components therefor, as follows:

N.B.:

For television and film-based photographic still cameras specially designed or modified for underwater use, see 1-8.A.2.d.1. and 1-8.A.2.e.

1-6.A.3.a. Instrumentation cameras and specially designed components therefor, as follows:

Note:

Instrumentation cameras, specified by 1-6.A.3.a.3. to 1-6.A.3.a.5., with modular structures should be evaluated by their maximum capability, using plug-ins available according to the camera manufacturer's specifications.

1. High-speed cinema recording cameras using any film format from 8 mm to 16 mm inclusive, in which the film is continuously advanced throughout the recording period, and that are capable of recording at framing rates exceeding 13,150 frames/s;

   Note:

   1-6.A.3.a.1. does not apply to cinema recording cameras designed for civil purposes.

2. Mechanical high speed cameras, in which the film does not move, capable of recording at rates exceeding 1,000,000 frames/s for the full framing height of 35 mm film, or at proportionately higher rates for lesser frame heights, or at proportionately lower rates for greater frame heights;
3. Mechanical or electronic streak cameras, having writing speeds exceeding 10 mm/μs;
4. Electronic framing cameras having a speed exceeding 1,000,000 frames/s;
5. Electronic cameras having all of the following:
   a. An electronic shutter speed (gating capability) of less than 1 μs per full frame; **and**
   b. A read out time allowing a framing rate of more than 125 full frames per second;
6. Plug-ins having all of the following characteristics:
   a. Specially designed for instrumentation cameras which have modular structures and which are specified by 1-6.A.3.a.; **and**
   b. Enabling these cameras to meet the characteristics specified by 1-6.A.3.a.3., 1-6.A.3.a.4. or 1-6.A.3.a.5., according to the manufacturer's specifications;

1-6.A.3.b. Imaging cameras as follows:

Note:

1-6.A.3.b. does not apply to television or video cameras, specially designed for television broadcasting.

1-6.A.3.b.1. Video cameras incorporating solid state sensors, having a peak response in the wavelength range exceeding 10 nm, but not exceeding 30,000 nm and having all of the following:

a. Having any of the following:

1. More than 4 x 10^6 "active pixels" per solid state array for monochrome (black and white) cameras;

2. More than 4 x 10^6 "active pixels" per solid state array for colour cameras incorporating three solid state arrays; **or**

3. More than 12 x 10^6 "active pixels" for solid state array colour cameras incorporating one solid state array; **and**

b. Having any of the following:

1. Optical mirrors specified by 1-6.A.4.a.;

2. Optical control equipment specified by 1-6.A.4.d.; **or**

3. The capability for annotating internally generated 'camera tracking data';

Technical Notes:

1. For the purpose of this entry, digital video cameras should be evaluated by the maximum number of "active pixels" used for capturing moving images.

2. For the purpose of this entry, 'camera tracking data' is the information necessary to define camera line of sight orientation with respect to the earth. This includes: 1) the horizontal angle the camera line of sight makes with respect to the earth's magnetic field direction and; 2) the vertical angle between the camera line of sight and the earth's horizon.

1-6.A.3.b.2. Scanning cameras and scanning camera systems, having all of the following:

a. A peak response in the wavelength range exceeding 10 nm, but not exceeding 30,000 nm;

b. Linear detector arrays with more than 8,192 elements per array; **and**

c. Mechanical scanning in one direction;

Note:

1-6.A.3.b.2. does not apply to scanning cameras and scanning camera systems, specially designed for any of the following:

a. Industrial or civilian photocopiers;

*b. Image scanners specially designed for civil, stationary, close proximity scanning applications (e.g., reproduction of images or print contained in documents, artwork or photographs); **or***

c. Medical equipment.

1-6.A.3.b.3. Imaging cameras incorporating image intensifier tubes having the characteristics listed in 1-6.A.2.a.2.a. or 1-6.A.2.a.2.b.;

1-6.A.3.b.4. Imaging cameras incorporating "focal plane arrays" having any of the following:

a. Incorporating "focal plane arrays" specified by 1-6.A.2.a.3.a. to 1-6.A.2.a.3.e.;

b. Incorporating "focal plane arrays" specified by 1-6.A.2.a.3.f.; **or**

c. Incorporating "focal plane arrays" specified by 1-6.A.2.a.3.g.;

Note 1:

Imaging cameras specified by 1-6.A.3.b.4. include "focal plane arrays" combined with sufficient "signal processing" electronics, beyond the read out integrated circuit, to enable as a minimum the output of an analogue or digital signal once power is supplied.

Note 2:

1-6.A.3.b.4.a. does not apply to imaging cameras incorporating linear "focal plane arrays" with 12 elements or fewer, not employing time-delay-and-integration within the element and designed for any of the following:

a. Industrial or civilian intrusion alarm, traffic or industrial movement control or counting systems;

b. Industrial equipment used for inspection or monitoring of heat flows in buildings, equipment or industrial processes;

c. Industrial equipment used for inspection, sorting or analysis of the properties of materials;

*d. Equipment specially designed for laboratory use; **or***

e. Medical equipment.

Note 3:

1-6.A.3.b.4.b. does not apply to imaging cameras having any of the following:

a. A maximum frame rate equal to or less than 9 Hz;

b. Having all of the following:

1. Having a minimum horizontal or vertical 'Instantaneous-Field-of-View (IFOV)' of at least 10 mrad/pixel (milliradians/pixel);

2. Incorporating a fixed focal-length lens that is not designed to be removed;

*3. Not incorporating a 'direct view' display; **and***

Technical Note:

'Direct view' refers to an imaging camera operating in the infrared spectrum that presents a visual image to a human observer using a near-to-eye micro display incorporating any light-security mechanism.

4. Having any of the following:

*a. No facility to obtain a viewable image of the detected field-of-view; **or***

*b. The camera is designed for a single kind of application and designed not to be user modified; **or***

Technical Note:

'Instantaneous Field of View (IFOV)' specified in Note 3.b. is the lesser figure of the 'Horizontal IFOV' or the 'Vertical IFOV'.

'Horizontal IFOV' = horizontal Field of View (FOV)/number of horizontal detector elements

'Vertical IFOV'= vertical Field of View (FOV)/number of vertical detector elements.

c. The camera is specially designed for installation into a civilian passenger land vehicle of less than 3 tonnes (gross vehicle weight) and having all of the following:

1. Is only operable when installed in any of the following:

*a. The civilian passenger land vehicle for which it was intended; **or***

*b. A specially designed, authorized maintenance test facility; **and***

2. Incorporates an active mechanism that forces the camera not to function when it is removed from the vehicle for which it was intended.

Note:

When necessary, details of the item will be provided, upon request, to the appropriate authority in the exporter's country in order to ascertain compliance with the conditions described in Note 3.b.4. and Note 3.c. above.

Note 4:

1-6.A.3.b.4.c. does not apply to imaging cameras having any of the following characteristics:

a. Having all of the following:

1. Where the camera is specially designed for installation as an integrated component into indoor and wall-plug-operated systems or equipment, limited by design for a single kind of application, as follows:

a. Industrial process monitoring, quality control, or analysis of the properties of materials;

b. Laboratory equipment specially designed for scientific research;

c. Medical equipment;

d. Financial fraud detection equipment;

2. Is only operable when installed in any of the following:

*a. The system(s) or equipment for which it was intended; **or***

*b. A specially designed, authorised maintenance facility; **and***

3. Incorporates an active mechanism that forces the camera not to function when it is removed from the system(s) or equipment for which it was intended;

b. Where the camera is specially designed for installation into a civilian passenger land vehicle of less than three tonnes (gross vehicle weight), or passenger and vehicle ferries having a length overall (LOA) 65 m or greater, and having all of the following:

1. Is only operable when installed in any of the following:

*a. The civilian passenger land vehicle or passenger and vehicle ferry for which it was intended; **or***

*b. A specially designed, authorised maintenance test facility; **and***

2. Incorporates an active mechanism that forces the camera not to function when it is removed from the vehicle for which it was intended;

c. Limited by design to have a maximum "radiant sensitivity" of 10 mA/W or less for wavelengths exceeding 760 nm, having all of the following:

1. Incorporating a response limiting mechanism designed not to be removed or modified;

*2. Incorporates an active mechanism that forces the camera not to function when the response limiting mechanism is removed; **and***

*3. Not specially designed or modified for underwater use; **or***

d. Having all of the following:

1. Not incorporating a 'direct view' or electronic image display;

2. Has no facility to output a viewable image of the detected field of view;

*3. The "focal plane array" is only operable when installed in the camera for which it was intended; **and***

4. The "focal plane array" incorporates an active mechanism that forces it to be permanently inoperable when removed from the camera for which it was intended.

Note:

When necessary, details of the item will be provided, upon request, to the appropriate authority in the exporter's country in order to ascertain compliance with the conditions described in Note 4 above.

1-6.A.3.b.5. Imaging cameras incorporating solid-state detectors specified by 1-6.A.2.a.1.

1-6.A.4. OPTICS

Optical equipment and components, as follows:

1-6.A.4.a. Optical mirrors (reflectors) as follows:

1. "Deformable mirrors" having either continuous or multi-element surfaces, and specially designed components therefor, capable of dynamically repositioning portions of the surface of the mirror at rates exceeding 100 Hz;
2. Lightweight monolithic mirrors having an average "equivalent density" of less than 30 kg/m^2 and a total mass exceeding 10 kg;
3. Lightweight "composite" or foam mirror structures having an average "equivalent density" of less than 30 kg/m^2 and a total mass exceeding 2 kg;
4. Beam steering mirrors more than 100 mm in diameter or length of major axis, which maintain a flatness of $\lambda/2$ or better (λ is equal to 633 nm) having a control bandwidth exceeding 100 Hz;

N.B.:

For optical mirrors specially designed for lithography equipment, see 1-3.B.1.

1-6.A.4.b. Optical components made from zinc selenide (ZnSe) or zinc sulphide (ZnS) with transmission in the wavelength range exceeding 3,000 nm but not exceeding 25,000 nm and having any of the following:

1. Exceeding 100 cm^3 in volume; **or**
2. Exceeding 80 mm in diameter or length of major axis and 20 mm in thickness (depth);

1-6.A.4.c. "Space-qualified" components for optical systems, as follows:

1. Components lightweighted to less than 20% "equivalent density" compared with a solid blank of the same aperture and thickness;
2. Raw substrates, processed substrates having surface coatings (single-layer or multi-layer, metallic or dielectric, conducting, semiconducting or insulating) or having protective films;

3. Segments or assemblies of mirrors designed to be assembled in space into an optical system with a collecting aperture equivalent to or larger than a single optic 1 m in diameter;
4. Components manufactured from "composite" materials having a coefficient of linear thermal expansion equal to or less than 5 x 10^{-6} in any coordinate direction;

1-6.A.4.d. Optical control equipment as follows:

1. Equipment specially designed to maintain the surface figure or orientation of the "space-qualified" components specified by 1-6.A.4.c.1. or 1-6.A.4.c.3.;
2. Equipment having steering, tracking, stabilisation or resonator alignment bandwidths equal to or more than 100 Hz and an accuracy of 10 µrad (microradians) or less;
3. Gimbals having all of the following:
   a. A maximum slew exceeding 5°;
   b. A bandwidth of 100 Hz or more;
   c. Angular pointing errors of 200 µrad (microradians) or less; **and**
   d. Having any of the following:
      1. Exceeding 0.15 m but not exceeding 1 m in diameter or major axis length and capable of angular accelerations exceeding 2 rad (radians)/s^2; **or**
      2. Exceeding 1 m in diameter or major axis length and capable of angular accelerations exceeding 0.5 rad (radians)/s^2;
4. Specially designed to maintain the alignment of phased array or phased segment mirror systems consisting of mirrors with a segment diameter or major axis length of 1 m or more;

1-6.A.4.e. 'Aspheric optical elements' having all of the following:

1. Largest dimension of the optical-aperture greater than 400 mm;
2. Surface roughness less than 1 nm (rms) for sampling lengths equal to or greater than 1 mm; **and**
3. Coefficient of linear thermal expansion's absolute magnitude less than 3 x 10^{-6}/K at 25° C.

Technical Notes:

1. An 'aspheric optical element' is any element used in an optical system whose imaging surface or surfaces are designed to depart from the shape of an ideal sphere.

2. Manufacturers are not required to measure the surface roughness listed in 1-6.A.4.e.2. unless the optical element was designed or manufactured with the intent to meet, or exceed, the specified parameter.

Note:

1-6.A.4.e. does not apply to 'aspheric optical elements' having any of the following:

a. Largest optical-aperture dimension less than 1 m and focal length to aperture ratio equal to or greater than 4.5:1;

b. Largest optical-aperture dimension equal to or greater than 1 m and focal length to aperture ratio equal to or greater than 7:1;

c. Designed as Fresnel, flyeye, stripe, prism or diffractive optical elements;

d. Fabricated from borosilicate glass having a coefficient of linear thermal expansion greater than 2.5 x 10^{-6}/K at 25° C; ***or***

e. An x-ray optical element having inner mirror capabilities (e.g., tube-type mirrors).

N.B.:

For 'aspheric optical elements' specially designed for lithography equipment, see 1-3.B.1.

1-6.A.5. LASERS

"Lasers", components and optical equipment, as follows:

Note 1:

Pulsed "lasers" include those that run in a continuous wave (CW) mode with pulses superimposed.

Note 2:

Excimer, semiconductor, chemical, CO, CO_2, and non-repetitive pulsed Nd:glass "lasers" are only specified by 1-6.A.5.d.

Note 3:

1-6.A.5. includes fibre "lasers".

Note 4:

The status of "lasers" incorporating frequency conversion (i.e., wavelength change) by means other than one "laser" pumping another "laser" is determined by applying the specified parameters for both the output of the source "laser" and the frequency-converted optical output.

Note 5:

1-6.A.5. does not apply to "lasers" as follows:

a. Ruby with output energy below 20 J;

b. Nitrogen;

c. Krypton.

1-6.A.5.a. Non-"tunable" continuous wave "(CW) lasers" having any of the following:

1. Output wavelength less than 150 nm and output power exceeding 1 W;
2. Output wavelength of 150 nm or more but not exceeding 520 nm and output power exceeding 30 W;

   Note:

   1-6.A.5.a.2. does not apply to Argon "lasers" having an output power equal to or less than 50 W.
3. Output wavelength exceeding 520 nm but not exceeding 540 nm and any of the following:
   a. Single transverse mode output and output power exceeding 50 W; **or**
   b. Multiple transverse mode output and output power exceeding 150 W;
4. Output wavelength exceeding 540 nm but not exceeding 800 nm and output power exceeding 30 W;

5. Output wavelength exceeding 800 nm but not exceeding 975 nm and any of the following:
   a. Single transverse mode output and output power exceeding 50 W; **or**
   b. Multiple transverse mode output and output power exceeding 80 W;
6. Output wavelength exceeding 975 nm but not exceeding 1,150 nm and any of the following:
   a. Single transverse mode output and any of the following:
      1. 'Wall-plug efficiency' exceeding 12% and output power exceeding 100 W; **or**
      2. Output power exceeding 150 W; **or**
   b. Multiple transverse mode output and any of the following:
      1. 'Wall-plug efficiency' exceeding 18% and output power exceeding 500 W; **or**
      2. Output power exceeding 2 kW;

      Note:

      1-6.A.5.a.6.b. does not apply to multiple transverse mode, industrial "lasers" with output power exceeding 2 kW and not exceeding 6 kW with a total mass greater than 1,200 kg. For the purpose of this note, total mass includes all components required to operate the "laser", e.g., "laser", power supply, heat exchanger, but excludes external optics for beam conditioning and/or delivery.

Technical Note:

'Wall-plug efficiency' is defined as the ratio of "laser" output power (or "average output power") to total electrical input power required to operate the "laser", including the power supply/conditioning and thermal conditioning/heat exchanger.

7. Output wavelength exceeding 1,150 nm but not exceeding 1,555 nm and any of the following:
   a. Single transverse mode and output power exceeding 50 W; **or**
   b. Multiple transverse mode and output power exceeding 80 W; **or**
8. Output wavelength exceeding 1,555 nm and output power exceeding 1 W;

1-6.A.5.b. Non-"tunable" "pulsed lasers" having any of the following:

1. Output wavelength less than 150 nm and any of the following:
   a. Output energy exceeding 50 mJ per pulse and "peak power" exceeding 1 W; **or**
   b. "Average output power" exceeding 1 W;
2. Output wavelength of 150 nm or more but not exceeding 520 nm and any of the following:
   a. Output energy exceeding 1.5 J per pulse and "peak power" exceeding 30 W; **or**
   b. "Average output power" exceeding 30 W;

      Note:

      1-6.A.5.b.2.b. does not apply to Argon "lasers" having an "average output power" equal to or less than 50 W.
3. Output wavelength exceeding 520 nm but not exceeding 540 nm and any of the following:

a. Single transverse mode output and any of the following:
    1. Output energy exceeding 1.5 J per pulse and "peak power" exceeding 50 W; **or**
    2. "Average output power" exceeding 50 W; **or**
b. Multiple transverse mode output and any of the following:
    1. Output energy exceeding 1.5 J per pulse and "peak power" exceeding 150 W; **or**
    2. "Average output power" exceeding 150 W;

4. Output wavelength exceeding 540 nm but not exceeding 800 nm and any of the following:
    a. Output energy exceeding 1.5 J per pulse and "peak power" exceeding 30 W; **or**
    b. "Average output power" exceeding 30 W;
5. Output wavelength exceeding 800 nm but not exceeding 975 nm and any of the following:
    a. "Pulse duration" not exceeding 1 μs and any of the following:
        1. Output energy exceeding 0.5 J per pulse and "peak power" exceeding 50 W;
        2. Single transverse mode output and "average output power" exceeding 20 W; **or**
        3. Multiple transverse mode output and "average output power" exceeding 50 W; **or**
    b. "Pulse duration" exceeding 1 μs and any of the following:
        1. Output energy exceeding 2 J per pulse and "peak power" exceeding 50 W;
        2. Single transverse mode output and "average output power" exceeding 50 W; **or**
        3. Multiple transverse mode output and "average output power" exceeding 80 W;
6. Output wavelength exceeding 975 nm but not exceeding 1,150 nm and any of the following:
    a. "Pulse duration" of less than 1 ns, and any of the following:
        1. Output "peak power" exceeding 5 GW per pulse;
        2. "Average output power" exceeding 10 W; **or**
        3. Output energy exceeding 0.1 J per pulse;
    b. "Pulse duration" equal to or exceeding 1 ns but not exceeding 1 μs and any of the following:
        1. Single transverse mode output and any of the following:
            a. "Peak power" exceeding 100 MW;
            b. "Average output power" exceeding 20 W limited by design to a maximum pulse repetition frequency less than or equal to 1 kHz;
            c. 'Wall-plug efficiency' exceeding 12%, "average output power" exceeding 100 W and capable of operating at a pulse repetition frequency greater than 1 kHz;

d. "Average output power" exceeding 150 W and capable of operating at a pulse repetition frequency greater than 1 kHz; **or**

e. Output energy exceeding 2 J per pulse; **or**

2. Multiple transverse mode output and any of the following:

a. "Peak power" exceeding 400 MW;

b. 'Wall-plug efficiency' exceeding 18% and "average output power" exceeding 500 W;

c. "Average output power" exceeding 2 kW; **or**

d. Output energy exceeding 4 J per pulse; **or**

c. "Pulse duration" exceeding 1 μs and any of the following:

1. Single transverse mode output and any of the following:

a. "Peak power" exceeding 500 kW;

b. 'Wall-plug efficiency' exceeding 12% and "average output power" exceeding 100 W; **or**

c. "Average output power" exceeding 150 W; **or**

2. Multiple transverse mode output and any of the following:

a. "Peak power" exceeding 1 MW;

b. 'Wall-plug efficiency' exceeding 18% and "average output power" exceeding 500 W; **or**

c. "Average output power" exceeding 2 kW;

7. Output wavelength exceeding 1,150 nm but not exceeding 1,555 nm, and any of the following:

a. "Pulse duration" not exceeding 1 μs and any of the following:

1. Output energy exceeding 0.5 J per pulse and "peak power" exceeding 50 W;

2. Single transverse mode output and "average output power" exceeding 20 W; **or**

3. Multiple transverse mode output and "average output power" exceeding 50 W; **or**

b. "Pulse duration" exceeding 1 μs and any of the following:

1. Output energy exceeding 2 J per pulse and "peak power" exceeding 50 W;

2. Single transverse mode output and "average output power" exceeding 50 W; **or**

3. Multiple transverse mode output and "average output power" exceeding 80 W; **or**

8. Output wavelength exceeding 1,555 nm and any of the following:

a. Output energy exceeding 100 mJ per pulse and "peak power" exceeding 1 W; **or**

b. "Average output power" exceeding 1 W;

1-6.A.5.c. "Tunable" "lasers" having any of the following:

Note:

1-6.A.5.c. includes titanium–sapphire (Ti: Al_2O_3), thulium-YAG (Tm: YAG), thulium-YSGG (Tm: YSGG), alexandrite (Cr: $BeAl_2O_4$), colour centre "lasers", dye "lasers", and liquid "lasers".

1. Output wavelength less than 600 nm and any of the following:
   a. Output energy exceeding 50 mJ per pulse and "peak power" exceeding 1 W; **or**
   b. Average or CW output power exceeding 1 W;

   Note:

   1-6.A.5.c.1. does not apply to dye lasers or other liquid lasers, having a multimode output and a wavelength of 150 nm or more but not exceeding 600 nm and all of the following:

   1. Output energy less than 1.5 J per pulse or a "peak power" less than 20 W; and

   2. Average or CW output power less than 20 W.
2. Output wavelength of 600 nm or more but not exceeding 1,400 nm, and any of the following:
   a. Output energy exceeding 1 J per pulse and "peak power" exceeding 20 W; **or**
   b. Average or CW output power exceeding 20 W; **or**
3. Output wavelength exceeding 1,400 nm and any of the following:
   a. Output energy exceeding 50 mJ per pulse and "peak power" exceeding 1 W; **or**
   b. Average or CW output power exceeding 1 W;

1-6.A.5.d. Other "lasers", not specified by 1-6.A.5.a., 1-6.A.5.b. or 1-6.A.5.c. as follows:

1. Semiconductor "lasers" as follows:

   Note 1:

   1-6.A.5.d.1. includes semiconductor "lasers" having optical output connectors (e.g. fibre optic pigtails).

   Note 2:

   The status of semiconductor "lasers" specially designed for other equipment is determined by the status of the other equipment.

   a. Individual single-transverse mode semiconductor "lasers" having any of the following:
      1. Wavelength equal to or less than 1,510 nm and average or CW output power, exceeding 1.5 W; **or**
      2. Wavelength greater than 1,510 nm and average or CW output power, exceeding 500 mW;
   b. Individual, multiple-transverse mode semiconductor "lasers" having any of the following:
      1. Wavelength of less than 1,400 nm and average or CW output power, exceeding 15 W;
      2. Wavelength equal to or greater than 1,400 nm and less than 1,900 nm and average or CW output power, exceeding 2.5 W; **or**

3. Wavelength equal to or greater than 1,900 nm and average or CW output power, exceeding 1 W;

c. Individual semiconductor "laser" 'bars' having any of the following:
   1. Wavelength of less than 1,400 nm and average or CW output power, exceeding 100 W;
   2. Wavelength equal to or greater than 1,400 nm and less than 1,900 nm and average or CW output power, exceeding 25 W; **or**
   3. Wavelength equal to or greater than 1,900 nm and average or CW output power, exceeding 10 W;

d. Semiconductor "laser" 'stacked arrays' (two-dimensional arrays) having any of the following:
   1. Wavelength less than 1,400 nm and having any of the following:
      a. Average or CW total output power less than 3 kW and having average or CW output 'power density' greater than 500 W/cm^2;
      b. Average or CW total output power equal to or exceeding 3 kW but less than or equal to 5 kW, and having average or CW output 'power density' greater than 350W/cm^2;
      c. Average or CW total output power exceeding 5 kW;
      d. Peak pulsed 'power density' exceeding 2,500 W/cm^2; **or**
      e. Spatially coherent average or CW total output power, greater than 150 W;
   2. Wavelength greater than or equal to 1,400 nm but less than 1,900 nm, and having any of the following:
      a. Average or CW total output power less than 250 W and average or CW output 'power density' greater than 150 W/cm^2;
      b. Average or CW total output power equal to or exceeding 250 W but less than or equal to 500 W, and having average or CW output 'power density' greater than 50W/cm^2;
      c. Average or CW total output power exceeding 500 W;
      d. Peak pulsed 'power density' exceeding 500 W/cm^2; **or**
      e. Spatially coherent average or CW total output power, exceeding 15 W;
   3. Wavelength greater than or equal to 1,900 nm and having any of the following:
      a. Average or CW output 'power density' greater than 50 W/cm^2;
      b. Average or CW output power greater than 10 W; **or**
      c. Spatially coherent average or CW total output power, exceeding 1.5 W; **or**
   4. At least one "laser" 'bar' specified by 1-6.A.5.d.1.c.;

Technical Note:

For the purposes of 1-6.A.5.d.1.d., 'power density' means the total "laser" output power divided by the emitter surface area of the 'stacked array'.

e. Semiconductor "laser" 'stacked arrays', other than those specified by 1-6.A.5.d.1.d., having all of the following:

1. Specially designed or modified to be combined with other 'stacked arrays' to form a larger 'stacked array'; **and**
2. Integrated connections, common for both electronics and cooling;

Note 1:

'Stacked arrays', formed by combining semiconductor "laser" 'stacked arrays' specified by 1-6.A.5.d.1.e., that are not designed to be further combined or modified are specified by 1-6.A.5.d.1.d.

Note 2:

'Stacked arrays', formed by combining semiconductor "laser" 'stacked arrays' specified by 1-6.A.5.d.1.e., that are designed to be further combined or modified are specified by 1-6.A.5.d.1.e.

Note 3:

1-6.A.5.d.1.e. does not apply to modular assemblies of single 'bars' designed to be fabricated into end-to-end stacked linear arrays.

Technical Notes:

1. *Semiconductor "lasers" are commonly called "laser" diodes.*
2. *A 'bar' (also called a semiconductor "laser" 'bar', a "laser" diode 'bar' or diode 'bar') consists of multiple semiconductor "lasers" in a one-dimensional array.*
3. *A 'stacked array' consists of multiple 'bars' forming a two-dimensional array of semiconductor "lasers".*

2. Carbon monoxide (CO) "lasers" having any of the following:
   a. Output energy exceeding 2 J per pulse and "peak power" exceeding 5 kW; **or**
   b. Average or CW output power exceeding 5 kW;
3. Carbon dioxide (CO_2) "lasers" having any of the following:
   a. CW output power exceeding 15 kW;
   b. Pulsed output with a "pulse duration" exceeding 10 µs and any of the following:
      1. "Average output power" exceeding 10 kW; **or**
      2. "Peak power" exceeding 100 kW; **or**
   c. Pulsed output with a "pulse duration" equal to or less than 10 µs and any of the following:
      1. Pulse energy exceeding 5 J per pulse; **or**
      2. "Average output power" exceeding 2.5 kW;
4. Excimer "lasers" having any of the following:
   a. Output wavelength not exceeding 150 nm and any of the following:
      1. Output energy exceeding 50 mJ per pulse; **or**
      2. "Average output power" exceeding 1 W;
   b. Output wavelength exceeding 150 nm but not exceeding 190 nm and any of the following:
      1. Output energy exceeding 1.5 J per pulse; **or**

2. "Average output power" exceeding 120 W;

c. Output wavelength exceeding 190 nm but not exceeding 360 nm and any of the following:

1. Output energy exceeding 10 J per pulse; **or**

2. "Average output power" exceeding 500 W; **or**

d. Output wavelength exceeding 360 nm and any of the following:

1. Output energy exceeding 1.5 J per pulse; **or**

2. "Average output power" exceeding 30 W;

N.B.:

For excimer "lasers" specially designed for lithography equipment, see 1-3.B.1.

5. "Chemical lasers" as follows:

a. Hydrogen Fluoride (HF) "lasers";

b. Deuterium Fluoride (DF) "lasers";

c. "Transfer lasers" as follows:

1. Oxygen Iodine (O_2-I) "lasers";

2. Deuterium Fluoride-Carbon dioxide (DF-CO_2) "lasers";

6. 'Non-repetitive pulsed' Nd: glass "lasers" having any of the following:

a. "Pulse duration" not exceeding 1 μs and output energy exceeding 50 J per pulse; **or**

b. "Pulse duration" exceeding 1 μs and output energy exceeding 100 J per pulse;

Note:

'Non-repetitive pulsed' refers to "lasers" that produce either a single output pulse or that have a time interval between pulses exceeding one minute.

1-6.A.5.e. Components as follows:

1. Mirrors cooled either by 'active cooling' or by heat pipe cooling;

Technical Notes:

'Active cooling' is a cooling technique for optical components using flowing fluids within the subsurface (nominally less than 1 mm below the optical surface) of the optical component to remove heat from the optic.

2. Optical mirrors or transmissive or partially transmissive optical or electro-optical components, specially designed for use with specified "lasers";

1-6.A.5.f. Optical equipment as follows:

N.B.:

For shared aperture optical elements, capable of operating in "Super-High Power Laser" ("SHPL") applications, see 2-19. Note 2.d.

1. Dynamic wavefront (phase) measuring equipment capable of mapping at least 50 positions on a beam wavefront and any of the following:

a. Frame rates equal to or more than 100 Hz and phase discrimination of at least 5% of the beam's wavelength; **or**

b. Frame rates equal to or more than 1,000 Hz and phase discrimination of at least 20% of the beam's wavelength;

2. "Laser" diagnostic equipment capable of measuring "SHPL" system angular beam steering errors of equal to or less than 10 μrad;
3. Optical equipment and components, specially designed for a phased-array "SHPL" system for coherent beam combination to an accuracy of λ/10 at the designed wavelength, or 0.1 μm, whichever is the smaller;
4. Projection telescopes specially designed for use with "SHPL" systems.

1-6.A.5.f. 'Laser acoustic detection equipment' having all of the following:

1. CW laser output power equal to or exceeding 20 mW;
2. Laser frequency stability equal to or better (less) than 10 MHz;
3. Laser wavelengths equal to or exceeding 1,000 nm but not exceeding 2,000 nm;
4. Optical system resolution better (less) than 1 nm; and
5. Optical Signal to Noise ratio equal to or exceeding 10^3.

Technical Note:

'Laser acoustic detection equipment' is sometimes referred to as a Laser Microphone or Particle Flow Detection Microphone.

1-6.A.6. MAGNETIC AND ELECTRIC FIELD SENSORS

"Magnetometers", "magnetic gradiometers", "intrinsic magnetic gradiometers", underwater electric field sensors, "compensation systems", and specially designed components therefor, as follows:

Note:

1-6.A.6. does not apply to instruments specially designed for fishery applications or biomagnetic measurements for medical diagnostics.

1-6.A.6.a. "Magnetometers" and subsystems, as follows:

1. "Magnetometers" using "superconductive" (SQUID) "technology" and having any of the following:
   a. SQUID systems designed for stationary operation, without specially designed subsystems designed to reduce in-motion noise, and having a 'sensitivity' equal to or lower (better) than 50 fT (rms) per square root Hz at a frequency of 1 Hz; **or**
   b. SQUID systems having an in-motion-magnetometer 'sensitivity' lower (better) than 20 pT (rms) per square root Hz at a frequency of 1 Hz and specially designed to reduce in-motion noise;
2. "Magnetometers" using optically pumped or nuclear precession (proton/Overhauser) "technology" having a 'sensitivity' lower (better) than 20 pT (rms) per square root Hz at a frequency of 1 Hz;
3. "Magnetometers" using fluxgate "technology" having a 'sensitivity' equal to or lower (better) than 10 pT (rms) per square root Hz at a frequency of 1 Hz;
4. Induction coil "magnetometers" having a 'sensitivity' lower (better) than any of the following:
   a. 0.05 nT (rms)/square root Hz at frequencies of less than 1 Hz;
   b. 1×10^{-3} nT (rms)/square root Hz at frequencies of 1 Hz or more but not exceeding 10 Hz; **or**

c. 1×10^{-4} nT (rms)/square root Hz at frequencies exceeding 10 Hz;

5. Fibre optic "magnetometers" having a 'sensitivity' lower (better) than 1 nT (rms) per square root Hz;

1-6.A.6.b. Underwater Electric Field Sensors having a 'sensitivity' lower (better) than 8 nanovolt per meter per square root Hz when measured at 1 Hz;

1-6.A.6.c. "Magnetic gradiometers" as follows:

1. "Magnetic gradiometers" using multiple "magnetometers" specified by 1-6.A.6.a.;
2. Fibre optic "intrinsic magnetic gradiometers" having a magnetic gradient field 'sensitivity' lower (better) than 0.3 nT/m (rms) per square root Hz;
3. "Intrinsic magnetic gradiometers", using "technology" other than fibre-optic "technology", having a magnetic gradient field 'sensitivity' lower (better) than 0.015 nT/m (rms) per square root Hz;

1-6.A.6.d. "Compensation systems" for magnetic or underwater electric field sensors resulting in a performance equal to or better than the specified parameters of 1-6.A.6.a., 1-6.A.6.b., or 1-6.A.6.c.

1-6.A.6.e. Underwater electromagnetic receivers incorporating magnetic field sensors specified by 1-6.A.6.a. or underwater electric field sensors specified by 1-6.A.6.b.

Technical Note:

For the purposes of 1-6.A.6., 'sensitivity' (noise level) is the root mean square of the device-limited noise floor which is the lowest signal that can be measured.

1-6.A.7. GRAVIMETERS

Gravity meters (gravimeters) and gravity gradiometers, as follows:

a. Gravity meters designed or modified for ground use and having a static accuracy of less (better) than 10 μgal;

Note:

1-6.A.7.a. does not apply to ground gravity meters of the quartz element (Worden) type.

b. Gravity meters designed for mobile platforms and having all of the following:

1. A static accuracy of less (better) than 0.7 mgal; **and**
2. An in-service (operational) accuracy of less (better) than 0.7 mgal having a time-to-steady-state registration of less than 2 minutes under any combination of attendant corrective compensations and motional influences;

c. Gravity gradiometers.

1-6.A.8. RADAR

Radar systems, equipment and assemblies, having any of the following, and specially designed components therefor:

Note:

1-6.A.8. does not apply to:

- Secondary Surveillance Radar (SSR);

- Civil Automotive Radar;

- Displays or monitors used for Air Traffic Control (ATC);

- Meteorological (weather) Radar;

- Precision Approach Radar (PAR) equipment conforming to ICAO standards and employing electronically steerable linear (1-dimensional) arrays or mechanically positioned passive antennae.

a. Operating at frequencies from 40 GHz to 230 GHz and having any of the following:
   1. An average output power exceeding 100 mW; **or**
   2. Locating accuracy of 1 m or less (better) in range and 0.2 degree or less (better) in azimuth;

b. A tunable bandwidth exceeding ± 6.25% of the 'centre operating frequency';

Technical Note:

The 'centre operating frequency' equals one half of the sum of the highest plus the lowest specified operating frequencies.

c. Capable of operating simultaneously on more than two carrier frequencies;

d. Capable of operating in synthetic aperture (SAR), inverse synthetic aperture (ISAR) radar mode, or sidelooking airborne (SLAR) radar mode;

e. Incorporating electronically steerable array antennae;

f. Capable of heightfinding non-cooperative targets;

g. Specially designed for airborne (balloon or airframe mounted) operation and having Doppler "signal processing" for the detection of moving targets;

h. Employing processing of radar signals and using any of the following:
   1. "Radar spread spectrum" techniques; **or**
   2. "Radar frequency agility" techniques;

i. Providing ground-based operation with a maximum "instrumented range" exceeding 185 km;

Note:

1-6.A.8.i. does not apply to:

a. Fishing ground surveillance radar;

b. Ground radar equipment specially designed for enroute air traffic control and having all of the following:
   1. A maximum "instrumented range" of 500 km or less;
   2. Configured so that radar target data can be transmitted only one way from the radar site to one or more civil ATC centres;
   *3. Contains no provisions for remote control of the radar scan rate from the enroute ATC centre; **and***
   4. Permanently installed.

c. Weather balloon tracking radars.

j. Being "laser" radar or Light Detection and Ranging (LIDAR) equipment and having any of the following:
   1. "Space-qualified";
   2. Employing coherent heterodyne or homodyne detection techniques and having an angular resolution of less (better) than 20 μrad (microradians); **or**

3. Designed for carrying out airborne bathymetric littoral surveys to International Hydrographic Organization (IHO) Order 1a Standard (5th Edition February 2008) for Hydrographic Surveys or better, and using one or more lasers with a wavelength exceeding 400 nm but not exceeding 600 nm;

Note 1:

LIDAR equipment specially designed for surveying is only specified by 1-6.A.8.j.3.

Note 2:

1-6.A.8.j. does not apply to LIDAR equipment specially designed for meteorological observation.

Note 3:

Parameters in the IHO Order 1a Standard 5th Edition February 2008 are summarized as follows:

Horizontal Accuracy (95% Confidence Level) = 5 m + 5% of depth.

Depth Accuracy for Reduced Depths (95% confidence level)

$= \pm \sqrt{(a2 + (b*d)2)}$ *where:*

a = 0.5 m = constant depth error, i.e. the sum of all constant depth errors

b = 0.013 = factor of depth dependent error

*b*d = depth dependent error, i.e. the sum of all depth dependent errors*

d = depth

Feature Detection

= Cubic features > 2 m in depths up to 40 m;

10% of depth beyond 40 m.

k. Having "signal processing" sub-systems using "pulse compression" and having any of the following:

1. A "pulse compression" ratio exceeding 150; **or**
2. A pulse width of less than 200 ns; **or**

l. Having data processing sub-systems and having any of the following:

1. "Automatic target tracking" providing, at any antenna rotation, the predicted target position beyond the time of the next antenna beam passage; **or**

Note:

1-6.A.8.l.1. does not apply to conflict alert capability in ATC systems, or marine or harbour radar.

2. Not used since 2010
3. Not used since 2010
4. Configured to provide superposition and correlation, or fusion, of target data within six seconds from two or more "geographically dispersed" radar sensors to improve the aggregate performance beyond that of any single sensor specified by 1-6.A.8.f. or 1-6.A.8.i.

N.B.:

See also 2-5.b.

Note:

1-6.A.8.l.4. does not apply to systems, equipment and assemblies used for marine traffic control.

1-6.B. TEST, INSPECTION AND PRODUCTION EQUIPMENT

1-6.B.1. ACOUSTICS

None

1-6.B.2. OPTICAL SENSORS

None

1-6.B.3. CAMERAS

None

1-6.B.4. OPTICS

Optical equipment as follows:

a. Equipment for measuring absolute reflectance to an accuracy of ± 0.1% of the reflectance value;

b. Equipment other than optical surface scattering measurement equipment, having an unobscured aperture of more than 10 cm, specially designed for the non-contact optical measurement of a non-planar optical surface figure (profile) to an "accuracy" of 2 nm or less (better) against the required profile.

Note:

1-6.B.4. does not apply to microscopes.

1-6.B.5. LASERS

None

1-6.B.6. MAGNETIC AND ELECTRIC FIELD SENSORS

None

1-6.B.7. GRAVIMETERS

Equipment to produce, align and calibrate land-based gravity meters with a static accuracy of better than 0.1 mgal.

1-6.B.8. RADAR

Pulse radar cross-section measurement systems having transmit pulse widths of 100 ns or less, and specially designed components therefor.

1-6.C. MATERIALS

1-6.C.1. ACOUSTICS

None

1-6.C.2. OPTICAL SENSORS

. Optical sensor materials as follows:

a. Elemental tellurium (Te) of purity levels of 99.9995% or more;

b. Single crystals (including epitaxial wafers) of any of the following:

1. Cadmium zinc telluride (CdZnTe) with zinc content of less than 6% by 'mole fraction';

2. Cadmium telluride (CdTe) of any purity level; **or**

3. Mercury cadmium telluride (HgCdTe) of any purity level.

Technical Note:

'Mole fraction' is defined as the ratio of moles of ZnTe to the sum of the moles of CdTe and ZnTe present in the crystal.

1-6.C.3. CAMERAS

None

1-6.C.4. OPTICS

Optical materials as follows:

a. Zinc selenide (ZnSe) and zinc sulphide (ZnS) "substrate blanks", produced by the chemical vapour deposition process and having any of the following:

1. A volume greater than 100 cm^3; **or**

2. A diameter greater than 80 mm and a thickness of 20 mm or more;

b. Boules of any of the following electro-optic materials:

1. Potassium titanyl arsenate (KTA) (CAS 59400-80-5);

2. Silver gallium selenide ($AgGaSe_2$) (CAS 12002-67-4); **or**

3. Thallium arsenic selenide (Tl_3AsSe_3, also known as TAS) (CAS 16142-89-5);

c. Non-linear optical materials having all of the following:

1. Third order susceptibility (chi 3) of 10^{-6} m^2/V^2 or more; **and**

2. A response time of less than 1 ms;

d. "Substrate blanks" of silicon carbide or beryllium beryllium (Be/Be) deposited materials, exceeding 300 mm in diameter or major axis length;

e. Glass, including fused silica, phosphate glass, fluorophosphate glass, zirconium fluoride (ZrF_4) (CAS 7783-64-4) and hafnium fluoride (HfF_4) (CAS 13709-52-9) and having all of the following:

1. A hydroxyl ion (OH-) concentration of less than 5 ppm;

2. Integrated metallic purity levels of less than 1 ppm; **and**

3. High homogeneity (index of refraction variance) less than 5×10^{-6};

f. Synthetically produced diamond material with an absorption of less than 10^{-5} cm^{-1} for wavelengths exceeding 200 nm but not exceeding 14,000 nm.

1-6.C.5. LASERS

Synthetic crystalline "laser" host material in unfinished form as follows:

a. Titanium doped sapphire;

b. Alexandrite.

1-6.C.6. MAGNETIC AND ELECTRIC FIELD SENSORS

None

1-6.C.7. GRAVIMETERS

None

1-6.C.8. RADAR

None

1-6.D. SOFTWARE

1-6.D.1. "Software" specially designed for the "development" or "production" of equipment specified by 1-6.A.4., 1-6.A.5., 1-6.A.8. or 1-6.B.8.

1-6.D.2. "Software" specially designed for the "use" of equipment specified by 1-6.A.2.b., 1-6.A.8. or 1-6.B.8.

1-6.D.3. Other "software" as follows:

a. ACOUSTICS

"Software" as follows:

1. "Software" specially designed for acoustic beam forming for the "real time processing" of acoustic data for passive reception using towed hydrophone arrays;
2. "Source code" for the "real time processing" of acoustic data for passive reception using towed hydrophone arrays;
3. "Software" specially designed for acoustic beam forming for the "real time processing" of acoustic data for passive reception using bottom or bay cable systems;
4. "Source code" for the "real time processing" of acoustic data for passive reception using bottom or bay cable systems;
5. "Software" or "source code", specially designed for all of the following:
   a. "Real time processing" of acoustic data from sonar systems specified by 1-6.A.1.a.1.e.; **and**
   b. Automatically detecting, classifying and determining the location of divers or swimmers;

   N.B.:

   For diver detection "software" or "source code", specially designed or modified for military use, see Group 2 - Munitions List.

b. OPTICAL SENSORS

None

c. CAMERAS

"Software" designed or modified for cameras incorporating "focal plane arrays" specified by 1-6.A.2.a.3.f. and designed or modified to remove a frame rate restriction and allow the camera to exceed the frame rate specified in 1-6.A.3.b.4. Note 3.a.

d. OPTICS

None

e. LASERS

None

f. MAGNETIC AND ELECTRIC FIELD SENSORS

"Software" as follows:

1. "Software" specially designed for magnetic and electric field "compensation systems" for magnetic sensors designed to operate on mobile platforms;
2. "Software" specially designed for magnetic and electric field anomaly detection on mobile platforms;
3. "Software" specially designed for "real time processing" of electromagnetic data using underwater electromagnetic receivers specified by 1-6.A.6.e.;
4. "Source code" for "real time processing" of electromagnetic data using underwater electromagnetic receivers specified by 1-6.A.6.e.;

g. GRAVIMETERS

"Software" specially designed to correct motional influences of gravity meters or gravity gradiometers;

h. RADAR

"Software" as follows:

1. Air Traffic Control (ATC) "software" application "programmes" designed to be hosted on general purpose computers located at Air Traffic Control centres and capable of accepting radar target data from more than four primary radars;
2. "Software" for the design or "production" of radomes and having all of the following:
   a. Specially designed to protect the "electronically steerable phased array antennae" specified by 1-6.A.8.e.; **and**
   b. Resulting in an antenna pattern having an 'average side lobe level' more than 40 dB below the peak of the main beam level.

Technical Note:

'Average side lobe level' in 1-6.D.3.h.2.b. is measured over the entire array excluding the angular extent of the main beam and the first two side lobes on either side of the main beam.

1-6.E. TECHNOLOGY

1-6.E.1. "Technology" according to the General Technology Note for the "development" of equipment, materials or "software" specified by 1-6.A., 1-6.B., 1-6.C. or 1-6.D.

1-6.E.2. "Technology" according to the General Technology Note for the "production" of equipment or materials specified by 1-6.A., 1-6.B. or 1-6.C.

1-6.E.3. Other "technology" as follows:

a. ACOUSTICS

None

b. OPTICAL SENSORS

None

c. CAMERAS

None

d. OPTICS

"Technology" as follows:

1. Optical surface coating and treatment "technology", "required" to achieve an 'optical thickness' uniformity of 99.5% or better for optical coatings 500 mm or more in diameter or major axis length and with a total loss (absorption and scatter) of less than 5×10^{-3};

N.B.:

See also 1-2.E.3.f.

Technical Note:

'Optical thickness' is the mathematical product of the index of refraction and the physical thickness of the coating.

2. Optical fabrication "technology" using single point diamond turning techniques to produce surface finish accuracies of better than 10 nm rms on non-planar surfaces exceeding 0.5 m^2;

e. LASERS

"Technology" "required" for the "development", "production" or "use" of specially designed diagnostic instruments or targets in test facilities for "SHPL" testing or testing or evaluation of materials irradiated by "SHPL" beams;

f. MAGNETIC AND ELECTRIC FIELD SENSORS

Not used since 2004

g. GRAVIMETERS

None

h. RADAR

None

CATEGORY 7: NAVIGATION AND AVIONICS

1-7.A. SYSTEMS, EQUIPMENT AND COMPONENTS

N.B.:

For automatic pilots for underwater vehicles, see Category 8.

For radar, see Category 6.

1-7.A.1. Accelerometers as follows and specially designed components therefor:

N.B.:

For angular or rotational accelerometers, see 1-7.A.1.b.

a. Linear accelerometers having any of the following:

1. Specified to function at linear acceleration levels less than or equal to 15 g and having any of the following:

a. A "bias" "stability" of less (better) than 130 micro g with respect to a fixed calibration value over a period of one year; **or**

b. A "scale factor" "stability" of less (better) than 130 ppm with respect to a fixed calibration value over a period of one year;

2. Specified to function at linear acceleration levels exceeding 15 g but less than or equal to 100 g and having all of the following:

a. A "bias" "repeatability" of less (better) than 5,000 micro g over a period of one year; **and**

b. A "scale factor" "repeatability" of less (better) than 2,500 ppm over a period of one year; **or**

3. Designed for use in inertial navigation or guidance systems and specified to function at linear acceleration levels exceeding 100 g;

Note:

1-7 A.1.a.1. and 1-7.A.1.a.2. do not apply to accelerometers limited to measurement of only vibration or shock.

b. Angular or rotational accelerometers, specified to function at linear acceleration levels exceeding 100 g.

1-7.A.2. Gyros or angular rate sensors, having any of the following and specially designed components therefor:

N.B.:

For angular or rotational accelerometers, see 1-7.A.1.b.

a. Specified to function at linear acceleration levels less than or equal to 100 g and having any of the following:

1. A rate range of less than 500 degrees per second and having any of the following:

a. A "bias" "stability" of less (better) than 0.5 degree per hour, when measured in a 1 g environment over a period of one month, and with respect to a fixed calibration value; **or**

b. An "angle random walk" of less (better) than or equal to 0.0035 degree per square root hour; **or**

Note:

1-7.A.2.a.1.b. does not apply to 'spinning mass gyros'.

Technical Note:

'Spinning mass gyros' are gyros which use a continually rotating mass to sense angular motion.

2. A rate range greater than or equal to 500 degrees per second and having any of the following:

a. A "bias" "stability", of less (better) than 40 degrees per hour, when measured in a 1 g environment over a period of three minutes, and with respect to a fixed calibration value; **or**

b. An "angle random walk" of less (better) than or equal to 0.2 degree per square root hour; **or**

Note:

1-7.A.2.a.2.b. does not apply to 'spinning mass gyros'.

b. Specified to function at linear acceleration levels exceeding 100 g.

1-7.A.3. Inertial systems and specially designed components, as follows:

a. Inertial Navigation Systems (INS) (gimballed or strapdown) and inertial equipment, designed for "aircraft", land vehicles, vessels (surface or underwater) or "spacecraft", for navigation, attitude, guidance or control and having any of the following and specially designed components therefor:

1. Navigation error (free inertial) subsequent to normal alignment of 0.8 nautical mile per hour (nm/hr) 'Circular Error Probable' ('CEP') or less (better); **or**

2. Specified to function at linear acceleration levels exceeding 10 g;

Technical Note:

'Circular Error Probable' ('CEP') - In a circular normal distribution, the radius of the circle containing 50% of the individual measurements being made, or the radius of the circle within which there is a 50% probability of being located.

b. Hybrid Inertial Navigation Systems embedded with Global Navigation Satellite System(s) (GNSS) or with "Data-Based Referenced Navigation" ("DBRN") System(s) for navigation, attitude, guidance or control, subsequent to normal alignment and having an INS navigation position accuracy, after loss of GNSS or "DBRN" for a period of up to 4 minutes, of less (better) than 10 meters 'CEP';

c. Inertial Measurement equipment for heading or True North determination and having any of the following and specially designed components therefor:

1. Designed to have heading or True North determination accuracy equal to or less (better) than 0.07 deg sec (Lat) (equivalent to 6 arc minutes rms at 45 degrees latitude); **or**

2. Designed to have a non-operating shock level of 900 g or greater at a duration of 1 msec or greater;

d. Inertial measurement equipment including Inertial Measurement Units (IMU) and Inertial Reference Systems (IRS), incorporating accelerometers or gyros specified by 1-7.A.1. or 1-7.A.2.

Note 1:

The parameters of 1-7.A.3.a. and 1-7.A.3.b. are applicable with any of the following environmental conditions:

a. Input random vibration with an overall magnitude of 7.7 g rms in the first 0.5 hour and a total test duration of 1.5 hour per axis in each of the 3 perpendicular axes, when the random vibration meets all of the following:

1. A constant Power Spectral Density (PSD) value of 0.04 g^2/Hz over a frequency interval of 15 to 1,000 Hz; ***and***

2. The PSD attenuates with frequency from 0.04 g^2/Hz to 0.01 g^2/Hz over a frequency interval from 1,000 to 2,000 Hz;

b. An angular rate capability about one or more axes of equal to or more than +2.62 rad/s (150 deg/s); ***or***

c. According to national standards equivalent to a. or b. above.

Note 2:

1-7.A.3. does not apply to inertial navigation systems which are certified for use on "civil aircraft" by civil authorities of a participating state.

Note 3:

1-7.A.3.c.1. does not apply to theodolite systems incorporating inertial equipment specially designed for civil surveying purposes.

Technical Note:

1-7.A.3.b. refers to systems in which an INS and other independent navigation aids are built into a single unit (embedded) in order to achieve improved performance.

1-7.A.4. Gyro-astro compasses and other devices which derive position or orientation by means of automatically tracking celestial bodies or satellites, with an azimuth accuracy of equal to or less (better) than 5 seconds of arc.

1-7.A.5. Global Navigation Satellite Systems (GNSS) receiving equipment having any of the following and specially designed components therefor:

N.B.:

For equipment specially designed for military use, see 2-11.

a. Employing a decryption algorithm specially designed or modified for government use to access the ranging code for position and time; **or**

b. Employing 'adaptive antenna systems'.

Note:

1-7.A.5.b. does not apply to GNSS receiving equipment that only uses components designed to filter, switch, or combine signals from multiple omni-directional antennae that do not implement adaptive antenna techniques.

Technical Note:

For the purposes of 1-7.A.5.b. 'adaptive antenna systems' dynamically generate one or more spatial nulls in an antenna array pattern by signal processing in the time domain or frequency domain.

1-7.A.6. Airborne altimeters operating at frequencies other than 4.2 to 4.4 GHz inclusive and having any of the following:

a. "Power management"; **or**

b. Using phase shift key modulation.

1-7.A.7. Not used since 2004

1-7.A.8. Underwater sonar navigation systems using doppler velocity or correlation velocity logs integrated with a heading source and having a positioning accuracy of equal to or less (better) than 3% of distance travelled 'Circular Error Probable' ('CEP') and specially designed components therefor.

Note:

1-7.A.8. does not apply to systems specially designed for installation on surface vessels or systems requiring acoustic beacons or buoys to provide positioning data.

N.B.:

See 1-6.A.1.a. for acoustic systems, and 1-6.A.1.b. for correlation-velocity and Doppler-velocity sonar log equipment.

See 1-8.A.2. for other marine systems.

1-7.B. TEST, INSPECTION AND PRODUCTION EQUIPMENT

1-7.B.1. Test, calibration or alignment equipment, specially designed for equipment specified by 1-7.A.

Note:

1-7.B.1. does not apply to test, calibration or alignment equipment for 'Maintenance Level I' or 'Maintenance Level II'.

Technical Notes:

1. *'Maintenance Level I'*

   The failure of an inertial navigation unit is detected on the aircraft by indications from the Control and Display Unit (CDU) or by the status message from the corresponding sub-system. By following the manufacturer's manual, the cause of the failure may be localised at the level of the malfunctioning Line Replaceable Unit (LRU). The operator then removes the LRU and replaces it with a spare.

2. *'Maintenance Level II'*

   The defective LRU is sent to the maintenance workshop (the manufacturer's or that of the operator responsible for level II maintenance). At the maintenance workshop, the malfunctioning LRU is tested by various appropriate means to verify and localise the defective Shop Replaceable Assembly (SRA) module responsible for the failure. This SRA is removed and replaced by an operative spare. The defective SRA (or possibly the complete LRU) is then shipped to the manufacturer. 'Maintenance Level II' does not include the disassembly or repair of specified accelerometers or gyro sensors.

1-7.B.2. Equipment specially designed to characterize mirrors for ring "laser" gyros, as follows:

a. Scatterometers having a measurement accuracy of 10 ppm or less (better);

b. Profilometers having a measurement accuracy of 0.5 nm (5 angstrom) or less (better).

1-7.B.3. Equipment specially designed for the "production" of equipment specified by 1-7.A.

Note:

1-7.B.3. includes:

a. Gyro tuning test stations;

b. Gyro dynamic balance stations;

c. Gyro run-in/motor test stations;

d. Gyro evacuation and fill stations;

e. Centrifuge fixtures for gyro bearings;

f. Accelerometer axis align stations;

g. Fibre optic gyro coil winding machines.

1-7.C. MATERIALS

None

1-7.D. SOFTWARE

1-7.D.1. "Software" specially designed or modified for the "development" or "production" of equipment specified by 1-7.A. or 1-7.B.

1-7.D.2. "Source code" for the "use" of any inertial navigation equipment, including inertial equipment not specified by 1-7.A.3. or 1-7.A.4., or Attitude and Heading Reference Systems ('AHRS').

Note:

1-7.D.2. does not apply to "source code" for the "use" of gimballed 'AHRS'.

Technical Note:

'AHRS' generally differ from Inertial Navigation Systems (INS) in that an 'AHRS' provides attitude and heading information and normally does not provide the acceleration, velocity and position information associated with an INS.

1-7.D.3. Other "software" as follows:

a. "Software" specially designed or modified to improve the operational performance or reduce the navigational error of systems to the levels specified by 1-7.A.3., 1-7.A.4. or 1-7.A.8.;

b. "Source code" for hybrid integrated systems which improves the operational performance or reduces the navigational error of systems to the level specified by 1-7.A.3. or 1-7.A.8. by continuously combining heading data with any of the following:

1. Doppler radar or sonar velocity data;
2. Global Navigation Satellite Systems (GNSS) reference data; **or**
3. Data from "Data-Based Referenced Navigation" ("DBRN") systems;

c. "Source code" for integrated avionics or mission systems which combine sensor data and employ "expert systems";

d. "Source code" for the "development" of any of the following:

1. Digital flight management systems for "total control of flight";
2. Integrated propulsion and flight control systems;
3. Fly-by-wire or fly-by-light control systems;
4. Fault-tolerant or self-reconfiguring "active flight control systems";
5. Airborne automatic direction finding equipment;
6. Air data systems based on surface static data; **or**
7. Raster-type head-up displays or three dimensional displays;

e. Computer-Aided-Design (CAD) "software" specially designed for the "development" of "active flight control systems", helicopter multi-axis fly-by-wire or fly-by-light controllers or helicopter "circulation controlled anti-torque or circulation-controlled direction control systems", whose "technology" is specified by 1-7.E.4.b., 1-7.E.4.c.1. or 1-7.E.4.c.2.

1-7.E. TECHNOLOGY

1-7.E.1. "Technology" according to the General Technology Note for the "development" of equipment or "software", specified by 1-7.A., 1-7.B. or 1-7.D.

1-7.E.2. "Technology" according to the General Technology Note for the "production" of equipment specified by 1-7.A. or 1-7.B.

1-7.E.3. "Technology" according to the General Technology Note for the repair, refurbishing or overhaul of equipment specified by 1-7.A.1. to 1-7.A.4.

Note:

1-7.E.3. does not apply to maintenance "technology" directly associated with calibration, removal or replacement of damaged or unserviceable LRUs and SRAs of a "civil aircraft" as described in 'Maintenance Level I' or 'Maintenance Level II'.

N.B.:

See Technical Notes to 1-7.B.1.

1-7.E.4. Other "technology" as follows:

a. "Technology" for the "development" or "production" of any of the following:

1. Airborne automatic direction finding equipment operating at frequencies exceeding 5 MHz;
2. Air data systems based on surface static data only, i.e., which dispense with conventional air data probes;
3. Three dimensional displays for "aircraft";
4. Not used since 2010
5. Electric actuators (i.e., electromechanical, electrohydrostatic and integrated actuator package) specially designed for "primary flight control";
6. "Flight control optical sensor array" specially designed for implementing "active flight control systems"; **or**
7. "DBRN" systems designed to navigate underwater, using sonar or gravity databases, that provide a positioning accuracy equal to or less (better) than 0.4 nautical miles;

b. "Development" "technology", as follows, for "active flight control systems" (including fly-by-wire or fly-by-light):

1. Configuration design for interconnecting multiple microelectronic processing elements (on-board computers) to achieve "real time processing" for control law implementation;
2. Control law compensation for sensor location or dynamic airframe loads, i.e., compensation for sensor vibration environment or for variation of sensor location from the centre of gravity;
3. Electronic management of data redundancy or systems redundancy for fault detection, fault tolerance, fault isolation or reconfiguration;

Note:

1-7.E.4.b.3. does not apply to "technology" for the design of physical redundancy.

4. Flight controls which permit inflight reconfiguration of force and moment controls for real time autonomous air vehicle control;
5. Integration of digital flight control, navigation and propulsion control data, into a digital flight management system for "total control of flight";

Note:

1-7.E.4.b.5. does not apply to:

1. *"Development" "technology" for integration of digital flight control, navigation and propulsion control data, into a digital flight management system for "flight path optimisation";*
2. *"Development" "technology" for "aircraft" flight instrument systems integrated solely for VOR, DME, ILS or MLS navigation or approaches.*

6. Full authority digital flight control or multisensor mission management systems, employing "expert systems";

N.B.:

For "technology" for Full Authority Digital Engine Control Systems ("FADEC Systems"), see 1-9.E.3.h.

c. "Technology" for the "development" of helicopter systems, as follows:
   1. Multi-axis fly-by-wire or fly-by-light controllers, which combine the functions of at least two of the following into one controlling element:
      a. Collective controls;
      b. Cyclic controls;
      c. Yaw controls;
   2. "Circulation-controlled anti-torque or circulation-controlled directional control systems";
   3. Rotor blades incorporating "variable geometry airfoils", for use in systems using individual blade control.

CATEGORY 8: MARINE

1-8.A. SYSTEMS, EQUIPMENT AND COMPONENTS

1-8.A.1. Submersible vehicles and surface vessels, as follows:

N.B.:

For the status of equipment for submersible vehicles, see:

- Category 5, Part 2 "Information Security" for encrypted communication equipment;

- Category 6 for sensors;

- Categories 7 and 8 for navigation equipment;

- Category 8.A. for underwater equipment.

a. Manned, tethered submersible vehicles designed to operate at depths exceeding 1,000 m;

b. Manned, untethered submersible vehicles having any of the following:

1. Designed to 'operate autonomously' and having a lifting capacity of all the following:

a. 10% or more of their weight in air; **and**

b. 15 kN or more;

2. Designed to operate at depths exceeding 1,000 m; **or**

3. Having all of the following:

a. Designed to continuously 'operate autonomously' for 10 hours or more; **and**

b. 'Range' of 25 nautical miles or more;

Technical Notes:

1. For the purposes of 1-8.A.1.b., 'operate autonomously' means fully submerged, without snorkel, all systems working and cruising at minimum speed at which the submersible can safely control its depth dynamically by using its depth planes only, with no need for a support vessel or support base on the surface, sea-bed or shore, and containing a propulsion system for submerged or surface use.

2. For the purposes of 1-8.A.1.b., 'range' means half the maximum distance a submersible vehicle can 'operate autonomously'.

c. Unmanned, tethered submersible vehicles designed to operate at depths exceeding 1,000 m and having any of the following:

1. Designed for self-propelled manoeuvre using propulsion motors or thrusters specified by 1-8.A.2.a.2.; **or**

2. Fibre optic data link;

d. Unmanned, untethered submersible vehicles having any of the following:

1. Designed for deciding a course relative to any geographical reference without real-time human assistance;

2. Acoustic data or command link; **or**

3. Optical data or command link exceeding 1,000 m;

e. Ocean salvage systems with a lifting capacity exceeding 5 MN for salvaging objects from depths exceeding 250 m and having any of the following:

   1. Dynamic positioning systems capable of position keeping within 20 m of a given point provided by the navigation system; **or**

   2. Seafloor navigation and navigation integration systems, for depths exceeding 1,000 m and with positioning accuracies to within 10 m of a predetermined point;

f. Surface-effect vehicles (fully skirted variety) having all of the following:

   1. Maximum design speed, fully loaded, exceeding 30 knots in a significant wave height of 1.25 m (Sea State 3) or more;

   2. Cushion pressure exceeding 3,830 Pa; **and**

   3. Light-ship-to-full-load displacement ratio of less than 0.70;

g. Surface-effect vehicles (rigid sidewalls) with a maximum design speed, fully loaded, exceeding 40 knots in a significant wave height of 3.25 m (Sea State 5) or more;

h. Hydrofoil vessels with active systems for automatically controlling foil systems, with a maximum design speed, fully loaded, of 40 knots or more in a significant wave height of 3.25 m (Sea State 5) or more;

i. 'Small waterplane area vessels' having any of the following:

   1. Full load displacement exceeding 500 tonnes with a maximum design speed, fully loaded, exceeding 35 knots in a significant wave height of 3.25 m (Sea State 5) or more; **or**

   2. Full load displacement exceeding 1,500 tonnes with a maximum design speed, fully loaded, exceeding 25 knots in a significant wave height of 4 m (Sea State 6) or more.

Technical Note:

A 'small waterplane area vessel' is defined by the following formula: waterplane area at an operational design draft less than 2x (displaced volume at the operational design draft)$^{2/3}$.

1-8.A.2. Marine systems, equipment and components, as follows:

N.B.:

For underwater communications systems, see Category 5, Part 1 - Telecommunications.

a. Systems, equipment and components, specially designed or modified for submersible vehicles and designed to operate at depths exceeding 1,000 m, as follows:

   1. Pressure housings or pressure hulls with a maximum inside chamber diameter exceeding 1.5 m;

   2. Direct current propulsion motors or thrusters;

   3. Umbilical cables, and connectors therefor, using optical fibre and having synthetic strength members;

   4. Components manufactured from material specified by 1-8.C.1.;

Technical Note:

The objective of 1-8.A.2.a.4. should not be defeated by the export of 'syntactic foam' specified by 1-8.C.1. when an intermediate stage of manufacture has been performed and it is not yet in its final component form.

b. Systems specially designed or modified for the automated control of the motion of submersible vehicles specified by 1-8.A.1., using navigation data, having closed loop servo-controls and having any of the following:
   1. Enabling a vehicle to move within 10 m of a predetermined point in the water column;
   2. Maintaining the position of the vehicle within 10 m of a predetermined point in the water column; **or**
   3. Maintaining the position of the vehicle within 10 m while following a cable on or under the seabed;

c. Fibre optic hull penetrators or connectors;

d. Underwater vision systems as follows:
   1. Television systems and television cameras, as follows:
      a. Television systems (comprising camera, monitoring and signal transmission equipment) having a 'limiting resolution' when measured in air of more than 800 lines and specially designed or modified for remote operation with a submersible vehicle;
      b. Underwater television cameras having a 'limiting resolution' when measured in air of more than 1,100 lines;
      c. Low light level television cameras specially designed or modified for underwater use and having all of the following:
         1. Image intensifier tubes specified by 1-6.A.2.a.2.a.; **and**
         2. More than 150,000 "active pixels" per solid state area array;

      Technical Note:

      'Limiting resolution' is a measure of horizontal resolution usually expressed in terms of the maximum number of lines per picture height discriminated on a test chart, using IEEE Standard 208/1960 or any equivalent standard.
   2. Systems specially designed or modified for remote operation with an underwater vehicle, employing techniques to minimise the effects of back scatter and including range-gated illuminators or "laser" systems;

e. Photographic still cameras specially designed or modified for underwater use below 150 m, with a film format of 35 mm or larger and having any of the following:
   1. Annotation of the film with data provided by a source external to the camera;
   2. Automatic back focal distance correction; **or**
   3. Automatic compensation control specially designed to permit an underwater camera housing to be usable at depths exceeding 1,000 m;

f. Not used since 2009
   1. Not used since 2009

      N.B.:

      For electronic imaging systems specially designed or modified for underwater use incorporating image intensifier tubes specified by 1-6.A.2.a.2.a. or 1-6.A.2.a.2.b., see 1-6.A.3.b.3.

2. Not used since 2009

N.B.:

For electronic imaging systems specially designed or modified for underwater use incorporating "focal plane arrays" specified by 1-6.A.2.a.3.g., see 1-6.A.3.b.4.c.

g. Light systems specially designed or modified for underwater use, as follows:
   1. Stroboscopic light systems capable of a light output energy of more than 300 J per flash and a flash rate of more than 5 flashes per second;
   2. Argon arc light systems specially designed for use below 1,000 m;

h. "Robots" specially designed for underwater use, controlled by using a dedicated computer and having any of the following:
   1. Systems that control the "robot" using information from sensors which measure force or torque applied to an external object, distance to an external object, or tactile sense between the "robot" and an external object; **or**
   2. The ability to exert a force of 250 N or more or a torque of 250 Nm or more and using titanium based alloys or "composite" "fibrous or filamentary materials" in their structural members;

i. Remotely controlled articulated manipulators specially designed or modified for use with submersible vehicles and having any of the following:
   1. Systems which control the manipulator using information from sensors which measure any of the following:
      a. Torque or force applied to an external object; **or**
      b. Tactile sense between the manipulator and an external object; **or**
   2. Controlled by proportional master-slave techniques or by using a dedicated computer and having 5 degrees of 'freedom of movement' or more;

Technical Note:

Only functions having proportional control using positional feedback or by using a dedicated computer are counted when determining the number of degrees of 'freedom of movement'.

j. Air independent power systems specially designed for underwater use, as follows:
   1. Brayton or Rankine cycle engine air independent power systems having any of the following:
      a. Chemical scrubber or absorber systems, specially designed to remove carbon dioxide, carbon monoxide and particulates from recirculated engine exhaust;
      b. Systems specially designed to use a monoatomic gas;
      c. Devices or enclosures, specially designed for underwater noise reduction in frequencies below 10 kHz, or special mounting devices for shock mitigation; **or**
      d. Systems having all of the following:
         1. Specially designed to pressurise the products of reaction or for fuel reformation;
         2. Specially designed to store the products of the reaction; **and**
         3. Specially designed to discharge the products of the reaction against a pressure of 100 kPa or more;

2. Diesel cycle engine air independent systems having all of the following:
    a. Chemical scrubber or absorber systems, specially designed to remove carbon dioxide, carbon monoxide and particulates from recirculated engine exhaust;
    b. Systems specially designed to use a monoatomic gas;
    c. Devices or enclosures, specially designed for underwater noise reduction in frequencies below 10 kHz, or special mounting devices for shock mitigation; **and**
    d. Specially designed exhaust systems that do not exhaust continuously the products of combustion;
3. Fuel cell air independent power systems with an output exceeding 2 kW and having any of the following:
    a. Devices or enclosures, specially designed for underwater noise reduction in frequencies below 10 kHz, or special mounting devices for shock mitigation; **or**
    b. Systems having all of the following:
        1. Specially designed to pressurise the products of reaction or for fuel reformation;
        2. Specially designed to store the products of the reaction; **and**
        3. Specially designed to discharge the products of the reaction against a pressure of 100 kPa or more;
4. Stirling cycle engine air independent power systems having all of the following:
    a. Devices or enclosures, specially designed for underwater noise reduction in frequencies below 10 kHz, or special mounting devices for shock mitigation; **and**
    b. Specially designed exhaust systems which discharge the products of combustion against a pressure of 100 kPa or more;

k. Skirts, seals and fingers, having any of the following:
    1. Designed for cushion pressures of 3,830 Pa or more, operating in a significant wave height of 1.25 m (Sea State 3) or more and specially designed for surface effect vehicles (fully skirted variety) specified by 1-8.A.1.f.; **or**
    2. Designed for cushion pressures of 6,224 Pa or more, operating in a significant wave height of 3.25 m (Sea State 5) or more and specially designed for surface effect vehicles (rigid sidewalls) specified by 1-8.A.1.g.;
l. Lift fans rated at more than 400 kW and specially designed for surface effect vehicles specified by 1-8.A.1.f. or 1-8.A.1.g.;
m. Fully submerged subcavitating or supercavitating hydrofoils, specially designed for vessels specified by 1-8.A.1.h.;
n. Active systems specially designed or modified to control automatically the sea-induced motion of vehicles or vessels, specified by 1-8.A.1.f., 1-8.A.1.g., 1-8.A.1.h. or 1-8.A.1.i.;

o. Propellers, power transmission systems, power generation systems and noise reduction systems, as follows:

1. Water-screw propeller or power transmission systems, specially designed for surface effect vehicles (fully skirted or rigid sidewall variety), hydrofoils or 'small waterplane area vessels', specified by 1-8.A.1.f., 1-8.A.1.g., 1-8.A.1.h. or 1-8.A.1.i., as follows:

a. Supercavitating, super-ventilated, partially-submerged or surface piercing propellers, rated at more than 7.5 MW;

b. Contrarotating propeller systems rated at more than 15 MW;

c. Systems employing pre-swirl or post-swirl techniques, for smoothing the flow into a propeller;

d. Light-weight, high capacity (K factor exceeding 300) reduction gearing;

e. Power transmission shaft systems incorporating "composite" material components and capable of transmitting more than 1 MW;

2. Water-screw propeller, power generation systems or transmission systems, designed for use on vessels, as follows:

a. Controllable-pitch propellers and hub assemblies, rated at more than 30 MW;

b. Internally liquid-cooled electric propulsion engines with a power output exceeding 2.5 MW;

c. "Superconductive" propulsion engines or permanent magnet electric propulsion engines, with a power output exceeding 0.1 MW;

d. Power transmission shaft systems incorporating "composite" material components and capable of transmitting more than 2 MW;

e. Ventilated or base-ventilated propeller systems, rated at more than 2.5 MW;

3. Noise reduction systems designed for use on vessels of 1,000 tonnes displacement or more, as follows:

a. Systems that attenuate underwater noise at frequencies below 500 Hz and consist of compound acoustic mounts for the acoustic isolation of diesel engines, diesel generator sets, gas turbines, gas turbine generator sets, propulsion motors or propulsion reduction gears, specially designed for sound or vibration isolation and having an intermediate mass exceeding 30% of the equipment to be mounted;

b. 'Active noise reduction or cancellation systems' or magnetic bearings, specially designed for power transmission systems;

Technical Note:

'Active noise reduction or cancellation systems' incorporate electronic control systems capable of actively reducing equipment vibration by the generation of anti-noise or anti-vibration signals directly to the source.

p. Pumpjet propulsion systems having all of the following:

1. Power output exceeding 2.5 MW; and

2. Using divergent nozzle and flow conditioning vane techniques to improve propulsive efficiency or reduce propulsion-generated underwater-radiated noise;

q. Underwater swimming and diving equipment as follows:

1. Closed circuit rebreathers;
2. Semi-closed circuit rebreathers;

Note:

1-8.A.2.q. does not apply to individual rebreathers for personal use when accompanying their users.

r. Diver deterrent acoustic systems specially designed or modified to disrupt divers and having a sound pressure level equal to or exceeding 190 dB (reference 1 μPa at 1 m) at frequencies of 200 Hz and below.

Note 1:

1-8.A.2.r. does not apply to diver deterrent systems based on underwater explosive devices, air guns or combustible sources.

Note 2:

1-8.A.2.r. includes diver deterrent acoustic systems that use spark gap sources, also known as plasma sound sources.

1-8.B. TEST, INSPECTION AND PRODUCTION EQUIPMENT

1-8.B.1. Water tunnels having a background noise of less than 100 dB (reference 1 μPa, 1 Hz) in the frequency range from 0 to 500 Hz and designed for measuring acoustic fields generated by a hydro-flow around propulsion system models.

1-8.C. MATERIALS

1-8.C.1. 'Syntactic foam' designed for underwater use and having all of the following:

a. Designed for marine depths exceeding 1,000 m; **and**

b. A density less than 561 kg/m^3.

Technical Note:

'Syntactic foam' consists of hollow spheres of plastic or glass embedded in a resin matrix.

N.B.:

See also 1-8.A.2.a.4.

1-8.D. SOFTWARE

1-8.D.1. "Software" specially designed or modified for the "development", "production" or "use" of equipment or materials, specified by 1-8.A., 1-8.B. or 1-8.C.

1-8.D.2. Specific "software" specially designed or modified for the "development", "production", repair, overhaul or refurbishing (re-machining) of propellers specially designed for underwater noise reduction.

1-8.E. TECHNOLOGY

1-8.E.1. "Technology" according to the General Technology Note for the "development" or "production" of equipment or materials, specified by 1-8.A., 1-8.B. or 1-8.C.

1-8.E.2. Other “technology” as follows:

a. “Technology” for the “development”, “production”, repair, overhaul or refurbishing (re-machining) of propellers specially designed for underwater noise reduction;

b. “Technology” for the overhaul or refurbishing of equipment specified by 1-8.A.1., 1-8.A.2.b., 1-8.A.2.j., 1-8.A.2.o. or 1-8.A.2.p.

CATEGORY 9: AEROSPACE AND PROPULSION

1-9.A. SYSTEMS, EQUIPMENT AND COMPONENTS

N.B.:

For propulsion systems designed or rated against neutron or transient ionizing radiation, see Group 2 - Munitions List.

1-9.A.1. Aero gas turbine engines having any of the following:

a. Incorporating any of the technologies specified by 1-9.E.3.a., 1-9.E.3.h. or 1-9.E.3.i.; **or**

Note:

1-9.A.1.a. does not apply to aero gas turbine engines which meet all of the following:

*a. Certified by the civil aviation authority in a Participating State; **and***

b. Intended to power non-military manned aircraft for which any of the following has been issued by a Participating State for the aircraft with this specific engine type:

*1. A civil type certificate; **or***

2. An equivalent document recognised by the International Civil Aviation Organisation (ICAO).

b. Designed to power an aircraft designed to cruise at Mach 1 or higher, for more than 30 minutes.

1-9.A.2. 'Marine gas turbine engines' with an ISO standard continuous power rating of 24,245 kW or more and a specific fuel consumption not exceeding 0.219 kg/kWh in the power range from 35 to 100%, and specially designed assemblies and components therefor.

Note:

The term 'marine gas turbine engines' includes those industrial, or aero-derivative, gas turbine engines adapted for a ship's electric power generation or propulsion.

1-9.A.3. Specially designed assemblies and components, incorporating any of the "technologies" specified by 1-9.E.3.a., 1-9.E.3.h. or 1-9.E.3.i., for any of the following gas turbine engine propulsion systems:

a. Specified by 1-9.A.1.; **or**

b. Whose design or production origins are either non-participating states or unknown to the manufacturer.

1-9.A.4. Space launch vehicles and "spacecraft".

Note:

1-9.A.4. does not apply to payloads.

N.B.:

For the status of products contained in "spacecraft" payloads, see the appropriate Categories.

1-9.A.5. Liquid rocket propulsion systems containing any of the systems or components, specified by 1-9.A.6.

1-9.A.6. Systems and components, specially designed for liquid rocket propulsion systems, as follows:

a. Cryogenic refrigerators, flightweight dewars, cryogenic heat pipes or cryogenic systems, specially designed for use in space vehicles and capable of restricting cryogenic fluid losses to less than 30% per year;

b. Cryogenic containers or closed-cycle refrigeration systems, capable of providing temperatures of 100 K (-173° C) or less for "aircraft" capable of sustained flight at speeds exceeding Mach 3, launch vehicles or "spacecraft";

c. Slush hydrogen storage or transfer systems;

d. High pressure (exceeding 17.5 MPa) turbo pumps, pump components or their associated gas generator or expander cycle turbine drive systems;

e. High-pressure (exceeding 10.6 MPa) thrust chambers and nozzles therefor;

f. Propellant storage systems using the principle of capillary containment or positive expulsion (i.e., with flexible bladders);

g. Liquid propellant injectors with individual orifices of 0.381 mm or smaller in diameter (an area of 1.14×10^{-3} cm^2 or smaller for non-circular orifices) and specially designed for liquid rocket engines;

h. One-piece carbon-carbon thrust chambers or one-piece carbon-carbon exit cones, with densities exceeding 1.4 g/cm^3 and tensile strengths exceeding 48 MPa.

1-9.A.7. Solid rocket propulsion systems having any of the following:

a. Total impulse capacity exceeding 1.1 MNs;

b. Specific impulse of 2.4 kNs/kg or more, when the nozzle flow is expanded to ambient sea level conditions for an adjusted chamber pressure of 7 MPa;

c. Stage mass fractions exceeding 88% and propellant solid loadings exceeding 86%;

d. Components specified by 1-9.A.8.; **or**

e. Insulation and propellant bonding systems, using direct-bonded motor designs to provide a 'strong mechanical bond' or a barrier to chemical migration between the solid propellant and case insulation material.

Technical Note:

A 'strong mechanical bond' means bond strength equal to or more than propellant strength.

1-9.A.8. Components specially designed for solid rocket propulsion systems, as follows:

a. Insulation and propellant bonding systems, using liners to provide a 'strong mechanical bond' or a barrier to chemical migration between the solid propellant and case insulation material;

b. Filament-wound "composite" motor cases exceeding 0.61 m in diameter or having 'structural efficiency ratios (PV/W)' exceeding 25 km;

Technical Note:

'Structural efficiency ratio (PV/W)' is the burst pressure (P) multiplied by the vessel volume (V) divided by the total pressure vessel weight (W).

c. Nozzles with thrust levels exceeding 45 kN or nozzle throat erosion rates of less than 0.075 mm/s;

d. Movable nozzle or secondary fluid injection thrust vector control systems, capable of any of the following:

1. Omni-axial movement exceeding ± 5°;
2. Angular vector rotations of 20°/s or more; **or**
3. Angular vector accelerations of 40°/s^2 or more.

1-9.A.9. Hybrid rocket propulsion systems having any of the following:

a. Total impulse capacity exceeding 1.1 MNs; **or**

b. Thrust levels exceeding 220 kN in vacuum exit conditions.

1-9.A.10. Specially designed components, systems and structures, for launch vehicles, launch vehicle propulsion systems or "spacecraft", as follows:

a. Components and structures, each exceeding 10 kg and specially designed for launch vehicles manufactured using metal "matrix", "composite", organic "composite", ceramic "matrix" or intermetallic reinforced materials specified by 1-1.C.7. or 1-1.C.10.;

Note:

The weight cut-off is not relevant for nose cones.

b. Components and structures, specially designed for launch vehicle propulsion systems specified by 1-9.A.5. to 1-9.A.9. manufactured using metal "matrix", "composite", organic "composite", ceramic "matrix" or intermetallic reinforced materials, specified by 1-1.C.7. or 1-1.C.10.;

c. Structural components and isolation systems, specially designed to control actively the dynamic response or distortion of "spacecraft" structures;

d. Pulsed liquid rocket engines with thrust-to-weight ratios equal to or more than 1 kN/kg and a response time (the time required to achieve 90% of total rated thrust from start-up) of less than 30 ms.

1-9.A.11. Ramjet, scramjet or combined cycle engines, and specially designed components therefor.

1-9.A.12. "Unmanned Aerial Vehicles" ("UAVs"), associated systems, equipment and components, as follows:

a. "UAVs" having any of the following:

1. An autonomous flight control and navigation capability (e.g., an autopilot with an Inertial Navigation System); **or**
2. Capability of controlled flight out of the direct visual range involving a human operator (e.g., televisual remote control);

b. Associated systems, equipment and components, as follows:

1. Equipment specially designed for remotely controlling the "UAVs" specified by 1-9.A.12.a.;
2. Systems for navigation, attitude, guidance or control, other than those specified by Category 7 and specially designed to provide autonomous flight control or navigation capability to "UAVs" specified by 1-9.A.12.a.;
3. Equipment and components, specially designed to convert a manned "aircraft" to a "UAV" specified by 1-9.A.12.a.;

4. Air breathing reciprocating or rotary internal combustion type engines, specially designed or modified to propel "UAVs" at altitudes above 50,000 feet (15,240 metres).

Note:

1-9.A.12. does not apply to model aircraft.

1-9.B. TEST, INSPECTION AND PRODUCTION

1-9.B.1. Equipment, tooling and fixtures, specially designed for manufacturing gas turbine blades, vanes or "tip shroud" castings, as follows:

a. Directional solidification or single crystal casting equipment;

b. Ceramic cores or shells.

1-9.B.2. On-line (real time) control systems, instrumentation (including sensors) or automated data acquisition and processing equipment, having all of the following:

a. Specially designed for the "development" of gas turbine engines, assemblies or components; **and**

b. Incorporating "technology" specified by 1-9.E.3.h. or 1-9.E.3.i.

1-9.B.3. Equipment specially designed for the "production" or test of gas turbine brush seals designed to operate at tip speeds exceeding 335 m/s and temperatures in excess of 773 K (500° C), and specially designed components or accessories therefor.

1-9.B.4. Tools, dies or fixtures, for the solid state joining of "superalloy", titanium or intermetallic airfoil-to-disk combinations described in 1-9.E.3.a.3. or 1-9.E.3.a.6. for gas turbines.

1-9.B.5. On-line (real time) control systems, instrumentation (including sensors) or automated data acquisition and processing equipment, specially designed for use with any of the following:

a. Wind tunnels designed for speeds of Mach 1.2 or more;

Note:

1-9.B.5.a. does not apply to wind tunnels specially designed for educational purposes and having a 'test section size' (measured laterally) of less than 250 mm.

Technical Note:

'Test section size' means the diameter of the circle, or the side of the square, or the longest side of the rectangle, at the largest test section location.

b. Devices for simulating flow-environments at speeds exceeding Mach 5, including hot-shot tunnels, plasma arc tunnels, shock tubes, shock tunnels, gas tunnels and light gas guns; **or**

c. Wind tunnels or devices, other than two-dimensional sections, capable of simulating Reynolds number flows exceeding 25 x 10^6.

1-9.B.6. Acoustic vibration test equipment capable of producing sound pressure levels of 160 dB or more (referenced to 20 μPa) with a rated output of 4 kW or more at a test cell temperature exceeding 1,273 K (1,000° C), and specially designed quartz heaters therefor.

1-9.B.7. Equipment specially designed for inspecting the integrity of rocket motors and using Non-Destructive Test (NDT) techniques other than planar x-ray or basic physical or chemical analysis.

1-9.B.8. Direct measurement wall skin friction transducers specially designed to operate at a test flow total (stagnation) temperature exceeding 833 K (560°C).

1-9.B.9. Tooling specially designed for producing turbine engine powder metallurgy rotor components capable of operating at stress levels of 60% of Ultimate Tensile Strength (UTS) or more and metal temperatures of 873 K (600° C) or more.

1-9.B.10. Equipment specially designed for the production of "UAVs" and associated systems, equipment and components, specified by 1-9.A.12.

1-9.C. MATERIALS

None

1-9.D. SOFTWARE

1-9.D.1. "Software" specially designed or modified for the "development" of equipment or "technology", specified by 1-9.A., 1-9.B. or 1-9.E.3.

1-9.D.2. "Software" specially designed or modified for the "production" of equipment specified by 1-9.A. or 1-9.B.

1-9.D.3. "Software" incorporating "technology" specified by 1-9.E.3.h. and used in "FADEC Systems" for propulsion systems specified by 1-9.A. or equipment specified by 1-9.B.

1-9.D.4. Other "software" as follows:

a. 2D or 3D viscous "software", validated with wind tunnel or flight test data required for detailed engine flow modelling;

b. "Software" for testing aero gas turbine engines, assemblies or components, specially designed to collect, reduce and analyse data in real time and capable of feedback control, including the dynamic adjustment of test articles or test conditions, as the test is in progress;

c. "Software" specially designed to control directional solidification or single crystal casting;

d. "Software" in "source code", "object code" or machine code, required for the "use" of active compensating systems for rotor blade tip clearance control;

Note:

1-9.D.4.d. does not apply to "software" embedded in equipment not specified in the Dual-Use List or required for maintenance activities associated with the calibration or repair or updates to the active compensating clearance control system.

e. "Software" specially designed or modified for the "use" of "UAVs" and associated systems, equipment and components, specified by 1-9.A.12.;

f. "Software" specially designed to design the internal cooling passages of aero gas turbine engine blades, vanes and "tip shrouds";

g. "Software" having all of the following:

1. Specially designed to predict aero thermal, aeromechanical and combustion conditions in aero gas turbine engines; **and**
2. Theoretical modelling predictions of the aero thermal, aeromechanical and combustion conditions, which have been validated with actual aero gas turbine engine (experimental or production) performance data.

1-9.E. TECHNOLOGY

Note:

"Development" or "production" "technology" specified by 1-9.E. for gas turbine engines remains specified by 1-9.E. when used as "use" "technology" for repair, rebuild and overhaul. Excluded from 1-9.E. are: technical data, drawings or documentation for maintenance activities directly associated with calibration, removal or replacement of damaged or unserviceable line replaceable units, including replacement of whole engines or engine modules.

1-9.E.1. "Technology" according to the General Technology Note for the "development" of equipment or "software", specified by 1-9.A.1.b., 1-9.A.4. to 1-9.A.12., 1-9.B. or 1-9.D.

1-9.E.2. "Technology" according to the General Technology Note for the "production" of equipment specified by 1-9.A.1.b., 1-9.A.4. to 1-9.A.11. or 1-9.B.

N.B.:

For "technology" for the repair of specified structures, laminates or materials, see 1-1.E.2.f.

1-9.E.3. Other "technology" as follows:

1-9.E.3.a. "Technology" "required" for the "development" or "production" of any of the following gas turbine engine components or systems:

1. Gas turbine blades, vanes or "tip shrouds", made from directionally solidified (DS) or single crystal (SC) alloys and having (in the 001 Miller Index Direction) a stress-rupture life exceeding 400 hours at 1,273 K (1,000° C) at a stress of 200 MPa, based on the average property values;
2. Multiple domed combustors operating at average burner outlet temperatures exceeding 1,813 K (1,540° C) or combustors incorporating thermally decoupled combustion liners, non-metallic liners or non-metallic shells;
3. Components manufactured from any of the following:
   a. Organic "composite" materials designed to operate above 588 K (315° C);
   b. Metal "matrix" "composite", ceramic "matrix", intermetallic or intermetallic reinforced materials, specified by 1-1.C.7.; **or**
   c. "Composite" material specified by 1-1.C.10. and manufactured with resins specified by 1-1.C.8.;
4. Uncooled turbine blades, vanes, tip-shrouds or other components designed to operate at gas path total (stagnation) temperatures of 1,323 K (1,050° C) or more at sea-level static take-off (ISA) in a 'steady state mode' of engine operation;

5. Cooled turbine blades, vanes, tip-shrouds other than those described in 1-9.E.3.a.1., exposed to gas path total (stagnation) temperatures of 1,643 K (1,370° C) or more at sea-level static take-off (ISA) in a 'steady state mode' of engine operation;

   Technical Note:

   The term 'steady state mode' defines engine operation conditions, where the engine parameters, such as thrust/power, rpm and others, have no appreciable fluctuations, when the ambient air temperature and pressure at the engine inlet are constant.

6. Airfoil-to-disk blade combinations using solid state joining;
7. Gas turbine engine components using "diffusion bonding" "technology" specified by 1-2.E.3.b.;
8. 'Damage tolerant' gas turbine engine rotor components using powder metallurgy materials specified by 1-1.C.2.b.; **or**

   Technical Note:

   'Damage tolerant' components are designed using methodology and substantiation to predict and limit crack growth.

9. Not used since 2009

   N.B.:

   For "FADEC systems", see 1-9.E.3.h.

10. Not used since 2010

    N.B.:

    For adjustable flow path geometry, see 1-9.E.3.i.

11. Hollow fan blades;

1-9.E.3.b. "Technology" "required" for the "development" or "production" of any of the following:

1. Wind tunnel aero-models equipped with non-intrusive sensors capable of transmitting data from the sensors to the data acquisition system; **or**
2. "Composite" propeller blades or prop fans, capable of absorbing more than 2,000 kW at flight speeds exceeding Mach 0.55;

1-9.E.3.c. "Technology" "required" for the "development" or "production" of gas turbine engine components using "laser", water jet, Electro-Chemical Machining (ECM) or Electrical Discharge Machines (EDM) hole drilling processes to produce holes having any of the following:

1. All of the following:
   a. Depths more than four times their diameter;
   b. Diameters less than 0.76 mm; **and**
   c. 'Incidence angles' equal to or less than 25°; **or**
2. All of the following:
   a. Depths more than five times their diameter;
   b. Diameters less than 0.4 mm; **and**
   c. 'Incidence angles' of more than 25°;

Technical Note:

For the purposes of 1-9.E.3.c., 'incidence angle' is measured from a plane tangential to the airfoil surface at the point where the hole axis enters the airfoil surface.

1-9.E.3.d. "Technology" "required" for the "development" or "production" of helicopter power transfer systems or tilt rotor or tilt wing "aircraft" power transfer systems;

1-9.E.3.e. "Technology" for the "development" or "production" of reciprocating diesel engine ground vehicle propulsion systems having all of the following:

1. 'Box volume' of 1.2 m^3 or less;
2. An overall power output of more than 750 kW based on 80/1269/EEC, ISO 2534 or national equivalents; **and**
3. Power density of more than 700 kW/m^3 of 'box volume';

Technical Note:

'Box volume' is the product of three perpendicular dimensions measured in the following way:

Length: The length of the crankshaft from front flange to flywheel face;

Width: The widest of any of the following:

a. The outside dimension from valve cover to valve cover;

*b. The dimensions of the outside edges of the cylinder heads; **or***

c. The diameter of the flywheel housing;

Height: The largest of any of the following:

*a. The dimension of the crankshaft centre-line to the top plane of the valve cover (or cylinder head) plus twice the stroke; **or***

b. The diameter of the flywheel housing.

1-9.E.3.f. "Technology" "required" for the "production" of specially designed components for high output diesel engines, as follows:

1. "Technology" "required" for the "production" of engine systems having all of the following components employing ceramics materials specified by 1-1.C.7.:
   a. Cylinder liners;
   b. Pistons;
   c. Cylinder heads; **and**
   d. One or more other components (including exhaust ports, turbochargers, valve guides, valve assemblies or insulated fuel injectors);
2. "Technology" "required" for the "production" of turbocharger systems with single-stage compressors and having all of the following:
   a. Operating at pressure ratios of 4:1 or higher;
   b. Mass flow in the range from 30 to 130 kg per minute; **and**
   c. Variable flow area capability within the compressor or turbine sections;

3. "Technology" "required" for the "production" of fuel injection systems with a specially designed multifuel (e.g., diesel or jet fuel) capability covering a viscosity range from diesel fuel (2.5 cSt at 310.8 K (37.8° C)) down to gasoline fuel (0.5 cSt at 310.8 K (37.8° C)) and having all of the following:
   a. Injection amount in excess of 230 mm^3 per injection per cylinder; **and**
   b. Electronic control features specially designed for switching governor characteristics automatically depending on fuel property to provide the same torque characteristics by using the appropriate sensors;

1-9.E.3.g. "Technology" "required" for the "development" or "production" of 'high output diesel engines' for solid, gas phase or liquid film (or combinations thereof) cylinder wall lubrication and permitting operation to temperatures exceeding 723 K (450° C), measured on the cylinder wall at the top limit of travel of the top ring of the piston;

Technical Note:

'High output diesel engines' are diesel engines with a specified brake mean effective pressure of 1.8 MPa or more at a speed of 2,300 r.p.m., provided the rated speed is 2,300 r.p.m. or more.

1-9.E.3.h. "Technology" for gas turbine engine "FADEC systems" as follows:

1. "Development" "technology" for deriving the functional requirements for the components necessary for the "FADEC system" to regulate engine thrust or shaft power (e.g., feedback sensor time constants and accuracies, fuel valve slew rate);
2. "Development" or "production" "technology" for control and diagnostic components unique to the "FADEC system" and used to regulate engine thrust or shaft power;
3. "Development" "technology" for the control law algorithms, including "source code", unique to the "FADEC system" and used to regulate engine thrust or shaft power.

Note:

1-9.E.3.h. does not apply to technical data related to engine-aircraft integration required by the civil aviation certification authorities to be published for general airline use (e.g., installation manuals, operating instructions, instructions for continued airworthiness) or interface functions (e.g., input/output processing, airframe thrust or shaft power demand).

1-9.E.3.i. "Technology" for adjustable flow path systems designed to maintain engine stability for gas generator turbines, fan or power turbines, or propelling nozzles, as follows:

1. "Development" "technology" for deriving the functional requirements for the components that maintain engine stability;
2. "Development" or "production" "technology" for components unique to the adjustable flow path system and that maintain engine stability;
3. "Development" "technology" for the control law algorithms, including "source code", unique to the adjustable flow path system and that maintain engine stability.

Note:

1-9.E.3.i. does not apply to "development" or "production" "technology" for any of the following:

a. Inlet guide vanes;

b. Variable pitch fans or prop-fans;

c. Variable compressor vanes;

d. Compressor bleed valves; or

e. Adjustable flow path geometry for reverse thrust.

GROUP 2 – MUNITIONS LIST

Note 1:

Terms in "quotations" are defined terms. Refer to 'Definitions of Terms used in these Lists' annexed to this List. References to the "Dual-Use List" and "Munitions List" within Groups 1 and 2 refer to the "Group 1 – Dual-Use List" and the "Group 2 – Munitions List" respectively.

Note 2:

In some instances chemicals are listed by name and CAS number. The list applies to chemicals of the same structural formula (including hydrates) regardless of name or CAS number. CAS numbers are shown to assist in identifying a particular chemical or mixture, irrespective of nomenclature. CAS numbers cannot be used as unique identifiers because some forms of the listed chemical have different CAS numbers, and mixtures containing a listed chemical may also have different CAS numbers.

2-1. Smooth-bore weapons with a calibre of less than 20 mm, other arms and automatic weapons with a calibre of 12.7 mm (calibre 0.50 inches) or less and accessories, as follows, and specially designed components therefor:

(All destinations)

a. Rifles, carbines, revolvers, pistols, machine pistols and machine guns;

b. Smooth-bore weapons;

c. Weapons using caseless ammunition;

d. Silencers, special gun-mountings, clips, weapons sights and flash suppressors for arms controlled by sub-items 2-1.a., 2-1.b. or 2-1.c.

e. Other firearms as defined by the Criminal Code, as follows:

1. Any firearm capable of discharging a dart or other object carrying an electrical current or substance, including the firearm of the design commonly known as the Taser Public Defender and any variant or modified version of it as set out in Part I of the Schedule to the *Regulations Prescribing Certain Firearms and other Weapons, Components and Parts of Weapons, Accessories, Cartridge Magazines, Ammunition and Projectiles as Prohibited or Restricted*;

2. Firearms, not specified by 2-1.a., 2-1.b., 2-1.c. or 2-1.e.1., designed to discharge a projectile at a muzzle velocity exceeding 152.4 m/s or at a muzzle energy exceeding 5.7 Joules.

Note:

2-1. does not control the following:

1. *Firearms specially designed for dummy ammunition and which are incapable of firing, or being modified to fire, any controlled ammunition;*
2. *Weapons deemed not to be firearms under the Criminal Code §84.3, as follows:*
   a. *Antique firearms;*
   b. *Those that are designed exclusively for firing stud cartridges, explosive-driven rivets or other industrial projectiles;*
   c. *Those that are designed exclusively for the slaughtering of domestic animals or the tranquilizing of animals.*
3. *Reproductions of flintlock, wheelock and matchlock muskets, rifles and carbines.*
4. *Optical weapon sights without electronic image processing, with a magnification of 4 times or less, provided they are not specially designed or modified for military use.*

2-2. Smooth-bore weapons with a calibre of 20 mm or more, other weapons or armament with a calibre greater than 12.7 mm (calibre 0.50 inches), projectors and accessories, as follows, and specially designed components therefor:

a. Guns, howitzers, cannon, mortars, anti-tank weapons, projectile launchers, military flame throwers, rifles, recoilless rifles, smooth-bore weapons and signature reduction devices therefor;

(All destinations)

Note 1:

2-2.a. includes injectors, metering devices, storage tanks and other specially designed components for use with liquid propelling charges for any of the equipment specified by 2-2.a.

Note 2:

2-2.a. does not control the following:

1. Antique firearms as defined by the Criminal Code;

2. Reproductions of flintlock, wheelock and matchlock muskets, rifles and carbines.

Note 3:

2-2.a. does not apply to hand-held projectile launchers specially designed to launch tethered projectiles having no high explosive charge or communications link, to a range of less than or equal to 500 m.

b. Smoke, gas and pyrotechnic projectors or generators, specially designed or modified for military use;

(All destinations)

Note:

2-2.b. does not apply to signal pistols.

c. Weapons sights and weapon sight mounts, having all of the following:

1. Specially designed for military use; **and**
2. Specially designed for weapons specified in 2-2.a.;

d. Mountings specially designed for the weapons specified in 2-2.a.

2-3. Ammunition and fuze setting devices, as follows, and specially designed components therefor:

(All destinations)

a. Ammunition for weapons specified by 2-1., 2-2. or 2-12.;

b. Fuze setting devices specially designed for ammunition specified by 2-3.a.

Note 1:

Specially designed components specified by 2-3. include:

a. Metal or plastic fabrications such as primer anvils, bullet cups, cartridge links, rotating bands and munitions metal parts;

b. Safing and arming devices, fuzes, sensors and initiation devices ;

c. Power supplies with high one-time operational output;

d. Combustible cases for charges;

e. Submunitions including bomblets, minelets and terminally guided projectiles.

Note 2:

2-3.a. does not apply to ammunition crimped without a projectile (blank star) and dummy ammunition with a pierced powder chamber.

Note 3:

2-3.a. does not apply to cartridges specially designed for any of the following purposes:

a. Signalling;

b. Bird scaring; ***or***

c. Lighting of gas flares at oil wells.

2-4. Bombs, torpedoes, rockets, missiles, other explosive devices and charges and related equipment and accessories, as follows, and specially designed components therefor:

N.B. 1:

For guidance and navigation equipment, see 2-11.

N.B. 2:

For Aircraft Missile Protection Systems (AMPS), see 2-4.c.

a. Bombs, torpedoes, grenades, smoke canisters, rockets, mines, missiles, depth charges, demolition-charges, demolition-devices, demolition-kits, "pyrotechnic" devices, cartridges and simulators (i.e., equipment simulating the characteristics of any of these items), specially designed for military use;

(All destinations)

Note:

2-4.a. includes:

a. Smoke grenades, fire bombs, incendiary bombs and explosive devices;

b. Missile rocket nozzles and re-entry vehicle nosetips.

b. Equipment having all of the following:

1. Specially designed for military use; **and**
2. Specially designed for 'activities' relating to any of the following:
   a. Items specified by 2-4.a.; **or**
   b. Improvised Explosive Devices (IEDs).

Technical Note:

For the purpose of 2-4.b.2. 'activities' applies to handling, launching, laying, controlling, discharging, detonating, activating, powering with one-time operational output, decoying, jamming, sweeping, detecting, disrupting or disposing.

Note 1:

2-4.b. includes:

a. Mobile gas liquefying equipment capable of producing 1,000 kg or more per day of gas in liquid form;

b. Buoyant electric conducting cable suitable for sweeping magnetic mines.

Note 2:

2-4.b. does not apply to hand-held devices limited by design solely to the detection of metal objects and incapable of distinguishing between mines and other metal objects.

c. Aircraft Missile Protection Systems (AMPS).

Note:

2-4.c. does not apply to AMPS having all of the following:

a. Any of the following missile warning sensors:

1. Passive sensors having peak response between 100-400 nm; ***or***

2. Active pulsed Doppler missile warning sensors;

b. Countermeasures dispensing systems;

c. Flares, which exhibit both a visible signature and an infrared signature, for decoying surface-to-air missiles; ***and***

d. Installed on "civil aircraft" and having all of the following:

1. The AMPS is only operable in a specific "civil aircraft" in which the specific AMPS is installed and for which any of the following has been issued:

a. A civil Type Certificate; ***or***

b. An equivalent document recognised by the International Civil Aviation Organisation (ICAO);

2. The AMPS employs protection to prevent unauthorised access to "software"; ***and***

3. The AMPS incorporates an active mechanism that forces the system not to function when it is removed from the "civil aircraft" in which it was installed.

2-5. Fire control, and related alerting and warning equipment, and related systems, test and alignment and countermeasure equipment, as follows, specially designed for military use, and specially designed components and accessories therefor:

a. Weapon sights, bombing computers, gun laying equipment and weapon control systems;

b. Target acquisition, designation, range-finding, surveillance or tracking systems; detection, data fusion, recognition or identification equipment; and sensor integration equipment;

c. Countermeasure equipment for items specified by 2-5.a. or 2-5.b.;

Note:

For the purposes of 2-5.c., countermeasure equipment includes detection equipment.

d. Field test or alignment equipment, specially designed for items specified by 2-5.a., 2-5.b. or 2-5.c.

2-6. Ground vehicles and components, as follows:

N.B.:

For guidance and navigation equipment, see 2-11.

a. Ground vehicles and components therefor, specially designed or modified for military use;

Technical Note:

For the purposes of 2-6.a. the term ground vehicles includes trailers.

b. Other ground vehicles and components, as follows:

1. All-wheel drive vehicles capable of off-road use which have been manufactured or fitted with materials or components to provide ballistic protection to level III (NIJ 0108.01, September 1985, or comparable national standard) or better.

2. Components having all of the following:
   a. Specially designed for vehicles specified in 2-6.b.1.; and
   b. Providing ballistic protection to level III (NIJ 0108.01, September 1985, or comparable national standard) or better.

N.B.:

See also 2-13.a.

Note 1:

2-6.a. includes:

a. Tanks and other military armed vehicles and military vehicles fitted with mountings for arms or equipment for mine laying or the launching of munitions specified by 2-4.;

b. Armoured vehicles;

c. Amphibious and deep water fording vehicles;

d. Recovery vehicles and vehicles for towing or transporting ammunition or weapon systems and associated load handling equipment.

Note 2:

Modification of a ground vehicle for military use specified by 2-6.a. entails a structural, electrical or mechanical change involving one or more components that are specially designed for military use. Such components include:

a. Pneumatic tyre casings of a kind specially designed to be bullet-proof;

b. Armoured protection of vital parts, (e.g., fuel tanks or vehicle cabs);

c. Special reinforcements or mountings for weapons;

d. Black-out lighting.

Note 3:

2-6. does not apply to civil automobiles, or trucks designed or modified for transporting money or valuables, having armoured or ballistic protection.

2-7. Chemical or biological toxic agents, "riot control agents", radioactive materials, related equipment, components and materials, as follows:

2-7.a. Biological agents or radioactive materials, "adapted for use in war" to produce casualties in humans or animals, degrade equipment or damage crops or the environment;

2-7.b. Chemical warfare (CW) agents, including:

1. CW nerve agents:
   a. O-Alkyl (equal to or less than C_{10}, including cycloalkyl) alkyl (Methyl, Ethyl, n-Propyl or Isopropyl) - phosphonofluoridates, such as:

      Sarin (GB):O-Isopropyl methylphosphonofluoridate (CAS 107-44-8); and

      Soman (GD):O-Pinacolyl methylphosphonofluoridate (CAS 96-64-0);

   b. O-Alkyl (equal to or less than C_{10}, including cycloalkyl) N,N-dialkyl (Methyl, Ethyl, n-Propyl or Isopropyl) phosphoramidocyanidates, such as:

      Tabun (GA):O-Ethyl N,N-dimethylphosphoramidocyanidate (CAS 77-81-6);

c. O-Alkyl (H or equal to or less than C_{10}, including cycloalkyl) S-2-dialkyl (Methyl, Ethyl, n-Propyl or Isopropyl)-aminoethyl alkyl (Methyl, Ethyl, n-Propyl or Isopropyl) phosphonothiolates and corresponding alkylated and protonated salts, such as:

VX: O-Ethyl S-2-diisopropylaminoethyl methyl phosphonothiolate (CAS 50782-69-9);

2. CW vesicant agents:
   a. Sulphur mustards, such as:
      1. 2-Chloroethylchloromethylsulphide (CAS 2625-76-5);
      2. Bis(2-chloroethyl) sulphide (CAS 505-60-2);
      3. Bis(2-chloroethylthio) methane (CAS 63869-13-6);
      4. 1,2-bis (2-chloroethylthio) ethane (CAS 3563-36-8);
      5. 1,3-bis (2-chloroethylthio) -n-propane (CAS 63905-10-2);
      6. 1,4-bis (2-chloroethylthio) -n-butane (CAS 142868-93-7) ;
      7. 1,5-bis (2-chloroethylthio) -n-pentane (CAS 142868-94-8);
      8. Bis (2-chloroethylthiomethyl) ether (CAS 63918-90-1);
      9. Bis (2-chloroethylthioethyl) ether (CAS 63918-89-8);
   b. Lewisites, such as:
      1. 2-chlorovinyldichloroarsine (CAS 541-25-3);
      2. Tris (2-chlorovinyl) arsine (CAS 40334-70-1);
      3. Bis (2-chlorovinyl) chloroarsine (CAS 40334-69-8);
   c. Nitrogen mustards, such as:
      1. HN1: bis (2-chloroethyl) ethylamine (CAS 538-07-8);
      2. HN2: bis (2-chloroethyl) methylamine (CAS 51-75-2);
      3. HN3: tris (2-chloroethyl) amine (CAS 555-77-1);
3. CW incapacitating agents, such as:
   a. 3-Quinuclidinyl benzilate (BZ) (CAS 6581-06-2);
4. CW defoliants, such as:
   a. Butyl 2-chloro-4-fluorophenoxyacetate (LNF);
   b. 2,4,5-trichlorophenoxyacetic acid (CAS 93-76-5) mixed with 2,4-dichlorophenoxyacetic acid (CAS 94-75-7) (Agent Orange (CAS 39277-47-9));

2-7.c. CW binary precursors and key precursors, as follows:

1. Alkyl (Methyl, Ethyl, n-Propyl or Isopropyl) Phosphonyl Difluorides, such as:

   DF: Methyl Phosphonyldifluoride (CAS 676-99-3);

2. O-Alkyl (H or equal to or less than C_{10}, including cycloalkyl) O-2-dialkyl (Methyl, Ethyl, n-Propyl or Isopropyl) aminoethyl alkyl (Methyl, Ethyl, n-Propyl or Isopropyl) phosphonites and corresponding alkylated and protonated salts, such as:

   QL: O-Ethyl-2-di-isopropylaminoethyl methylphosphonite (CAS 57856-11-8);

3. Chlorosarin: O-Isopropyl methylphosphonochloridate (CAS 1445-76-7);

4. Chlorosoman: O-Pinacolyl methylphosphonochloridate (CAS 7040-57-5);

2-7.d. "Riot control agents", active constituent chemicals and combinations thereof, including:

1. α-Bromobenzeneacetonitrile, (Bromobenzyl cyanide) (CA) (CAS 5798-79-8);
2. [(2-chlorophenyl) methylene] propanedinitrile, (o-Chlorobenzylidenemalononitrile) (CS) (CAS 2698-41-1);
3. 2-Chloro-1-phenylethanone, Phenylacyl chloride (ω-chloroacetophenone) (CN) (CAS 532-27-4);
4. Dibenz-(b,f)-1,4-oxazephine, (CR) (CAS 257-07-8);
5. 10-Chloro-5,10-dihydrophenarsazine, (Phenarsazine chloride), (Adamsite), (DM) (CAS 578-94-9);
6. N-Nonanoylmorpholine, (MPA) (CAS 5299-64-9);

Note 1:

2-7.d. does not apply to "riot control agents" individually packaged for personal self defence purposes.

Note 2:

2-7.d. does not apply to active constituent chemicals, and combinations thereof, identified and packaged for food production or medical purposes.

2-7.e. Equipment, specially designed or modified for military use, designed or modified for the dissemination of any of the following, and specially designed components therefor:

1. Materials or agents specified by 2-7.a., 2-7.b. or 2-7.d.; **or**
2. CW agents made up of precursors specified by 2-7.c.;

2-7.f. Protective and decontamination equipment specially designed or modified for military use, components and chemical mixtures, as follows:

1. Equipment designed or modified for defence against materials specified by 2-7.a., 2-7.b. or 2-7.d., and specially designed components therefor;
2. Equipment designed or modified for decontamination of objects contaminated with materials specified by 2-7.a. or 2-7.b., and specially designed components therefor;
3. Chemical mixtures specially developed or formulated for the decontamination of objects contaminated with materials specified by 2-7.a. or 2-7.b.;

Note:

2-7.f.1. includes:

a. Air conditioning units specially designed or modified for nuclear, biological or chemical filtration;

b. Protective clothing.

N.B.:

For civil gas masks, protective and decontamination equipment, see also 1-1.A.4. on the Dual-Use List.

2-7.g. Equipment, specially designed or modified for military use designed or modified for the detection or identification of materials specified by 2-7.a., 2-7.b. or 2-7.d., and specially designed components therefor;

Note:

2-7.g. does not apply to personal radiation monitoring dosimeters.

N.B.:

See also 1-1.A.4. on the Dual-Use List.

2-7.h. "Biopolymers" specially designed or processed for the detection or identification of CW agents specified by 2-7.b., and the cultures of specific cells used to produce them;

2-7.i. "Biocatalysts" for the decontamination or degradation of CW agents, and biological systems therefor, as follows:

1. "Biocatalysts" specially designed for the decontamination or degradation of CW agents specified by 2-7.b. resulting from directed laboratory selection or genetic manipulation of biological systems;
2. Biological systems containing the genetic information specific to the production of "biocatalysts" specified by 2-7.i.1., as follows:
   a. "Expression vectors";
   b. Viruses;
   c. Cultures of cells.

Note 1:

2-7.b. and 2-7.d. do not apply to the following:

a. Cyanogen chloride (CAS 506-77-4);

b. Hydrocyanic acid (CAS 74-90-8);

c. Chlorine (CAS 7782-50-5);

d. Carbonyl chloride (phosgene) (CAS 75-44-5);

e. Diphosgene (trichloromethyl-chloroformate) (CAS 503-38-8);

f. Not used since 2004

g. Xylyl bromide, ortho: (CAS 89-92-9), meta: (CAS 620-13-3), para: (CAS 104-81-4);

h. Benzyl bromide (CAS 100-39-0);

i. Benzyl iodide (CAS 620-05-3);

j. Bromo acetone (CAS 598-31-2);

k. Cyanogen bromide (CAS 506-68-3);

l. Bromo methylethylketone (CAS 816-40-0);

m. Chloro acetone (CAS 78-95-5);

n. Ethyl iodoacetate (CAS 623-48-3);

o. Iodo acetone (CAS 3019-04-3);

p. Chloropicrin (CAS 76-06-2).

Note 2:

The cultures of cells and biological systems specified by 2-7.h. and 2-7.i.2. are exclusive and these sub-items do not apply to cells or biological systems for civil purposes, such as agricultural, pharmaceutical, medical, veterinary, environmental, waste management, or in the food industry.

2-8. "Energetic materials" and related substances, as follows:

N.B. 1:

See also 1-1.C.11. on the Dual-Use List.

N.B. 2:

For charges and devices, see 2-4. and 1-1.A.8. on the Dual-Use List.

Technical Notes:

1. *For the purposes of 2-8., mixture refers to a composition of two or more substances with at least one substance being listed in the 2-8. sub-items.*
2. *Any substance listed in the 2-8. sub-items is subject to this list, even when utilised in an application other than that indicated. (e.g., TAGN is predominantly used as an explosive but can also be used either as a fuel or an oxidizer.)*

2-8.a. "Explosives" as follows, and mixtures thereof:

1. ADNBF (aminodinitrobenzofuroxan or 7-amino-4,6-dinitrobenzofurazane-1-oxide) (CAS 97096-78-1);
2. BNCP (cis-bis (5-nitrotetrazolato) tetra amine-cobalt (III) perchlorate) (CAS 117412-28-9);
3. CL-14 (diamino dinitrobenzofuroxan or 5,7-diamino-4,6-dinitrobenzofurazane-1-oxide) (CAS 117907-74-1);
4. CL-20 (HNIW or Hexanitrohexaazaisowurtzitane) (CAS 135285-90-4); chlathrates of CL-20 (see also 2-8.g.3. and 2-8.g.4. for its "precursors");
5. CP (2-(5-cyanotetrazolato) penta amine-cobalt (III) perchlorate) (CAS 70247-32-4);
6. DADE (1,1-diamino-2,2-dinitroethylene, FOX7) (CAS 145250-81-3);
7. DATB (diaminotrinitrobenzene) (CAS 1630-08-6);
8. DDFP (1,4-dinitrodifurazanopiperazine);
9. DDPO (2,6-diamino-3,5-dinitropyrazine-1-oxide, PZO) (CAS 194486-77-6);
10. DIPAM (3,3′-diamino-2,2′,4,4′,6,6′-hexanitrobiphenyl or dipicramide) (CAS 17215-44-0);
11. DNGU (DINGU or dinitroglycoluril) (CAS 55510-04-8);
12. Furazans as follows:
    a. DAAOF (diaminoazoxyfurazan);
    b. DAAzF (diaminoazofurazan) (CAS 78644-90-3);
13. HMX and derivatives (see also 2-8.g.5. for its "precursors"), as follows:
    a. HMX (Cyclotetramethylenetetranitramine, octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazine, 1,3,5,7-tetranitro-1,3,5,7-tetraza-cyclooctane, octogen or octogene) (CAS 2691-41-0);
    b. Difluoroaminated analogs of HMX;
    c. K-55 (2,4,6,8-tetranitro-2,4,6,8-tetraazabicyclo [3,3,0]-octanone-3, tetranitrosemiglycouril or keto-bicyclic HMX) (CAS 130256-72-3);
14. HNAD (hexanitroadamantane) (CAS 143850-71-9);
15. HNS (hexanitrostilbene) (CAS 20062-22-0);
16. Imidazoles as follows:
    a. BNNII (Octahydro-2,5-bis(nitroimino)imidazo [4,5-d]imidazole);
    b. DNI (2,4-dinitroimidazole) (CAS 5213-49-0);
    c. FDIA (1-fluoro-2,4-dinitroimidazole);
    d. NTDNIA (N-(2-nitrotriazolo)-2,4-dinitroimidazole);

e. PTIA (1-picryl-2,4,5-trinitroimidazole);

17. NTNMH (1-(2-nitrotriazolo)-2-dinitromethylene hydrazine);
18. NTO (ONTA or 3-nitro-1,2,4-triazol-5-one) (CAS 932-64-9);
19. Polynitrocubanes with more than four nitro groups;
20. PYX (2,6-Bis(picrylamino)-3,5-dinitropyridine) (CAS 38082-89-2);
21. RDX and derivatives, as follows:
    a. RDX (cyclotrimethylenetrinitramine, cyclonite, T4, hexahydro-1,3,5-trinitro-1,3,5-triazine, 1,3,5-trinitro-1,3,5-triaza-cyclohexane, hexogen or hexogene) (CAS 121-82-4);
    b. Keto-RDX (K-6 or 2,4,6-trinitro-2,4,6-triazacyclohexanone) (CAS 115029-35-1);
22. TAGN (triaminoguanidinenitrate) (CAS 4000-16-2);
23. TATB (triaminotrinitrobenzene) (CAS 3058-38-6) (see also 2-8.g.7 for its "precursors");
24. TEDDZ (3,3,7,7-tetrabis(difluoroamine) octahydro-1,5-dinitro-1,5-diazocine);
25. Tetrazoles as follows:
    a. NTAT (nitrotriazol aminotetrazole);
    b. NTNT (1-N-(2-nitrotriazolo)-4-nitrotetrazole);
26. Tetryl (trinitrophenylmethylnitramine) (CAS 479-45-8);
27. TNAD (1,4,5,8-tetranitro-1,4,5,8-tetraazadecalin) (CAS 135877-16-6) (see also 2-8.g.6. for its "precursors");
28. TNAZ (1,3,3-trinitroazetidine) (CAS 97645-24-4) (see also 2-8.g.2. for its "precursors");
29. TNGU (SORGUYL or tetranitroglycoluril) (CAS 55510-03-7);
30. TNP (1,4,5,8-tetranitro-pyridazino[4,5-d]pyridazine) (CAS 229176-04-9);
31. Triazines as follows:
    a. DNAM (2-oxy-4,6-dinitroamino-s-triazine) (CAS 19899-80-0);
    b. NNHT (2-nitroimino-5-nitro-hexahydro-1,3,5-triazine) (CAS 130400-13-4);
32. Triazoles as follows:
    a. 5-azido-2-nitrotriazole;
    b. ADHTDN (4-amino-3,5-dihydrazino-1,2,4-triazole dinitramide) (CAS-1614-08-0);
    c. ADNT (1-amino-3,5-dinitro-1,2,4-triazole);
    d. BDNTA ([bis-dinitrotriazole]amine);
    e. DBT (3,3′-dinitro-5,5-bi-1,2,4-triazole) (CAS 30003-46-4);
    f. DNBT (dinitrobistriazole) (CAS 70890-46-9);
    g. Not used since 2010
    h. NTDNT (1-N-(2-nitrotriazolo) 3,5-dinitrotriazole);
    i. PDNT (1-picryl-3,5-dinitrotriazole);
    j. TACOT (tetranitrobenzotriazolobenzotriazole) (CAS 25243-36-1);
33. Explosives not listed elsewhere in 2-8.a. and having any of the following:

a. Detonation velocity exceeding 8,700 m/s, at maximum density, **or**

b. Detonation pressure exceeding 34 GPa (340 kbar);

34. Organic explosives not listed elsewhere in 2-8.a. and having all of the following:

a. Yielding detonation pressures of 25 GPa (250 kbar) or more; **and**

b. Remaining stable at temperatures of 523 K (250° C) or higher, for periods of 5 minutes or longer;

2-8.b. "Propellants" as follows:

1. Any United Nations (UN) Class 1.1 solid "propellant" with a theoretical specific impulse (under standard conditions) of more than 250 seconds for non-metallized, or more than 270 seconds for aluminized compositions;

2. Any UN Class 1.3 solid "propellant" with a theoretical specific impulse (under standard conditions) of more than 230 seconds for non-halogenized, 250 seconds for non-metallized compositions and 266 seconds for metallized compositions;

3. "Propellants" having a force constant of more than 1,200 kJ/kg;

4. "Propellants" that can sustain a steady-state linear burning rate of more than 38 mm/s under standard conditions (as measured in the form of an inhibited single strand) of 6.89 MPa (68.9 bar) pressure and 294 K (21° C);

5. Elastomer Modified Cast Double Base (EMCDB) "propellants" with extensibility at maximum stress of more than 5% at 233 K (-40° C);

6. Any "propellant" containing substances specified by 2-8.a.;

7. "Propellants", not specified elsewhere in the Munitions List, specially designed for military use;

2-8.c. "Pyrotechnics", fuels and related substances, as follows, and mixtures thereof:

1. Aircraft fuels specially formulated for military purposes;

2. Alane (aluminum hydride) (CAS 7784-21-6);

3. Carboranes; decaborane (CAS 17702-41-9); pentaboranes (CAS 19624-22-7 and 18433-84-6) and their derivatives;

4. Hydrazine and derivatives, as follows (see also 2-8.d.8. and 2-8.d.9. for oxidising hydrazine derivatives):

a. Hydrazine (CAS 302-01-2) in concentrations of 70% or more;

b. Monomethyl hydrazine (CAS 60-34-4);

c. Symmetrical dimethyl hydrazine (CAS 540-73-8);

d. Unsymmetrical dimethyl hydrazine (CAS 57-14-7);

5. Metal fuels in particle form whether spherical, atomized, spheroidal, flaked or ground, manufactured from material consisting of 99% or more of any of the following:

a. Metals as follows and mixtures thereof:

1. Beryllium (CAS 7440-41-7) in particle sizes of less than 60 µm;

2. Iron powder (CAS 7439-89-6) with particle size of 3 µm or less produced by reduction of iron oxide with hydrogen;

b. Mixtures containing any of the following:

1. Zirconium (CAS 7440-67-7), magnesium (CAS 7439-95-4) or alloys of these in particle sizes of less than 60 μm; **or**
2. Boron (CAS 7440-42-8) or boron carbide (CAS 12069-32-8) fuels of 85% purity or higher and particle sizes of less than 60 μm;

6. Military materials, containing thickeners for hydrocarbon fuels, specially formulated for use in flame throwers or incendiary munitions, such as metal stearates or palmates (e.g. octal (CAS 637-12-7)) and M1, M2, and M3 thickeners;
7. Perchlorates, chlorates and chromates, composited with powdered metal or other high energy fuel components;
8. Spherical aluminium powder (CAS 7429-90-5) with a particle size of 60 μm or less, manufactured from material with an aluminium content of 99% or more;
9. Titanium subhydride (TiH_n) of stoichiometry equivalent to n = 0.65-1.68;

Note 1:

Aircraft fuels specified by 2-8.c.1. are finished products, not their constituents.

Note 2:

2-8.c.4.a. does not apply to hydrazine 'mixtures' specially formulated for corrosion control.

Note 3:

2-8.c.5. applies to explosives and fuels, whether or not the metals or alloys are encapsulated in aluminium, magnesium, zirconium, or beryllium.

Note 4:

2-8.c.5.b.2. does not apply to boron and boron carbide enriched with boron-10 (20% or more of total boron-10 content.)

Note 5:

2-8.c.5.b. only applies to metal fuels in particle form when they are mixed with other substances to form a mixture formulated for military purposes such as liquid propellant slurries, solid propellants, or pyrotechnic mixtures.

2-8.d. Oxidizers as follows, and mixtures thereof:

1. ADN (ammonium dinitramide or SR 12) (CAS 140456-78-6);
2. AP (ammonium perchlorate) (CAS 7790-98-9);
3. Compounds composed of fluorine and any of the following:
   a. Other halogens;
   b. Oxygen; **or**
   c. Nitrogen;

   Note 1:

   2-8.d.3. does not apply to chlorine trifluoride (CAS 7790-91-2).

   Note 2:

   2-8.d.3. does not apply to nitrogen trifluoride (CAS 7783-54-2) in its gaseous state.
4. DNAD (1,3-dinitro-1,3-diazetidine) (CAS 78246-06-7);
5. HAN (hydroxylammonium nitrate) (CAS 13465-08-2);
6. HAP (hydroxylammonium perchlorate) (CAS 15588-62-2);

7. HNF (hydrazinium nitroformate) (CAS 20773-28-8);
8. Hydrazine nitrate (CAS 37836-27-4);
9. Hydrazine perchlorate (CAS 27978-54-7);
10. Liquid oxidisers comprised of or containing inhibited red fuming nitric acid (IRFNA) (CAS 8007-58-7);

Note:

2-8.d.10. does not apply to non-inhibited fuming nitric acid.

2-8.e. Binders, plasticizers, monomers and polymers, as follows:

1. AMMO (azidomethylmethyloxetane and its polymers) (CAS 90683-29-7) (see also 2-8.g.1. for its "precursors");
2. BAMO (bisazidomethyloxetane and its polymers) (CAS 17607-20-4) (see also 2-8.g.1. for its "precursors");
3. BDNPA (bis (2,2-dinitropropyl)acetal) (CAS 5108-69-0);
4. BDNPF (bis (2,2-dinitropropyl)formal) (CAS 5917-61-3);
5. BTTN (butanetrioltrinitrate) (CAS 6659-60-5) (see also 2-8.g.8. for its "precursors");
6. Energetic monomers, plasticizers or polymers, specially formulated for military use and containing any of the following:
   a. Nitro groups;
   b. Azido groups;
   c. Nitrate groups;
   d. Nitraza groups; **or**
   e. Difluoroamino groups;
7. FAMAO (3-difluoroaminomethyl-3-azidomethyl oxetane) and its polymers;
8. FEFO (bis-(2-fluoro-2,2-dinitroethyl) formal) (CAS 17003-79-1);
9. FPF-1 (poly-2,2,3,3,4,4-hexafluoropentane-1,5-diol formal) (CAS 376-90-9);
10. FPF-3 (poly-2,4,4,5,5,6,6-heptafluoro-2-tri-fluoromethyl-3-oxaheptane-1, 7-diol formal);
11. GAP (glycidylazide polymer) (CAS 143178-24-9) and its derivatives;
12. HTPB (hydroxyl terminated polybutadiene) with a hydroxyl functionality equal to or greater than 2.2 and less than or equal to 2.4, a hydroxyl value of less than 0.77 meq/g, and a viscosity at 30° C of less than 47 poise (CAS 69102-90-5);
13. Alcohol functionalised poly(epichlorohydrin) with a molecular weight less than 10,000, as follows:
    a. Poly(epichlorohydrindiol);
    b. Poly(epichlorohydrintriol).
14. NENAs (nitratoethylnitramine compounds) (CAS 17096-47-8, 85068-73-1, 82486-83-7, 82486-82-6 and 85954-06-9);
15. PGN (poly-GLYN, polyglycidylnitrate or poly(nitratomethyl oxirane) (CAS 27814-48-8);
16. Poly-NIMMO (poly nitratomethylmethyloxetane) or poly-NMMO (poly[3-Nitratomethyl-3-methyloxetane]) (CAS 84051-81-0);

17. Polynitroorthocarbonates;
18. TVOPA (1,2,3-tris[1,2-bis(difluoroamino)ethoxy] propane or tris vinoxy propane adduct) (CAS 53159-39-0);

2-8.f. "Additives" as follows:

1. Basic copper salicylate (CAS 62320-94-9);
2. BHEGA (bis-(2-hydroxyethyl) glycolamide) (CAS 17409-41-5);
3. BNO (butadienenitrileoxide) (CAS 9003-18-3);
4. Ferrocene derivatives as follows:
   a. Butacene (CAS 125856-62-4);
   b. Catocene (2,2-bis-ethylferrocenyl propane) (CAS 37206-42-1);
   c. Ferrocene carboxylic acids including:

      Ferrocene carboxylic acid CAS (1271-42-7),
      1,1'-Ferrocenedicarboxylic acid (CAS 1293-87-4);
   d. n-butyl-ferrocene (CAS 31904-29-7);
   e. Other adducted polymer ferrocene derivatives;
5. Lead beta-resorcylate (CAS 20936-32-7);
6. Lead citrate (CAS 14450-60-3);
7. Lead-copper chelates of beta-resorcylate or salicylates (CAS 68411-07-4);
8. Lead maleate (CAS 19136-34-6);
9. Lead salicylate (CAS 15748-73-9);
10. Lead stannate (CAS 12036-31-6);
11. MAPO (tris-1-(2-methyl)aziridinyl phosphine oxide) (CAS 57-39-6); BOBBA 8 (bis(2-methyl aziridinyl) 2-(2-hydroxypropanoxy) propylamino phosphine oxide); and other MAPO derivatives;
12. Methyl BAPO (bis(2-methyl aziridinyl) methylamino phosphine oxide) (CAS 85068-72-0);
13. N-methyl-p-nitroaniline (CAS 100-15-2);
14. 3-Nitraza-1,5-pentane diisocyanate (CAS 7406-61-9);
15. Organo-metallic coupling agents as follows:
   a. Neopentyl[diallyl]oxy, tri[dioctyl]phosphato-titanate (CAS 103850-22-2); also known as titanium IV, 2,2[bis 2-propenolato-methyl, butanolato, tris (dioctyl) phosphato] (CAS 110438-25-0); or LICA 12 (CAS 103850-22-2);
   b. Titanium IV, [(2-propenolato-1) methyl, n-propanolatomethyl] butanolato-1, tris[dioctyl] pyrophosphate or KR3538;
   c. Titanium IV, [(2-propenolato-1)methyl, n-propanolatomethyl] butanolato-1, tris(dioctyl)phosphate;
16. Polycyanodifluoroaminoethyleneoxide;
17. Polyfunctional aziridine amides with isophthalic, trimesic (BITA or butylene imine trimesamide), isocyanuric or trimethyladipic backbone structures and 2-methyl or 2-ethyl substitutions on the aziridine ring;
18. Propyleneimine (2-methylaziridine) (CAS 75-55-8);
19. Superfine iron oxide (Fe_2O_3) (CAS 1317-60-8) with a specific surface area more than 250 m^2/g and an average particle size of 3.0 nm or less;

20. TEPAN (tetraethylenepentaamineacrylonitrile) (CAS 68412-45-3); cyanoethylated polyamines and their salts;
21. TEPANOL (tetraethylenepentaamineacrylonitrileglycidol) (CAS 68412-46-4); cyanoethylated polyamines adducted with glycidol and their salts;
22. TPB (triphenyl bismuth) (CAS 603-33-8);

2-8.g. "Precursors" as follows:

N.B.:

In 2-8.g. the references are to specified "Energetic Materials" manufactured from these substances.

1. BCMO (bischloromethyloxetane) (CAS 142173-26-0) (see also 2-8.e.1. and 2-8.e.2.);
2. Dinitroazetidine-t-butyl salt (CAS 125735-38-8) (see also 2-8.a.28.);
3. HBIW (hexabenzylhexaazaisowurtzitane) (CAS 124782-15-6) (see also 2-8.a.4.);
4. TAIW (tetraacetyldibenzylhexaazaisowurtzitane) (see also 2-8.a.4.) (CAS 182763-60-6);
5. TAT (1,3,5,7 tetraacetyl-1,3,5,7,-tetraaza cyclo-octane) (CAS 41378-98-7) (see also 2-8.a.13.);
6. 1,4,5,8-tetraazadecalin (CAS 5409-42-7) (see also 2-8.a.27.);
7. 1,3,5-trichlorobenzene (CAS 108-70-3) (see also 2-8.a.23.);
8. 1,2,4-trihydroxybutane (1,2,4-butanetriol) (CAS 3068-00-6) (see also 2-8.e.5.).

Note 5:

Not used since 2009

Note 6:

2-8. does not apply to the following substances unless they are compounded or mixed with the "energetic material" specified by 2-8.a. or powdered metals specified by 2-8.c.:

a. Ammonium picrate (CAS 131-74-8);
b. Black powder;
c. Hexanitrodiphenylamine (CAS 131-73-7);
d. Difluoroamine (CAS 10405-27-3);
e. Nitrostarch (CAS 9056-38-6);
f. Potassium nitrate (CAS 7757-79-1);
g. Tetranitronaphthalene;
h. Trinitroanisol;
i. Trinitronaphthalene;
j. Trinitroxylene;
k. N-pyrrolidinone; 1-methyl-2-pyrrolidinone (CAS 872-50-4);
l. Dioctylmaleate (CAS 142-16-5);
m. Ethylhexylacrylate (CAS 103-11-7);
n. Triethylaluminium (TEA) (CAS 97-93-8), trimethylaluminium (TMA) (CAS 75-24-1), and other pyrophoric metal alkyls and aryls of lithium, sodium, magnesium, zinc or boron;
o. Nitrocellulose (CAS 9004-70-0);

p. Nitroglycerin (or glyceroltrinitrate, trinitroglycerine) (NG) (CAS 55-63-0);

q. 2,4,6-trinitrotoluene (TNT) (CAS 118-96-7);

r. Ethylenediaminedinitrate (EDDN) (CAS 20829-66-7);

s. Pentaerythritoltetranitrate (PETN) (CAS 78-11-5);

t. Lead azide (CAS 13424-46-9), normal lead styphnate (CAS 15245-44-0) and basic lead styphnate (CAS 12403-82-6), and primary explosives or priming compositions containing azides or azide complexes;

u. Triethyleneglycoldinitrate (TEGDN) (CAS 111-22-8);

v. 2,4,6-trinitroresorcinol (styphnic acid) (CAS 82-71-3);

w. Diethyldiphenylurea; (CAS 85-98-3); dimethyldiphenylurea;(CAS 611-92-7), methylethyldiphenylurea; [Centralites]

x. N,N-diphenylurea (unsymmetrical diphenylurea) (CAS 603-54-3);

y. Methyl-N,N-diphenylurea (methyl unsymmetrical diphenylurea) (CAS 13114-72-2);

z. Ethyl-N,N-diphenylurea (ethyl unsymmetrical diphenylurea) (CAS 64544-71-4);

aa. 2-Nitrodiphenylamine (2-NDPA) (CAS 119-75-5);

bb. 4-Nitrodiphenylamine (4-NDPA) (CAS 836-30-6);

cc. 2,2-dinitropropanol (CAS 918-52-5);

dd. Nitroguanidine (CAS 556-88-7) (see 1-1.C.11.d. on the Dual-Use List).

2-9. Vessels of war (surface or underwater), special naval equipment, accessories, components and other surface vessels, as follows:

N.B.:

For guidance and navigation equipment, see 2-11.

2-9.a. Vessels and components, as follows:

1. Vessels (surface or underwater) specially designed or modified for military use, regardless of current state of repair or operating condition, and whether or not they contain weapon delivery systems or armour, and hulls or parts of hulls for such vessels, and components therefor specially designed for military use;
2. Surface vessels, other than those specified in 2-9.a.1., having any of the following, fixed or integrated into the vessel:
   a. Automatic weapons having a calibre of 12.7 mm or greater specified in 2-1., or weapons specified in 2-2., 2-4., 2-12. or 2-19., or 'mountings' or hard points for such weapons;

      Technical Note:

      'Mountings' refers to weapon mounts or structural strengthening for the purpose of installing weapons.

   b. Fire control systems specified in 2-5.;
   c. Having all of the following:
      1. 'Chemical, Biological, Radiological and Nuclear (CBRN) protection'; **and**
      2. 'Pre-wet or wash down system' designed for decontamination purposes; **or**

Technical Notes:

1. 'CBRN protection' is a self contained interior space containing features such as over-pressurization, isolation of ventilation systems, limited ventilation openings with CBRN filters and limited personnel access points incorporating air-locks.

2. 'Pre-wet or wash down system' is a seawater spray system capable of simultaneously wetting the exterior superstructure and decks of a vessel.

d. Active weapon countermeasure systems specified in 2-4.b., 2-5.c. or 2-11.a. and having any of the following:

1. 'CBRN protection';
2. Hull and superstructure, specially designed to reduce the radar cross section;
3. Thermal signature reduction devices, (e.g., an exhaust gas cooling system), excluding those specially designed to increase overall power plant efficiency or to reduce the environmental impact; **or**
4. A degaussing system designed to reduce the magnetic signature of the whole vessel;

2-9.b. Engines and propulsion systems, as follows, specially designed for military use and components therefor specially designed for military use:

1. Diesel engines specially designed for submarines and having all of the following:
   a. Power output of 1.12 MW (1,500 hp) or more; **and**
   b. Rotary speed of 700 rpm or more;
2. Electric motors specially designed for submarines and having all of the following:
   a. Power output of more than 0.75 MW (1,000 hp);
   b. Quick reversing;
   c. Liquid cooled; **and**
   d. Totally enclosed;
3. Non-magnetic diesel engines having all of the following:
   a. Power output of 37.3 kW (50 hp) or more; **and**
   b. Non-magnetic content in excess of 75% of total mass;
4. 'Air Independent Propulsion' (AIP) systems specially designed for submarines;

Technical Note:

'Air Independent Propulsion' (AIP) allows a submerged submarine to operate its propulsion system, without access to atmospheric oxygen, for a longer time than the batteries would have otherwise allowed. For the purposes of 2-9.b.4., AIP does not include nuclear power.

2-9.c. Underwater detection devices, specially designed for military use, controls therefor and components therefor specially designed for military use;

2-9.d. Anti-submarine nets and anti-torpedo nets, specially designed for military use;

2-9.e. Not used since 2003

2-9.f. Hull penetrators and connectors, specially designed for military use, that enable interaction with equipment external to a vessel, and components therefor specially designed for military use;

Note:

2-9.f. includes connectors for vessels which are of the single-conductor, multi-conductor, coaxial or waveguide type, and hull penetrators for vessels, both of which are capable of remaining impervious to leakage from without and of retaining required characteristics at marine depths exceeding 100 m; and fibre-optic connectors and optical hull penetrators, specially designed for "laser" beam transmission, regardless of depth. 2-9.f. does not apply to ordinary propulsive shaft and hydrodynamic control-rod hull penetrators.

2-9.g. Silent bearings having any of the following, components therefor and equipment containing those bearings, specially designed for military use:

1. Gas or magnetic suspension;
2. Active signature controls; **or**
3. Vibration suppression controls.

2-10. "Aircraft", "lighter-than-air vehicles", unmanned airborne vehicles, aero-engines and "aircraft" equipment, related equipment and components, specially designed or modified for military use, as follows:

N.B.:

For guidance and navigation equipment, see 2-11.

a. Combat "aircraft" and specially designed components therefor;

b. Other "aircraft" and "lighter-than-air vehicles", specially designed or modified for military use, including military reconnaissance, assault, military training, transporting and airdropping troops or military equipment, logistics support, and specially designed components therefor;

c. Unmanned airborne vehicles and related equipment, specially designed or modified for military use, as follows, and specially designed components therefor:

1. Unmanned airborne vehicles including remotely piloted air vehicles (RPVs), autonomous programmable vehicles and "lighter-than-air vehicles";
2. Associated launchers and ground support equipment;
3. Related equipment for command and control;

d. Aero-engines specially designed or modified for military use, and specially designed components therefor;

e. Airborne equipment, including airborne refuelling equipment, specially designed for use with the "aircraft" specified by 2-10.a. or 2-10.b. or the aero-engines specified by 2-10.d., and specially designed components therefor;

f. Pressure refuellers, pressure refuelling equipment, equipment specially designed to facilitate operations in confined areas and ground equipment, developed specially for "aircraft" specified by 2-10.a. or 2-10.b., or for aero-engines specified by 2-10.d.;

g. Military crash helmets and protective masks, and specially designed components therefor, pressurised breathing equipment and partial pressure suits for use in "aircraft", anti-g suits, liquid oxygen converters used for "aircraft" or

missiles, and catapults and cartridge actuated devices, for emergency escape of personnel from "aircraft";

h. Parachutes, paragliders and related equipment, as follows, and specially designed components therefor:

1. Parachutes not specified elsewhere in the Munitions List;
2. Paragliders;
3. Equipment specially designed for high altitude parachutists (e.g., suits, special helmets, breathing systems, navigation equipment);

i. Automatic piloting systems for parachuted loads; equipment specially designed or modified for military use for controlled opening jumps at any height, including oxygen equipment.

Note 1:

2-10.b. does not apply to "aircraft" or variants of those "aircraft" specially designed for military use and which are all of the following:

a. Not configured for military use and not fitted with equipment or attachments specially designed or modified for military use; ***and***

b. Certified for civil use by the civil aviation authority in a participating state.

Note 2:

2-10.d. does not apply to:

a. Aero-engines designed or modified for military use which have been certified by civil aviation authorities in a participating state for use in "civil aircraft", or specially designed components therefor;

b. Reciprocating engines or specially designed components therefor, except those specially designed for unmanned airborne vehicles.

Note 3:

2-10.b. and 2-10.d. on specially designed components and related equipment for non-military "aircraft" or aero-engines modified for military use applies only to those military components and to military related equipment required for the modification to military use.

2-11. Electronic equipment, not specified elsewhere on the Munitions List, as follows, and specially designed components therefor:

a. Electronic equipment specially designed for military use;

Note:

2-11.a. includes:

a. Electronic countermeasure and electronic counter-countermeasure equipment (i.e., equipment designed to introduce extraneous or erroneous signals into radar or radio communication receivers or otherwise hinder the reception, operation or effectiveness of adversary electronic receivers including their countermeasure equipment), including jamming and counter-jamming equipment;

b. Frequency agile tubes;

c. Electronic systems or equipment, designed either for surveillance and monitoring of the electro-magnetic spectrum for military intelligence or security purposes or for counteracting such surveillance and monitoring;

d. Underwater countermeasures, including acoustic and magnetic jamming and decoy, equipment designed to introduce extraneous or erroneous signals into sonar receivers;

e. Data processing security equipment, data security equipment and transmission and signalling line security equipment, using ciphering processes;

f. Identification, authentification and keyloader equipment and key management, manufacturing and distribution equipment;

g. Guidance and navigation equipment;

h. Digital troposcatter-radio communications transmission equipment;

i. Digital demodulators specially designed for signals intelligence;

j. "Automated Command and Control Systems".

N.B.:

For "software" associated with military "Software" Defined Radio (SDR), see 2-21.

b. Global Navigation Satellite Systems (GNSS) jamming equipment.

2-12. High velocity kinetic energy weapon systems and related equipment, as follows, and specially designed components therefor:

a. Kinetic energy weapon systems specially designed for destruction or effecting mission-abort of a target;

b. Specially designed test and evaluation facilities and test models, including diagnostic instrumentation and targets, for dynamic testing of kinetic energy projectiles and systems.

N.B.:

For weapon systems using sub-calibre ammunition or employing solely chemical propulsion and ammunition therefor, see 2-1. to 2-4.

Note 1:

2-12. includes the following when specially designed for kinetic energy weapon systems:

a. Launch propulsion systems capable of accelerating masses larger than 0.1 g to velocities in excess of 1.6 km/s, in single or rapid fire modes;

b. Prime power generation, electric armour, energy storage, thermal management, conditioning, switching or fuel-handling equipment; and electrical interfaces between power supply, gun and other turret electric drive functions;

c. Target acquisition, tracking, fire control or damage assessment systems;

d. Homing seeker, guidance or divert propulsion (lateral acceleration) systems for projectiles.

Note 2:

2-12. applies to weapon systems using any of the following methods of propulsion:

a. Electromagnetic;

b. Electrothermal;

c. Plasma;

d. Light gas; ***or***

e. Chemical (when used in combination with any of the above).

2-13. Armoured or protective equipment, constructions and components, as follows:

a. Armoured plate, having any of the following:

1. Manufactured to comply with a military standard or specification; **or**
2. Suitable for military use;

b. Constructions of metallic or non-metallic materials, or combinations thereof, specially designed to provide ballistic protection for military systems, and specially designed components therefor;

c. Helmets manufactured according to military standards or specifications, or comparable national standards, and specially designed components therefor (i.e., helmet shell, liner and comfort pads);

d. Body armour and protective garments, manufactured according to military standards or specifications, or equivalent, and specially designed components therefor.

Note 1:

2-13.b. includes materials specially designed to form explosive reactive armour or to construct military shelters.

Note 2:

2-13.c. does not apply to conventional steel helmets, neither modified or designed to accept, nor equipped with any type of accessory device.

Note 3:

2-13.c. and 2-13.d. do not apply to helmets, body armour or protective garments, when accompanying their user for the user's own personal protection.

Note 4:

The only helmets specially designed for bomb disposal personnel that are specified by 2-13. are those specially designed for military use.

N.B. 1:

See also entry1-1.A.5. on the Dual-Use List.

N.B. 2:

For "fibrous or filamentary materials" used in the manufacture of body armour and helmets, see entry 1-1.C.10. on the Dual-Use List.

2-14. 'Specialised equipment for military training' or for simulating military scenarios, simulators specially designed for training in the use of any firearm or weapon specified by 2-1. or 2-2., and specially designed components and accessories therefor.

Technical Note:

The term 'specialised equipment for military training' includes military types of attack trainers, operational flight trainers, radar target trainers, radar target generators, gunnery training devices, anti-submarine warfare trainers, flight simulators (including human-rated centrifuges for pilot/astronaut training), radar trainers, instrument flight trainers, navigation trainers, missile launch trainers, target equipment, drone "aircraft", armament trainers, pilotless "aircraft" trainers, mobile training units and training equipment for ground military operations.

Note 1:

2-14. includes image generating and interactive environment systems for simulators, when specially designed or modified for military use.

Note 2:

2-14. does not apply to equipment specially designed for training in the use of hunting or sporting weapons.

2-15. Imaging or countermeasure equipment, as follows, specially designed for military use, and specially designed components and accessories therefor:

a. Recorders and image processing equipment;

b. Cameras, photographic equipment and film processing equipment;

c. Image intensifier equipment;

d. Infrared or thermal imaging equipment;

e. Imaging radar sensor equipment;

f. Countermeasure or counter-countermeasure equipment, for the equipment specified by 2-15.a. to 2-15.e.

Note:

2-15.f. includes equipment designed to degrade the operation or effectiveness of military imaging systems or to minimize such degrading effects.

Note 1:

In 2-15., the term specially designed components includes the following, when specially designed for military use:

a. Infrared image converter tubes;

b. Image intensifier tubes (other than first generation);

c. Microchannel plates;

d. Low-light-level television camera tubes;

e. Detector arrays (including electronic interconnection or read out systems);

f. Pyroelectric television camera tubes;

g. Cooling systems for imaging systems;

h. Electrically triggered shutters of the photochromic or electro-optical type having a shutter speed of less than 100 µs, except in the case of shutters which are an essential part of a high speed camera;

i. Fibre optic image inverters;

j. Compound semiconductor photocathodes.

Note 2:

2-15. does not apply to "first generation image intensifier tubes" or equipment specially designed to incorporate "first generation image intensifier tubes".

N.B.:

For the classification of weapons sights incorporating "first generation image intensifier tubes" see 2-1., 2-2. and 2-5.a.

N.B.:

See also 1-6.A.2.a.2. and 1-6.A.2.b. on the Dual-Use List.

2-16. Forgings, castings and other unfinished products, specially designed for items specified by 2-1.to 2-4., 2-6., 2-9., 2-10., 2-12. or 2-19.

Note:

2-16. applies to unfinished products when they are identifiable by material composition, geometry or function.

2-17. Miscellaneous equipment, materials and 'libraries', as follows, and specially designed components therefor:

a. Self-contained diving and underwater swimming apparatus, as follows:

1. Closed or semi-closed circuit (rebreathing) apparatus, specially designed for military use (i.e., specially designed to be non magnetic);
2. Specially designed components for use in the conversion of open-circuit apparatus to military use;
3. Articles designed exclusively for military use with self-contained diving and underwater swimming apparatus;

b. Construction equipment specially designed for military use;

c. Fittings, coatings and treatments, for signature suppression, specially designed for military use;

d. Field engineer equipment specially designed for use in a combat zone;

e. "Robots", "robot" controllers and "robot" "end-effectors", having any of the following characteristics:

1. Specially designed for military use;
2. Incorporating means of protecting hydraulic lines against externally induced punctures caused by ballistic fragments (e.g., incorporating self-sealing lines) and designed to use hydraulic fluids with flash points higher than 839 K (566° C); **or**
3. Specially designed or rated for operating in an electro-magnetic pulse (EMP) environment;

Technical Note:

Electro-magnetic pulse does not refer to unintentional interference caused by electromagnetic radiation from nearby equipment (e.g., machinery, appliances or electronics) or lightning.

f. 'Libraries' (parametric technical databases) specially designed for military use with equipment specified by the Munitions List;

g. Nuclear power generating equipment or propulsion equipment, including "nuclear reactors", specially designed for military use and components therefor specially designed or 'modified' for military use;

h. Equipment and material, coated or treated for signature suppression, specially designed for military use, other than those specified elsewhere in the Munitions List;

i. Simulators specially designed for military "nuclear reactors";

j. Mobile repair shops specially designed or 'modified' to service military equipment;

k. Field generators specially designed or 'modified' for military use;

l. Containers specially designed or 'modified' for military use;

m. Ferries, other than those specified elsewhere in the Munitions List, bridges and pontoons, specially designed for military use;

n. Test models specially designed for the "development" of items specified by 2-4., 2-6., 2-9. or 2-10.;

o. Laser protection equipment (e.g., eye and sensor protection) specially designed for military use;

p. "Fuel cells", other than those specified elsewhere in the Munitions List, specially designed or 'modified' for military use.

Technical Notes:

1. For the purpose of 2-17., the term 'library' (parametric technical database) means a collection of technical information of a military nature, reference to which may enhance the performance of military equipment or systems.

2. For the purpose of 2-17., 'modified' means any structural, electrical, mechanical, or other change that provides a non-military item with military capabilities equivalent to an item which is specially designed for military use.

2-18. Production equipment and components, as follows:

a. Specially designed or modified 'production' equipment for the 'production' of products specified by the Munitions List, and specially designed components therefor;

b. Specially designed environmental test facilities and specially designed equipment therefor, for the certification, qualification or testing of products specified by the Munitions List.

Technical Note:

For the purposes of 2-18., the term 'production' includes design, examination, manufacture, testing and checking.

Note:

2-18.a. and 2-18.b. include the following equipment:

a. Continuous nitrators;

b. Centrifugal testing apparatus or equipment, having any of the following:

1. Driven by a motor or motors having a total rated horsepower of more than 298 kW (400 hp);

2. Capable of carrying a payload of 113 kg or more; ***or***

3. Capable of exerting a centrifugal acceleration of 8 g or more on a payload of 91 kg or more;

c. Dehydration presses;

d. Screw extruders specially designed or modified for military explosive extrusion;

e. Cutting machines for the sizing of extruded propellants;

f. Sweetie barrels (tumblers) 1.85 m or more in diameter and having over 22 kg product capacity;

g. Continuous mixers for solid propellants;

h. Fluid energy mills for grinding or milling the ingredients of military explosives;

i. Equipment to achieve both sphericity and uniform particle size in metal powder listed in 2-8.c.8.;

j. Convection current converters for the conversion of materials listed in 2-8.c.3.

2-19. Directed Energy Weapon (DEW) systems, related or countermeasure equipment and test models, as follows, and specially designed components therefor:

a. "Laser" systems specially designed for destruction or effecting mission-abort of a target;

b. Particle beam systems capable of destruction or effecting mission-abort of a target;

c. High power Radio-Frequency (RF) systems capable of destruction or effecting mission-abort of a target;

d. Equipment specially designed for the detection or identification of, or defence against, systems specified by 2-19.a. to 2-19.c.;

e. Physical test models for the systems, equipment and components, specified by 2-19.;

f. "Laser" systems specially designed to cause permanent blindness to unenhanced vision, i.e., to the naked eye or to the eye with corrective eyesight devices.

Note 1:

DEW systems specified by 2-19. include systems whose capability is derived from the controlled application of:

a. "Lasers" of sufficient power to effect destruction similar to the manner of conventional ammunition;

b. Particle accelerators which project a charged or neutral particle beam with destructive power;

c. High pulsed power or high average power radio frequency beam transmitters, which produce fields sufficiently intense to disable electronic circuitry at a distant target.

Note 2:

2-19. includes the following when specially designed for DEW systems:

a. Prime power generation, energy storage, switching, power conditioning or fuel-handling equipment;

b. Target acquisition or tracking systems;

c. Systems capable of assessing target damage, destruction or mission-abort;

d. Beam-handling, propagation or pointing equipment;

e. Equipment with rapid beam slew capability for rapid multiple target operations;

f. Adaptive optics and phase conjugators;

g. Current injectors for negative hydrogen ion beams;

h. "Space-qualified" accelerator components;

i. Negative ion beam funnelling equipment;

j. Equipment for controlling and slewing a high energy ion beam;

k. "Space qualified" foils for neutralising negative hydrogen isotope beams.

2-20. Cryogenic and "superconductive" equipment, as follows, and specially designed components and accessories therefor:

a. Equipment specially designed or configured to be installed in a vehicle for military ground, marine, airborne or space applications, capable of operating while in motion and of producing or maintaining temperatures below 103 K (-170° C);

Note:

2-20.a. includes mobile systems incorporating or employing accessories or components manufactured from non-metallic or non-electrical conductive materials, such as plastics or epoxy-impregnated materials.

b. "Superconductive" electrical equipment (rotating machinery and transformers) specially designed or configured to be installed in a vehicle for military ground, marine, airborne or space applications and capable of operating while in motion.

Note:

2-20.b. does not apply to direct-current hybrid homopolar generators that have single-pole normal metal armatures which rotate in a magnetic field produced by

superconducting windings, provided those windings are the only superconducting components in the generator.

2-21. "Software" as follows:

a. "Software" specially designed or modified for the "development", "production" or "use" of equipment, materials or "software", specified by the Munitions List;

b. Specific "software", other than that specified by 2-21.a., as follows:

1. "Software" specially designed for military use and specially designed for modelling, simulating or evaluating military weapon systems;

2. "Software" specially designed for military use and specially designed for modelling or simulating military operational scenarios;

3. "Software" for determining the effects of conventional, nuclear, chemical or biological weapons;

4. "Software" specially designed for military use and specially designed for Command, Communications, Control and Intelligence (C^3I) or Command, Communications, Control, Computer and Intelligence (C^4I) applications;

c. "Software", not specified by 2-21.a., or 2-21.b., specially designed or modified to enable equipment not specified by the Munitions List to perform the military functions of equipment specified by the Munitions List.

2-22. "Technology" as follows:

a. "Technology", other than specified in 2-22.b., which is "required" for the "development", "production" or "use" of items specified by the Munitions List;

b. "Technology" as follows:

1. "Technology" "required" for the design of, the assembly of components into, and the operation, maintenance and repair of, complete production installations for items specified by the Munitions List, even if the components of such production installations are not specified;

2. "Technology" "required" for the "development" and "production" of small arms, even if used to produce reproductions of antique small arms;

3. "Technology" "required" for the "development", "production" or "use" of toxicological agents, related equipment or components, specified by 2-7.a. to 2-7.g.;

4. "Technology" "required" for the "development", "production" or "use" of "biopolymers" or cultures of specific cells, specified by 2-7.h.;

5. "Technology" "required" exclusively for the incorporation of "biocatalysts", specified by 2-7.i.1., into military carrier substances or military material.

Note 1:

"Technology" "required" for the "development", "production" or "use" of items specified by the Munitions List remains under control even when applicable to any item not specified by the Munitions List.

Note 2:

2-22. does not apply to:

a. "Technology" that 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;

b. "Technology" that is "in the public domain", "basic scientific research" or the minimum necessary information for patent applications;

c. "Technology" for magnetic induction for continuous propulsion of civil transport devices.

DEFINITIONS OF TERMS USED IN GROUPS 1 AND 2

This document contains the definitions of the terms used in Groups 1 and 2, in alphabetical order.

Note 1: *Definitions apply throughout Groups 1 and 2. The references are purely advisory and have no effect on the universal application of defined terms throughout Groups 1 and 2.*

Note 2: *Words and terms contained in the List of Definitions only take the defined meaning where this is indicated by their being enclosed in quotations marks (" "). Elsewhere, words and terms take their commonly accepted (dictionary) meanings, unless a local definition for a particular control is given.*

"Accuracy" - Cat 2, cat 6

(Usually measured in terms of inaccuracy) is the maximum deviation, positive or negative, of an indicated value from an accepted standard or true value.

"Active flight control systems" - Cat 7

Function to prevent undesirable "aircraft" and missile motions or structural loads by autonomously processing outputs from multiple sensors and then providing necessary preventive commands to effect automatic control.

"Active pixel" - Cat 6, cat 8

A minimum (single) element of the solid state array which has a photoelectric transfer function when exposed to light (electromagnetic) radiation.

"Adapted for use in war" - Cat 1, 2-7

Any modification or selection (such as altering purity, shelf life, virulence, dissemination characteristics, or resistance to UV radiation) designed to increase the effectiveness in producing casualties in humans or animals, degrading equipment or damaging crops or the environment.

"Additives" - 2-8

Substances used in explosive formulations to improve their properties.

"Aircraft" - Cat 1, cat 7, cat 9, 2-8, 2-10, 2-14

A fixed wing, swivel wing, rotary wing (helicopter), tilt rotor or tilt-wing airborne vehicle.

"All compensations available" - Cat 2

"All compensations available" means after all feasible measures available to the manufacturer to minimise all systematic positioning errors for the particular machine-tool model or measuring errors for the particular coordinate measuring machine are considered.

"Allocated by the ITU" - Cat 3, cat 5P1

The allocation of frequency bands according to the current edition of the ITU Radio Regulations for primary, permitted and secondary services.

N.B.: *Additional and alternative allocations are not included.*

"Angle random walk" - Cat 7

The angular error build up with time that is due to white noise in angular rate. (IEEE STD 528-2001)

"Angular position deviation" - Cat 2

The maximum difference between angular position and the actual, very accurately measured angular position after the workpiece mount of the table has been turned out of its initial position. (Reference: VDI/VDE 2617, Draft: 'Rotary tables on coordinate measuring machines').

"Asymmetric algorithm" - Cat 5P2

A cryptographic algorithm using different, mathematically-related keys for encryption and decryption.

Technical Note:

A common use of "asymmetric algorithms" is key management.

"Automated Command and Control Systems" - 2-11

Electronic systems, through which information essential to the effective operation of the grouping, major formation, tactical formation, unit, ship, subunit or weapons under command is entered, processed and transmitted. This is achieved by the use of computer and other specialised hardware designed to support the functions of a military command and control organisation. The main functions of an automated command and control system are: the efficient automated collection, accumulation, storage and processing of information; the display of the situation and the circumstances affecting the preparation and conduct of combat operations; operational and tactical calculations for the allocation of resources among force groupings or elements of the operational order of battle or battle deployment according to the mission or stage of the operation; the preparation of data for appreciation of the situation and decision-making at any point during operation or battle; computer simulation of operations.

"Automatic target tracking" - Cat 6

A processing technique that automatically determines and provides as output an extrapolated value of the most probable position of the target in real time.

"Average output power" - Cat 6

The total "laser" output energy in joules divided by the "laser duration" in seconds.

"Basic gate propagation delay time" - Cat 3

The propagation delay time value corresponding to the basic gate used in a "monolithic integrated circuit". For a 'family' of "monolithic integrated circuits", this may be specified either as the propagation delay time per typical gate within the given 'family' or as the typical propagation delay time per gate within the given 'family'.

Technical Notes:

1. *"Basic gate propagation delay time" is not to be confused with the input/output delay time of a complex "monolithic integrated circuit".*
2. *'Family' consists of all integrated circuits to which all of the following are applied as their manufacturing methodology and specifications except their respective functions:*
    a. *The common hardware and software architecture;*
    b. *The common design and process technology;* ***and***
    c. *The common basic characteristics.*

"Basic scientific research" - General Technology Note, 2-22

Experimental or theoretical work undertaken principally to acquire new knowledge of the fundamental principles of phenomena or observable facts, not primarily directed towards a specific practical aim or objective.

"Bias" (accelerometer) - Cat 7

The average over a specified time of accelerometer output, measured at specified operating conditions that has no correlation with input acceleration or rotation. "Bias" is expressed in g or in metres per second^2 (g or m/s^2). (IEEE Std 528-2001) (Micro g equals 1 x 10^{-6} g).

"Bias" (gyro) - Cat 7

The average over a specified time of gyro output measured at specified operating conditions that has no correlation with input rotation or acceleration. "Bias" is typically expressed in degrees per hour (deg/hr). (IEEE Std 528-2001).

"Biocatalysts" - 2-7, 2-22

Enzymes for specific chemical or biochemical reactions or other biological compounds which bind to and accelerate the degradation of CW agents.

Technical Note:

'Enzymes' means "biocatalysts" for specific chemical or biochemical reactions.

"Biopolymers" - 2-7, 2-22

Biological macromolecules as follows:

a. Enzymes for specific chemical or biochemical reactions;

b. Antibodies, monoclonal, polyclonal or anti-idiotypic;

c. Specially designed or specially processed receptors;

Technical Notes:

1. *'Anti-idiotypic antibodies' means antibodies which bind to the specific antigen binding sites of other antibodies;*
2. *'Monoclonal antibodies' means proteins which bind to one antigenic site and are produced by a single clone of cells;*
3. *'Polyclonal antibodies' means a mixture of proteins which bind to the specific antigen and are produced by more than one clone of cells;*
4. *'Receptors' means biological macromolecular structures capable of binding ligands, the binding of which affects physiological functions.*

"Camming" (axial displacement) - Cat 2

Axial displacement in one revolution of the main spindle measured in a plane perpendicular to the spindle faceplate, at a point next to the circumference of the spindle faceplate (Reference: ISO 230/1 1986, paragraph 5.63).

"Carbon fibre preforms" - Cat 1

An ordered arrangement of uncoated or coated fibres intended to constitute a framework of a part before the "matrix" is introduced to form a "composite".

"Chemical Laser" - Cat 6

A "laser" in which the excited species is produced by the output energy from a chemical reaction.

"Circuit element" - Definitions

A single active or passive functional part of an electronic circuit, such as one diode, one transistor, one resistor, one capacitor, etc.

"Circulation-controlled anti-torque or circulation-controlled direction control systems" - Cat 7

Control systems using air blown over aerodynamic surfaces to increase or control the forces generated by the surfaces.

"Civil aircraft" - Cat 1, cat 3, cat 7, 2-4, 2-10

Those "aircraft" listed by designation in published airworthiness certification lists by the civil aviation authorities to fly commercial civil internal and external routes or for legitimate civil, private or business use.

"Commingled" - Cat 1

Filament to filament blending of thermoplastic fibres and reinforcement fibres in order to produce a fibre reinforcement "matrix" mix in total fibre form.

"Comminution" - Cat 1

A process to reduce a material to particles by crushing or grinding.

"Common channel signalling" - Cat 5P1

A signalling method in which a single channel between exchanges conveys, by means of labelled messages, signalling information relating to a multiplicity of circuits or calls and other information such as that used for network management.

"Communications channel controller" - Cat 4

The physical interface which controls the flow of synchronous or asynchronous digital information. It is an assembly that can be integrated into computer or telecommunications equipment to provide communications access.

"Compensation systems" - Cat 6

Consist of the primary scalar sensor, one or more reference sensors (e.g. vector magnetometers) together with software that permit reduction of rigid body rotation noise of the platform.

"Composite" - Cat 1, cat 2, cat 6, cat 8 & 9

A "matrix" and an additional phase or additional phases consisting of particles, whiskers, fibres or any combination thereof, present for a specific purpose or purposes.

"Compound rotary table" - Cat 2

A table allowing the workpiece to rotate and tilt about two non-parallel axes, which can be coordinated simultaneously for "contouring control".

"III/V compounds" - Cat 3, cat 6

Polycrystalline or binary or complex monocrystalline products consisting of elements of groups IIIA and VA of Mendeleyev's periodic classification table (e.g., gallium arsenide, gallium-aluminium arsenide, indium phosphide).

"Contouring control" - Cat 2

Two or more "numerically controlled" motions operating in accordance with instructions that specify the next required position and the required feed rates to that position. These feed rates are varied in relation to each other so that a desired contour is generated (Ref. ISO/DIS 2806 - 1980).

"Critical temperature" - Cat 1, cat 3, cat 5P1

(Sometimes referred to as the transition temperature) of a specific "superconductive" material is the temperature at which the material loses all resistance to the flow of direct electrical current.

"Cryptographic activation" - Cat 5P2

Any technique that activates or enables cryptographic capability, via a secure mechanism that is implemented by the manufacturer of the item and is uniquely bound to the item or customer for which the cryptographic capability is being activated or enabled (e.g., a serial number-based licence key or an authentication instrument such as a digitally signed certificate).

Technical Note

"Cryptographic activation" techniques and mechanisms may be implemented as hardware, "software" or "technology".

"Cryptography" - Cat 5P2

The discipline which embodies principles, means and methods for the transformation of data in order to hide its information content, prevent its undetected modification or prevent its unauthorized use. "Cryptography" is limited to the transformation of information using one or more secret parameters (e.g., crypto variables) or associated key management.

Technical Note:

'Secret parameter': a constant or key kept from the knowledge of others or shared only within a group.

"CW Laser" - Cat 6

A "laser" that produces a nominally constant output energy for greater than 0.25 seconds.

"Data-Based Referenced Navigation" ("DBRN") Systems - Cat 7

Systems which use various sources of previously measured geo-mapping data integrated to provide accurate navigation information under dynamic conditions. Data sources include bathymetric maps, stellar maps, gravity maps, magnetic maps or 3-D digital terrain maps.

"Deformable Mirrors" - Cat 6

Mirrors:

a. Having a single continuous optical reflecting surface which is dynamically deformed by the application of individual torques or forces to compensate for distortions in the optical waveform incident upon the mirror; **or**

b. Having multiple optical reflecting elements that can be individually and dynamically repositioned by the application of torques or forces to compensate for distortions in the optical waveform incident upon the mirror.

"Deformable mirrors" are also known as adaptive optic mirrors.

"Development" - General Technology Note, Both Lists

Is related to all stages prior to serial production, such as: design, design research, design analyses, design concepts, assembly and testing of prototypes, pilot production schemes, design data, process of transforming design data into a product, configuration design, integration design, layouts.

"Diffusion bonding" - Cat 1, cat 2, cat 9

A solid state molecular joining of at least two separate metals into a single piece with a joint strength equivalent to that of the weakest material.

"Digital computer" - Cat 4, cat 5P1

Equipment which can, in the form of one or more discrete variables, perform all of the following:

a. Accept data;

b. Store data or instructions in fixed or alterable (writable) storage devices;

c. Process data by means of a stored sequence of instructions which is modifiable; **and**

d. Provide output of data.

Technical Note:

Modifications of a stored sequence of instructions include replacement of fixed storage devices, but not a physical change in wiring or interconnections.

"Digital transfer rate" - Definitions

The total bit rate of the information that is directly transferred on any type of medium. (See also "total digital transfer rate").

"Direct-acting hydraulic pressing" - Cat 2

A deformation process which uses a fluid-filled flexible bladder in direct contact with the workpiece.

"Discrete component" - Definitions

A separately packaged "circuit element" with its own external connections.

"Dynamic signal analysers" - Cat 3

"Signal analysers" which use digital sampling and transformation techniques to form a Fourier spectrum display of the given waveform including amplitude and phase information.

"Effective gram" - Cat 1

"Effective gram" for plutonium isotope is defined as the isotope weight in grams.

"Electronically steerable phased array antenna" - Cat 5P1, cat 6

An antenna which forms a beam by means of phase coupling, (i.e., the beam direction is controlled by the complex excitation coefficients of the radiating elements) and the direction of that beam can be varied (both in transmission and reception) in azimuth or in elevation, or both, by application of an electrical signal.

"Electronic assembly" - Cat 2, cat 3, cat 4, cat 5P2

A number of electronic components (i.e., "circuit elements", "discrete components", integrated circuits, etc.) connected together to perform (a) specific function(s), replaceable as an entity and normally capable of being disassembled.

"End-effectors" - Cat 2, 2-17

Grippers, active tooling units and any other tooling that is attached to the baseplate on the end of a "robot" manipulator arm.

Technical Note:

'Active tooling units' are devices for applying motive power, process energy or sensing to a workpiece.

"Energetic materials" - Cat 1, 2-8

Substances or mixtures that react chemically to release energy required for their intended application. "Explosives", "pyrotechnics" and "propellants" are subclasses of energetic materials.

"Equivalent Density" - Cat 6

The mass of an optic per unit optical area projected onto the optical surface.

"Expert systems" - Cat 7

Systems providing results by application of rules to data which are stored independently of the "programme" and capable of any of the following:

a. Modifying automatically the "source code" introduced by the user;

b. Providing knowledge linked to a class of problems in quasi-natural language; **or**

c. Acquiring the knowledge required for their development (symbolic training).

"Explosives" - Cat 1, 2-8, 2-18,

Solid, liquid or gaseous substances or mixtures of substances which, in their application as primary, booster, or main charges in warheads, demolition and other applications, are required to detonate.

"Expression Vectors" - 2-7

Carriers (e.g., plasmid or virus) used to introduce genetic material into host cells.

"FADEC Systems" - Cat 7, cat 9

Full Authority Digital Engine Control Systems – A digital electronic control system for a gas turbine engine that is able to autonomously control the engine throughout its whole operating range from demanded engine start until demanded engine shut-down, in both normal and fault conditions.

"Fault tolerance" - Cat 4

The capability of a computer system, after any malfunction of any of its hardware or "software" components, to continue to operate without human intervention, at a given level of service that provides continuity of operation, data integrity and recovery of service within a given time.

"Fibrous or filamentary materials" - Cat 1, cat 8, 2-13

Include:

a. Continuous monofilaments;

b. Continuous yarns and rovings;

c. Tapes, fabrics, random mats and braids;

d. Chopped fibres, staple fibres and coherent fibre blankets;

e. Whiskers, either monocrystalline or polycrystalline, of any length;

f. Aromatic polyamide pulp.

"Film type integrated circuit" - Cat 3

An array of "circuit elements" and metallic interconnections formed by deposition of a thick or thin film on an insulating "substrate".

"First generation image intensifier tubes" - 2-15

Electrostatically focused tubes, employing input and output fibre optic or glass face plates, multi-alkali photocathodes (S-20 or S-25), but not microchannel plate amplifiers.

"Fixed" - Cat 5P2

The coding or compression algorithm cannot accept externally supplied parameters (e.g., cryptographic or key variables) and cannot be modified by the user.

"Flight control optical sensor array" - Cat 7

A network of distributed optical sensors, using "laser" beams, to provide real-time flight control data for on-board processing.

"Flight path optimization" - Cat 7

A procedure that minimizes deviations from a four-dimensional (space and time) desired trajectory based on maximizing performance or effectiveness for mission tasks.

"Focal plane array" - Cat 6, cat 8

A linear or two-dimensional planar layer, or combination of planar layers, of individual detector elements, with or without readout electronics, which work in the focal plane.

Note: *This definition does not include a stack of single detector elements or any two, three or four element detectors provided time delay and integration is not performed within the element.*

"Fractional bandwidth" - Cat 3, cat 5P1, cat 5P2

The "instantaneous bandwidth" divided by the centre frequency, expressed as a percentage.

"Frequency hopping" - Cat 5P1, cat 5P2

A form of "spread spectrum" in which the transmission frequency of a single communication channel is made to change by a random or pseudo-random sequence of discrete steps.

"Frequency switching time" - Cat 3, cat 5P1

The time (i.e., delay) taken by a signal when switched from an initial specified output frequency, to arrive at or within ±0.05% of a final specified output frequency. Items having a specified frequency range of less than ±0.05% around their centre frequency are defined to be incapable of frequency switching.

"Frequency synthesizer" - Cat 3

Any kind of frequency source, regardless of the actual technique used, providing a multiplicity of simultaneous or alternative output frequencies, from one or more outputs, controlled by, derived from or disciplined by a lesser number of standard (or master) frequencies.

"Fuel cell" - Cat 8, 2-17

An electrochemical device that converts chemical energy directly into Direct Current (DC) electricity by consuming fuel from an external source.

"Fusible" - Cat 1

Capable of being cross-linked or polymerized further (cured) by the use of heat, radiation, catalysts, etc., or that can be melted without pyrolysis (charring).

"Gas atomisation" - Cat 1

A process to reduce a molten stream of metal alloy to droplets of 500 μm diameter or less by a high pressure gas stream.

"Geographically dispersed" - Cat 6

Sensors are considered "geographically dispersed" when each location is distant from any other more than 1,500 m in any direction. Mobile sensors are always considered "geographically dispersed".

"Hot isostatic densification" - Cat 2

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.

"Hybrid integrated circuit" - Cat 3

Any combination of integrated circuit(s), or integrated circuit with "circuit elements" or "discrete components" connected together to perform (a) specific function(s), and having all of the following characteristics:

a. Containing at least one unencapsulated device;

b. Connected together using typical IC production methods;

c. Replaceable as an entity; **and**

d. Not normally capable of being disassembled.

"Image enhancement" - Cat 4

The processing of externally derived information-bearing images by algorithms such as time compression, filtering, extraction, selection, correlation, convolution or transformations between domains (e.g., fast Fourier transform or Walsh transform). This does not include algorithms using only linear or rotational transformation of a single image, such as translation, feature extraction, registration or false coloration.

"In the public domain" - General Technology Note, General Software Note, 2-22

This means "technology" or "software" which has been made available without restrictions upon its further dissemination.

Note: *Copyright restrictions do not remove "technology" or "software" from being "in the public domain".*

"Information security" - Cat 5P2

All the means and functions ensuring the accessibility, confidentiality or integrity of information or communications, excluding the means and functions intended to safeguard against malfunctions. This includes "cryptography", "cryptographic activation", cryptanalysis, protection against compromising emanations and computer security.

Technical Note:

'Cryptanalysis': the analysis of a cryptographic system or its inputs and outputs to derive confidential variables or sensitive data, including clear text. (ISO 7498-2-1988 (E), paragraph 3.3.18).

"Instantaneous bandwidth" - Cat 3, cat 5P1

The bandwidth over which output power remains constant within 3 dB without adjustment of other operating parameters.

"Instrumented range" - Cat 6

The specified unambiguous display range of a radar.

"Intrinsic magnetic gradiometer" - Cat 6

A single magnetic field gradient sensing element and associated electronics the output of which is a measure of magnetic field gradient.

"Isostatic presses" - Cat 2

Equipment capable of pressurising a closed cavity through various media (gas, liquid, solid particles, etc.) to create equal pressure in all directions within the cavity upon a workpiece or material.

"Laser" - Cat 2, cat 3, cat 5P1, cat 6, cat 7, cat 8, cat 9, 2-9, 2-19

An assembly of components which produce both spatially and temporally coherent light that is amplified by stimulated emission of radiation.

"Lighter-than-air vehicles" 2-10

Balloons and airships that rely on hot air or on lighter-than-air gases such as helium or hydrogen for their lift.

"Laser duration" - Definitions

The time over which a "laser" emits "laser" radiation, which for "pulsed lasers" corresponds to the time over which a single pulse or series of consecutive pulses is emitted.

"Linearity" - Cat 2

(Usually measured in terms of non-linearity) is the maximum deviation of the actual characteristic (average of upscale and downscale readings), positive or negative, from a straight line so positioned as to equalise and minimise the maximum deviations.

"Local area network" - Cat 4, cat 5P1

A data communication system having all of the following characteristics:

a. Allows an arbitrary number of independent data devices to communicate directly with each other; **and**

b. Is confined to a geographical area of moderate size (e.g., office building, plant, campus, warehouse).

Technical Note:

'Data device' means equipment capable of transmitting or receiving sequences of digital information.

"Magnetic gradiometers" - Cat 6

Are designed to detect the spatial variation of magnetic fields from sources external to the instrument. They consist of multiple "magnetometers" and associated electronics the output of which is a measure of magnetic field gradient. (See also "Intrinsic Magnetic Gradiometer")

"Magnetometers" - Cat 6

Are designed to detect magnetic fields from sources external to the instrument. They consist of a single magnetic field sensing element and associated electronics the output of which is a measure of the magnetic field.

"Main storage" - Cat 4

The primary storage for data or instructions for rapid access by a central processing unit. It consists of the internal storage of a "digital computer" and any hierarchical extension thereto, such as cache storage or non-sequentially accessed extended storage.

"Matrix" - Cat 1, cat 2, cat 8, cat 9

A substantially continuous phase that fills the space between particles, whiskers or fibres.

"Measurement uncertainty" - Cat 2

The characteristic parameter which specifies in what range around the output value the correct value of the measurable variable lies with a confidence level of 95%. It includes the uncorrected systematic deviations, the uncorrected backlash and the random deviations (Reference: ISO 10360-2, or VDI/VDE 2617).

"Mechanical alloying" - Cat 1

An alloying process resulting from the bonding, fracturing and rebonding of elemental and master alloy powders by mechanical impact. Non-metallic particles may be incorporated in the alloy by addition of the appropriate powders.

"Melt extraction" - Cat 1

A process to "solidify rapidly" and extract a ribbon-like alloy product by the insertion of a short segment of a rotating chilled block into a bath of a molten metal alloy.

"Melt spinning" - Cat 1

A process to "solidify rapidly" a molten metal stream impinging upon a rotating chilled block, forming a flake, ribbon or rod-like product.

"Microcomputer microcircuit" - Cat 3

A "monolithic integrated circuit" or "multichip integrated circuit" containing an arithmetic logic unit (ALU) capable of executing general purpose instructions from an internal storage, on data contained in the internal storage.

Technical Note:

The internal storage may be augmented by an external storage.

"Microprocessor microcircuit" - Cat 3

A "monolithic integrated circuit" or "multichip integrated circuit" containing an arithmetic logic unit (ALU) capable of executing a series of general purpose instructions from an external storage.

Technical Note:

The "microprocessor microcircuit" normally does not contain integral user-accessible storage, although storage present on-the-chip may be used in performing its logic function.

Note: This definition includes chip sets which are designed to operate together to provide the function of a "microprocessor microcircuit".

"Microprogramme" - Definitions

A sequence of elementary instructions maintained in a special storage, the execution of which is initiated by the introduction of its reference instruction register.

"Monolithic integrated circuit" - Cat 3

A combination of passive or active "circuit elements" or both which:

a. Are formed by means of diffusion processes, implantation processes or deposition processes in or on a single semiconducting piece of material, a so-called 'chip';

b. Can be considered as indivisibly associated; **and**

c. Perform the function(s) of a circuit.

"Monospectral imaging sensors" - Cat 6

Are capable of acquisition of imaging data from one discrete spectral band.

"Multichip integrated circuit" - Cat 3

Two or more "monolithic integrated circuits" bonded to a common "substrate".

"Multilevel security" - Cat 5

A class of system containing information with different sensitivities that simultaneously permits access by users with different security clearances and needs-to-know, but prevents users from obtaining access to information for which they lack authorization.

Technical Note:

"Multilevel security" is computer security and not computer reliability which deals with equipment fault prevention or human error prevention in general.

"Multispectral imaging sensors" - Cat 6

Are capable of simultaneous or serial acquisition of imaging data from two or more discrete spectral bands. Sensors having more than twenty discrete spectral bands are sometimes referred to as hyperspectral imaging sensors.

"Network access controller" - Cat 4

A physical interface to a distributed switching network. It uses a common medium which operates throughout at the same "digital transfer rate" using arbitration (e.g., token or carrier sense) for transmission. Independently from any other, it selects data packets or data groups (e.g., IEEE 802) addressed to it. It is an assembly that can be integrated into computer or telecommunications equipment to provide communications access.

"Neural computer" - Cat 4

A computational device designed or modified to mimic the behaviour of a neuron or a collection of neurons, i.e., a computational device which is distinguished by its hardware capability to modulate the weights and numbers of the interconnections of a multiplicity of computational components based on previous data.

"Nuclear reactor" - 2-17

Includes the items within or attached directly to the reactor vessel, the equipment which controls the level of power in the core, and the components which normally contain or come into direct contact with or control the primary coolant of the reactor core.

"Numerical control" - Cat 2

The automatic control of a process performed by a device that makes use of numeric data usually introduced as the operation is in progress (Ref. ISO 2382).

"Object code" - Cat 9

An equipment executable form of a convenient expression of one or more processes ("source code" (or source language)) which has been compiled by a programming system.

"Optical amplification" - Cat 5P1

In optical communications, an amplification technique that introduces a gain of optical signals that have been generated by a separate optical source, without conversion to electrical signals, i.e., using semiconductor optical amplifiers, optical fibre luminescent amplifiers.

"Optical computer" - Cat 4

A computer designed or modified to use light to represent data and whose computational logic elements are based on directly coupled optical devices.

"Optical integrated circuit" - Cat 3

A "monolithic integrated circuit" or a "hybrid integrated circuit", containing one or more parts designed to function as a photosensor or photoemitter or to perform (an) optical or (an) electro-optical function(s).

"Optical switching" - Cat 5P1

The routing of or switching of signals in optical form without conversion to electrical signals.

"Overall current density" - Cat 3

The total number of ampere-turns in the coil (i.e., the sum of the number of turns multiplied by the maximum current carried by each turn) divided by the total cross-section of the coil (comprising the superconducting filaments, the metallic matrix in which the superconducting filaments are embedded, the encapsulating material, any cooling channels, etc.).

"Peak power" - Cat 6

The highest level of power attained in the "laser duration".

"Personal area network" - Cat 5P2

A data communication system having all of the following characteristics:

a. Allows an arbitrary number of independent or interconnected 'data devices' to communicate directly with each other; **and**

b. Is confined to the communication between devices within the immediate vicinity of an individual person or device controller (e.g., single room, office, or automobile).

Technical Note:

'Data device' means equipment capable of transmitting or receiving sequences of digital information.

"Power management" - Cat 7

Changing the transmitted power of the altimeter signal so that received power at the "aircraft" altitude is always at the minimum necessary to determine the altitude.

"Precursors" - 2-8

Speciality chemicals used in the manufacture of explosives.

"Previously separated" - Cat 1

The application of any process intended to increase the concentration of the controlled isotope.

"Primary flight control" - Cat 7

"Aircraft" stability or manoeuvering control using force/moment generators, i.e. aerodynamic control surfaces or propulsive thrust vectoring.

"Principal element" - Cat 4

An element is a "principal element" when its replacement value is more than 35% of the total value of the system of which it is an element. Element value is the price paid for the element by the manufacturer of the system, or by the system integrator. Total value is the normal international selling price to unrelated parties at the point of manufacture or consolidation of shipment.

"Production" - General Technology Note, Both Lists

Means all production stages, such as: product engineering, manufacture, integration, assembly (mounting), inspection, testing, quality assurance.

"Programme" - Cat 2, cat 6

A sequence of instructions to carry out a process in, or convertible into, a form executable by an electronic computer.

"Propellants" - 2-8

Substances or mixtures that react chemically to produce large volumes of hot gases at controlled rates to perform mechanical work.

"Pulse compression" - Cat 6

The coding and processing of a radar signal pulse of long time duration to one of short time duration, while maintaining the benefits of high pulse energy.

"Pulse duration" - Cat 6

Duration of a "laser" pulse measured at Full Width Half Intensity (FWHI) levels.

"Pulsed laser" - Cat 6

A "laser" having a "pulse duration" that is less than or equal to 0.25 seconds.

"Pyrotechnic(s)" - 2-4, 2-8

Mixtures of solid or liquid fuels and oxidizers which, when ignited, undergo an energetic chemical reaction at a controlled rate intended to produce specific time delays, or quantities of heat, noise, smoke, visible light or infrared radiation. Pyrophorics are a subclass of pyrotechnics, which contain no oxidizers but ignite spontaneously on contact with air.

"Quantum cryptography" - Cat 5P2

A family of techniques for the establishment of a shared key for "cryptography" by measuring the quantum-mechanical properties of a physical system (including those physical properties explicitly governed by quantum optics, quantum field theory, or quantum electrodynamics).

"Radar frequency agility" - Cat 6

Any technique which changes, in a pseudo-random sequence, the carrier frequency of a pulsed radar transmitter between pulses or between groups of pulses by an amount equal to or larger than the pulse bandwidth.

"Radar spread spectrum" - Cat 6

Any modulation technique for spreading energy originating from a signal with a relatively narrow frequency band, over a much wider band of frequencies, by using random or pseudo-random coding.

"Radiant sensitivity" - Cat 6

Radiant sensitivity (mA/W) = 0.807 x (wavelength in nm) x Quantum Efficiency (QE).

Technical Note:

QE is usually expressed as a percentage; however, for the purposes of this formula QE is expressed as a decimal number less than one, e.g., 78% is 0.78.

"Repeatability" - Cat 7

The closeness of agreement among repeated measurements of the same variable under the same operating conditions when changes in conditions or non-operating periods occur between measurements. (Reference: IEEE STD 528-2001 (one sigma standard deviation))

"Real-time bandwidth" - Cat 3

For "dynamic signal analysers", the widest frequency range which the analyser can output to display or mass storage without causing any discontinuity in the analysis of the input data. For analysers with more than one channel, the channel configuration yielding the widest "real-time bandwidth" shall be used to make the calculation.

"Real time processing" - Cat 2, cat 6, cat 7

The processing of data by a computer system providing a required level of service, as a function of available resources, within a guaranteed response time, regardless of the load of the system, when stimulated by an external event.

"Required" - Cat 5P1, cat 6, cat 9, General Technology Note, 2-22

As applied to "technology", refers to only that portion of "technology" which is peculiarly responsible for achieving or exceeding the controlled performance levels, characteristics or functions. Such "required" "technology" may be shared by different products.

"Resolution" - Cat 2

The least increment of a measuring device; on digital instruments, the least significant bit. (Reference: ANSI B-89.1.12)

"Riot control agents" - Cat 1, 2-7

Substances which, under the expected conditions of use for riot control purposes, produce rapidly in humans sensory irritation or disabling physical effects which disappear within a short time following termination of exposure. (Tear gases are a subset of "riot control agents".)

"Robot" - Cat 2, cat 8, 2-17

A manipulation mechanism, which may be of the continuous path or of the point-to-point variety, may use sensors, and has all the following characteristics:

a. Is multifunctional;

b. Is capable of positioning or orienting material, parts, tools or special devices through variable movements in three dimensional space;

c. Incorporates three or more closed or open loop servo-devices which may include stepping motors; **and**

d. Has "user-accessible programmability" by means of the teach/playback method or by means of an electronic computer which may be a programmable logic controller, i.e., without mechanical intervention.

Note: *The above definition does not include the following devices:*

1. *Manipulation mechanisms which are only manually/teleoperator controllable;*

2. *Fixed sequence manipulation mechanisms which are automated moving devices, operating according to mechanically fixed programmed motions. The programme is mechanically limited by fixed stops, such as pins or cams. The sequence of motions and the selection of paths or angles are not variable or changeable by mechanical, electronic or electrical means;*

3. *Mechanically controlled variable sequence manipulation mechanisms which are automated moving devices, operating according to mechanically fixed programmed motions. The programme is mechanically limited by fixed, but adjustable stops, such as pins or cams. The sequence of motions and the selection of paths or angles are variable within the fixed programme pattern. Variations or modifications of the programme pattern (e.g., changes of pins or exchanges of cams) in one or more motion axes are accomplished only through mechanical operations;*

4. *Non-servo-controlled variable sequence manipulation mechanisms which are automated moving devices, operating according to mechanically fixed programmed motions. The programme is variable but the sequence proceeds only by the binary signal from mechanically fixed electrical binary devices or adjustable stops;*

5. *Stacker cranes defined as Cartesian coordinate manipulator systems manufactured as an integral part of a vertical array of storage bins and designed to access the contents of those bins for storage or retrieval.*

"Rotary atomisation" - Cat 1

A process to reduce a stream or pool of molten metal to droplets to a diameter of 500 µm or less by centrifugal force.

"Run-out" (out-of-true running) - Cat 2

Radial displacement in one revolution of the main spindle measured in a plane perpendicular to the spindle axis at a point on the external or internal revolving surface to be tested (Reference: ISO 230/1-1986, paragraph 5.61).

"Scale factor" (gyro or accelerometer) - Cat 7

The ratio of change in output to a change in the input intended to be measured. Scale factor is generally evaluated as the slope of the straight line that can be fitted by the method of least squares to input-output data obtained by varying the input cyclically over the input range.

"Settling time" - Cat 3

The time required for the output to come within one-half bit of the final value when switching between any two levels of the converter.

"SHPL" - Cat 6

"SHPL" is equivalent to "Super High Power Laser".

"Signal analysers" - Cat 3

Apparatus capable of measuring and displaying basic properties of the single-frequency components of multi-frequency signals.

"Signal processing" - Cat 3, cat 4, cat 5P1, cat 6

The processing of externally derived information-bearing signals by algorithms such as time compression, filtering, extraction, selection, correlation, convolution or transformations between domains (e.g., fast Fourier transform or Walsh transform).

"Software" - Both Lists

A collection of one or more "programmes" or "microprogrammes" fixed in any tangible medium of expression.

"Solidify rapidly" - Definitions

A process involving the solidification of molten material at cooling rates exceeding 1000 K/sec.

"Source code" - Cat 6, cat 7, cat 9

A convenient expression of one or more processes which may be turned by a programming system into equipment executable form ("object code" (or object language)).

"Spacecraft" - Cat 7, cat 9

Active and passive satellites and space probes.

"Space-qualified" - Cat 3, cat 6, cat 8, 2-19

Products designed, manufactured and tested to meet the special electrical, mechanical or environmental requirements for use in the launch and deployment of satellites or high altitude flight systems operating at altitudes of 100 km or higher.

"Specific modulus" - Cat 1

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)%.

"Specific tensile strength" - Cat 1

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)%.

"Splat quenching" - Cat 1

A process to "solidify rapidly" a molten metal stream impinging upon a chilled block, forming a flake-like product.

"Spread spectrum" - Cat 5P1, cat 5P2

The technique whereby energy in a relatively narrow-band communication channel is spread over a much wider energy spectrum.

"Spread spectrum" radar - see "Radar spread spectrum" - Cat 6

"Stability" - Cat 7

Standard deviation (1 sigma) of the variation of a particular parameter from its calibrated value measured under stable temperature conditions. This can be expressed as a function of time.

"Substrate" - Cat 3

A sheet of base material with or without an interconnection pattern and on which or within which "discrete components" or integrated circuits or both can be located.

"Substrate blanks" - Cat 6

Monolithic compounds with dimensions suitable for the production of optical elements such as mirrors or optical windows.

"Super High Power Laser" ("SHPL") - Cat 6

A "laser" capable of delivering (the total or any portion of) the output energy exceeding 1 kJ within 50 ms or having an average or CW power exceeding 20 kW.

"Superalloy" - Cat 2, cat 9

Nickel-, cobalt- or iron-base alloys having strengths superior to any alloys in the AISI 300 series at temperatures over 922 K (649° C) under severe environmental and operating conditions.

"Superconductive" - Cat 1, cat 3, cat 5P1, cat 6, cat 8, 2-20

Refers to materials, (i.e., metals, alloys or compounds) which can lose all electrical resistance (i.e., which can attain infinite electrical conductivity and carry very large electrical currents without Joule heating).

Technical Note:

The "superconductive" state of a material is individually characterised by a "critical temperature", a critical magnetic field, which is a function of temperature, and a critical current density which is, however, a function of both magnetic field and temperature.

"Superplastic forming" - Cat 1, cat 2

A deformation process using heat for metals that are normally characterised by low values of elongation (less than 20%) at the breaking point as determined at room temperature by conventional tensile strength testing, in order to achieve elongations during processing which are at least 2 times those values.

"Symmetric algorithm" - Cat 5P2

A cryptographic algorithm using an identical key for both encryption and decryption.

Technical Note:

A common use of "symmetric algorithms" is confidentiality of data.

"System tracks" - Cat 6

Processed, correlated, (fusion of radar target data to flight plan position) and updated aircraft flight position report available to the Air Traffic Control centre controllers.

"Systolic array computer" - Cat 4

A computer where the flow and modification of the data is dynamically controllable at the logic gate level by the user.

"Technology" - General Technology Note, Both Lists

Specific information necessary for the "development", "production" or "use" of a product. The information takes the form of technical data or technical assistance. Controlled "technology" for the Dual-Use List is defined in the General Technology Note and in the Dual-Use List. Controlled "technology" for Group 2 - Munitions List is specified in 2-22.

Technical Notes:

1. *'Technical data' may take forms such as blueprints, plans, diagrams, models, formulae, tables, engineering designs and specifications, manuals and instructions written or recorded on other media or devices such as disk, tape, read-only memories.*
2. *'Technical assistance' may take forms such as instruction, skills, training, working knowledge, consulting services. 'Technical assistance' may involve transfer of 'technical data'.*

"Tilting spindle" - Cat 2

A tool-holding spindle which alters, during the machining process, the angular position of its centre line with respect to any other axis.

"Time constant" - Cat 6

The time taken from the application of a light stimulus for the current increment to reach a value of 1-1/e times the final value (i.e., 63% of the final value).

"Tip shroud" - Cat 9

A stationary ring component (solid or segmented) attached to the inner surface of the engine turbine casing or a feature at the outer tip of the turbine blade, which primarily provides a gas seal between the stationary and rotating components.

"Total control of flight" - Cat 7

Automated control of "aircraft" state variables and flight path to meet mission objectives responding to real time changes in data regarding objectives, hazards or other "aircraft".

"Total digital transfer rate" - Cat 5P1

The number of bits, including line coding, overhead and so forth per unit time passing between corresponding equipment in a digital transmission system. (See also "digital transfer rate")

"Transfer laser" - Cat 6

A "laser" in which the lasing species is excited through the transfer of energy by collision of a non-lasing atom or molecule with a lasing atom or molecule species.

"Tunable" - Cat 6

The ability of a "laser" to produce a continuous output at all wavelengths over a range of several "laser" transitions. A line selectable "laser" produces discrete wavelengths within one "laser" transition and is not considered "tunable".

"Unmanned aerial vehicle" ("UAV") - Cat 9

Any "aircraft" capable of initiating flight and sustaining controlled flight and navigation without any human presence on board.

"Use" - General Technology Note, Dual-Use List, 2-21, 2-22

Operation, installation (including on-site installation), maintenance (checking), repair, overhaul and refurbishing.

"User-accessible programmability" - Cat 4, cat 5, cat 6

The facility allowing a user to insert, modify or replace "programmes" by means other than:

a. A physical change in wiring or interconnections; **or**

b. The setting of function controls including entry of parameters.

"Vacuum atomisation" - Cat 1

A process to reduce a molten stream of metal to droplets of a diameter of 500 μm or less by the rapid evolution of a dissolved gas upon exposure to a vacuum.

"Variable geometry airfoils" - Cat 7

Use trailing edge flaps or tabs, or leading edge slats or pivoted nose droop, the position of which can be controlled in flight.

ACRONYMS AND ABBREVIATIONS USED IN GROUPS 1 AND 2

An acronym or abbreviation, when used as a defined term, will be found in 'Definitions of Terms used in Groups 1 and 2'.

ABEC	Annular Bearing Engineers Committee
AGMA	American Gear Manufacturers' Association
AHRS	attitude and heading reference systems
ALU	arithmetic logic unit
ATC	air traffic control
C^3I	command, communications, control & intelligence
CAD	computer-aided-design
CAS	Chemical Abstracts Service
CDU	control and display unit
CEP	circular error probable
CNTD	controlled nucleation thermal deposition
CVD	chemical vapour deposition
CW	chemical warfare
CW (for lasers)	continuous wave
DEW	directed energy weapon systems
DME	distance measuring equipment
DS	directionally solidified
EB-PVD	electron beam physical vapour deposition
EBU	European Broadcasting Union
ECM	electro-chemical machining
ECR	electron cyclotron resonance
EDM	electrical discharge machines
EEPROMS	electrically erasable programmable read only memory
EIA	Electronic Industries Association
EMC	electromagnetic compatibility
EMCDB	elastomer modified cast double based propellants
FFT	Fast Fourier Transform

GLONASS	global navigation satellite system
GPS	global positioning system
HBT	hetero-bipolar transistors
HDDR	high density digital recording
HEMT	high electron mobility transistors
ICAO	International Civil Aviation Organisation
IEC	International Electro-technical Commission
IEEE	Institute of Electrical and Electronic Engineers
IFOV	instantaneous-field-of-view
ILS	instrument landing system
IRIG	inter-range instrumentation group
ISA	international standard atmosphere
ISAR	inverse synthetic aperture radar
ISO	International Organization for Standardization
ITU	International Telecommunication Union
JIS	Japanese Industrial Standard
JT	Joule-Thomson
LIDAR	light detection and ranging
LRU	line replaceable unit
MAC	message authentication code
Mach	ratio of speed of an object to speed of sound (after Ernst Mach)
MLS	microwave landing systems
MOCVD	metal organic chemical vapour deposition
MRI	magnetic resonance imaging
MTBF	mean-time-between-failures
Mtops	million theoretical operations per second
MTTF	mean-time-to-failure
NBC	Nuclear, Biological and Chemical
NDT	non-destructive test
PAR	precision approach radar

PIN	personal identification number
ppm	parts per million
PSD	power spectral density
QAM	quadrature-amplitude-modulation
RF	radio frequency
RPV	remotely piloted air vehicles
SACMA	Suppliers of Advanced Composite Materials Association
SAR	synthetic aperture radar
SC	single crystal
SLAR	sidelooking airborne radar
SMPTE	Society of Motion Picture and Television Engineers
SRA	shop replaceable assembly
SRAM	static random access memory
SRM	SACMA Recommended Methods
SSB	single sideband
SSR	secondary surveillance radar
TCSEC	trusted computer system evaluation criteria
TIR	total indicated reading
UTS	ultimate tensile strength
VOR	very high frequency omni-directional range
YAG	yttrium/aluminum garnet