SCHEDULE 1 Article 2

PROHIBITED GOODS

CONTENTS

PART I

1. In Group 1 of this Part—

(a) "bovine offal" means the brain, spinal cord, spleen, thymus, tonsils and intestines of a bovine animal over six months of age which has died or has been slaughtered, as the case may be, in the United Kingdom;

(b) "intestines" means that part of the digestive tract of a bovine animal from the junction of the abomasum and the duodenum to (and including) the rectum; and

(c) any description of goods specified in relation to a Combined Nomenclature heading or sub-heading, other than one covering a whole heading, shall be taken to comprise all goods which would be classified under an entry in the same terms constituting a sub-heading in the relevant heading in the Combined Nomenclature of the European Community(**1**).

GROUP 1

GOODS SPECIFIED BY REFERENCE TO HEADINGS AND SUB-HEADINGS OF THE COMBINED NOMENCLATURE ("CN")

1. The following goods are prohibited to be exported unless the place of export is in Great Britain, or the export of the goods is from Northern Ireland to the Republic of Ireland:

CN Heading and Sub Heading No.	*Description of Goods*
0102	Live bovine animals
0103	Live swine
010410	Live sheep.

2. The following goods are prohibited to be exported to any destination except a destination in another Member State:

CN Heading and Sub Heading No.	*Description of Goods*
ex 0206	Bovine offal
ex 0210	Protein derived from bovine offal
ex 0504	Bovine offal

(**1**) Annex 1 to Council Regulation (EC) No. 2658/87 O.J. No. L256, 7.9.87, p.1. replaced by Commission Regulation 2551/93 O.J. No. L241, 27.9.93, to which there are amendments not relevant to this Order.

CN Heading and Sub Heading No.	*Description of Goods*
ex 0511	Bovine offal and protein derived from such offal
ex 2301	Protein derived from bovine offal
ex 2309	Feeding stuff containing bovine offal or protein derived from such offal.

GROUP 2

(**2**)

GROUP 3

VEHICLES

1. The export of goods specified in this Group(**3**) is prohibited to any destination in Bosnia-Herzegovina, Croatia, or the former Yugoslav Republic of Macedonia:

(a) All wheel drive utility vehicles capable of off road use that have a ground clearance of greater than 175 millimetres;

(b) Heavy duty recovery vehicles capable of towing suspended a load of more than 6 tonnes or winching a load of more than 10 tonnes;

(c) Drop sided trucks that have a load carrying capacity of more than 5 tonnes.

PART II

Goods capable of being used in relation to chemical, biological or nuclear weapons and related missiles

1. Goods of a description specified in paragraph (2) below are prohibited to be exported—

(a) if the exporter knows that they are intended or likely to be used in—

(i) the development, production, handling, operation, delivery, detection, identification or storage of any chemical or biological weapon;

(ii) the disposal of waste arising out of the development or production of any chemical or biological weapon;

(iii) the development, production, handling, operation, delivery, detection, identification or storage of any vaccine, toxoid, protein or immunoglobulin for protection against, or the treatment of, the harmful effects of any chemical or biological weapon;

(iv) the development, production, handling, operation, delivery, or storage of any nuclear weapon; or

(v) the development, production, handling, operation, delivery or storage of missiles capable of delivering any nuclear, chemical or biological weapon;

(b) where the exporter knows or has grounds for suspecting that they might be used for any purpose referred to in sub-paragraph (a) above, unless he has made all reasonable enquiries as to their proposed use and satisfied himself that the goods will not be so used.

(a) (a) Any chemical, toxin, microorganism or other biological agent;

(**2**) See article 9. The Export of Goods (Control) Order 1992 S.I.1992/3092, remains in force in relation to the export of antiques.
(**3**) See also ML6 and PL5031 of Group 1 of Part III of this Schedule.

(b) Any vaccine, toxoid, protein or immunoglobulin capable of being used for protection against, or treatment of, any harmful effect of any chemical, toxin, microorganism or other biological agent;

(c) Any equipment (including clothing), software or materials capable of being used in the development, production, handling, operation, delivery, detection, identification or storage of any of the substances specified in sub-paragraph (a) or (b) above;

(d) Any equipment (including clothing), software or materials capable of being used in the disposal of waste arising out of the development or production of substances specified in sub-paragraph (a) or (b) above;

(e) Any equipment (including clothing), software or materials capable of being used in the development, production, handling, operation, delivery or storage of nuclear weapons or missiles capable of delivering nuclear, chemical or biological weapons;

(f) Technology the information in which includes information relating to any goods in sub-paragraphs (a) to (e) above.

PART III

Note: The goods in this Part are for convenience specified by reference to the classification system used by the Department of Trade and Industry for export control purposes. For convenience only, defined terms are highlighted in bold type.

GROUP 1

MILITARY, SECURITY AND PARA-MILITARY GOODS AND ARMS, AMMUNITION AND RELATED MATERIAL

Definitions

In this Group:

the "critical temperature" (sometimes referred to as the transition temperature) of a specific superconductive material means the temperature at which the specific material loses all resistance to the flow of direct electrical current;

"end-effectors" include grippers, active tooling units and any other tooling that is attached to the baseplate on the end of a **robot** manipulator arm; for this purpose, "active tooling unit" means a device for applying motive power, process energy or sensing to the workpiece;

"laser" means an assembly of components which produce both spatially and temporally coherent light which is amplified by stimulated emission of radiation;

"military pyrotechnics" means mixtures of solid or liquid fuels and oxidisers 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 oxidisers but ignite spontaneously on contact with air;

"nuclear reactor" means 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, come into direct contact with or control the primary coolant of the reactor core;

"robot" means a manipulation mechanism, which may be of the continuous path or of the point-to-point variety, may use sensors, and which:

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;

except:

a. manipulation mechanisms which are only manually/teleoperator controllable;

b. fixed sequence manipulation mechanisms, which are automated moving devices, operating according to programmes where the motions are limited by fixed stops, such as pins or cams and the sequence of motions and the selection of paths or angles are not variable or changeable by mechanical, electronic or electrical means;

c. mechanically controlled variable sequence manipulation mechanisms, which are automated moving devices, operating according to programmes where the motions are limited by fixed, but adjustable stops, such as pins or cams and 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;

d. 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;

e. 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;

"superconductive" in relation to materials (i.e., metals, alloys or compounds) means those which can lose all electrical resistance (i.e., which can attain infinite electrical conductivity and carry very large electrical currents without Joule heating); the superconductive state of a material is individually characterized by a **critical temperature**, a critical magnetic field, which is a function of temperature, and a critical current density which is a function of both magnetic field and temperature;

"user-accessible programmability" means 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.

(ML1) Small arms, machine guns and accessories, as follows, and specially designed components therefor:

(a) Rifles, carbines, revolvers, pistols, machine pistols and machine guns;

(b) Smooth-bore weapons specially designed for military use;

(c) Weapons using caseless ammunition;

(d) Silencers, special gun-mountings, clips, magazines and flash suppressors for the **goods** specified in heads a., b. and c. above;

except:

a. Air weapons (other than those declared by the Firearms (Dangerous Air Weapons) Rules 1969(**4**) to be specially dangerous);

b. Firearms specially designed for dummy ammunition and which are incapable of firing any ammunition specified in this Group;

c. Firearms which have been de-activated by a registered UK Proof House as being incapable of firing any ammunition specified in this Group;

d. Bayonets.

In this entry:

"special gun-mounting" means any fixture designed to mount a gun;

"small arms" means:

a. Rifle barrelled weapons with a calibre of 12.7 mm or less; or

b. Smooth bore weapons with a calibre of 30 mm or less.

(PL5002) Telescopic sights for firearms, other than those specified in entry ML5.(**5**)

(PL5018) Smooth-bore weapons, other than those specified in head b. of entry ML1, and specially designed components therefor;

except:

(a) Air weapons (other than those declared by the Firearms (Dangerous Air Weapons) Rules 1969 to be specially dangerous);

(b) Air (pneumatic) or cartridge (explosive) powered guns or pistols designed as:

(1) Industrial tools; or

(2) Humane stunning devices employed specifically for animal slaughter.

(PL5021) Ammunition or cartridges, including projectiles, and specially designed components therefor, for the **goods** specified in entry PL5018;

except:

(a) Lead or lead alloy pellet ammunition specially designed for air weapons;

(b) Ammunition crimped without a projectile (blank star) and dummy ammunition with a pierced powder chamber.

(ML2) Large calibre armament or weapons, projectors and accessories, as follows, and specially designed components therefor:

(a) Guns, howitzers, cannon, mortars, tank destroyers, projectile launchers, military flame throwers, recoilless rifles and signature reduction devices therefor; except:

Air (pneumatic) powered launchers designed for the purposes of safety of life;

(b) Military smoke, gas and pyrotechnic projectors or generators;

except:

Signal pistols.

In this entry:

"large calibre armament" means:

a. Rifle barrelled weapons with a calibre greater than 12.7 mm; or

(**4**) S.I. 1967/47.
(**5**) See also article 3(e).

b. Smooth bore weapons with a calibre greater than 30 mm; 'specially designed components' include injectors, metering devices and storage tanks for use with liquid propelling charges.

(ML3) Ammunition, and specially designed components therefor, for the **goods** specified in entries ML1, ML2 or ML26;except:

(a) Lead or lead alloy pellet ammunition specially designed for air weapons;

(b) ammunition crimped without a projectile (blank star) and dummy ammunition with a pierced powder chamber.

(ML4) Bombs, torpedoes, rockets, missiles, mines, charges, related equipment and accessories, as follows, specially designed for military use and specially designed components therefor:

(a) Bombs, torpedoes, grenades, smoke canisters, rockets, mines, missiles, depth charges, demolition-charges, demolition-devices and demolition-kits, cartridges and simulators;

(b) Equipment specially designed for the handling, control, activation, powering with one time operational output, launching, laying, sweeping, discharging, decoying, jamming, detonation or detection of **goods** specified in head a. above.

(PL5030) Bombs and grenades, other than those specified in entry ML4.

(PL5006) Apparatus or devices specially designed for military use, used for the handling, control, discharging, decoying, jamming, detonation, disruption or detection of improvised explosive devices or other explosive devices not specified in head a. of entry ML4, and specially designed components therefor;

except:

Inspection devices not employing electronic management.

In this entry, "improvised explosive devices" means devices placed or fabricated in an improvised manner incorporating destructive, lethal, noxious, pyrotechnic or incendiary chemicals, designed to destroy, disfigure or harass; they may incorporate military stores, but are normally devised from non-military components.

(ML5) Fire control, and related alerting and warning equipment, and related systems, as follows, specially designed for military use, and specially designed components and accessories therefor:

(a) Weapon sights, bombing computers, gun laying equipment and on-board weapon control systems;

(b) Target acquisition, designation, range-finding, surveillance or tracking systems; detection, recognition or identification equipment; and sensor integration equipment.

(ML6) Vehicles and related equipment, as follows, specially designed or modified for military use and components therefor specially designed or modified for military use:

(a) Tanks and self-propelled guns;

(b) Armed, armoured vehicles and vehicles fitted with mounting for arms;

(c) Armoured railway trains;

(d) Half-tracks;

(e) Recovery vehicles;

(f) Gun-carriers, tractors and trailers specially designed for towing or transporting ammunition or weapon systems and related load handling equipment;

(g) Amphibious and deep water fording vehicles;

(h) Mobile repair shops specially designed to service military equipment;

(i) All other vehicles specially designed or modified for military use, including tank transporters, tracked amphibious cargo carriers, high speed tractors, heavy artillery transporters, bridge laying vehicles and specialised bulk refuellers;

(j) Pneumatic tyre casings of a kind specially constructed to be bullet proof or to run when deflated;

(k) Engines and power transfer systems for the propulsion of the vehicles specified in heads a. to i. above;

(l) Tyre inflation pressure control systems, operated from inside a moving vehicle;

(m) Suspensions.

In this entry "modified for military use" means a structural, electrical or mechanical change which entails replacing a component with at least one specially designed military component, or adding at least one such component.

(PL5031) Other vehicles and related equipment as follows:

(a) All wheel drive utility vehicles capable of off road use which have been fitted with metallic or non-metallic materials to provide ballistic protection;

(b) Containers for mounting on vehicles, specially designed or modified for military use and components therefor specially designed or modified for military use.

(ML7) Toxicological agents, riot control agents and related equipment, components, materials and **technology**, as follows:

(a) Biological agents and radioactive materials adapted for use in war to produce casualties in humans or animals, degrade equipment or damage crops or the environment, and chemical warfare (CW) agents;

Head a. of this entry does not specify:

1. Cyanogen chloride;
2. Hydrocyanic acid;
3. Chlorine;
4. Carbonyl chloride (phosgene);
5. Diphosgene (trichloromethyl-chloroformate);
6. Ethyl bromoacetate;
7. Xylyl bromide;
8. Benzyl bromide;
9. Benzyl iodide;
10. Bromoacetone;
11. Cyanogen bromide;
12. Bromomethylethylketone;
13. Chloroacetone;
14. Ethyl iodoacetate;
15. Iodoacetone;
16. Chloropicrin;

(b) CW binary precursors, as follows:

(1) DF: Methyl phosphonyldifluoride;

(2) QL: o-Ethyl-2-diisopropylaminoethyl methylphosphonite;

(c) Riot control agents, including tear gases;

(d) Equipment specially designed or modified for the dissemination of the materials or agents specified in head a. above and specially designed components therefor;

(e) **Goods** specially designed or modified for defence against materials or agents specified in head a. above and specially designed components therefor;

(f) **Goods** specially designed or modified for the detection or identification of materials or agents specified in head a. above and specially designed components therefor;

except:

Personal radiation monitoring dosimeters;

(g) Biopolymers specially designed or processed for detection and identification of chemical warfare (CW) agents specified in head a. above and the cultures of specific cells used to produce them;

(h) Biocatalysts for decontamination or degradation of CW agents, and biological systems therefor, as follows:

(1) Biocatalysts, specially designed for decontamination or degradation of CW agents described in head a. above resulting from directed laboratory selection or genetic manipulation of biological systems;

(2) Biological systems, as follows: expression vectors, viruses or cultures of cells containing the genetic information specific to the production of biocatalysts specified in sub-head h.1. above;

(i) **Technology**, as follows:

(1) **Technology** for the **development, production** or **use** of goods specified in heads a. to f. above;

(2) **Technology** for the **development, production** or **use** of biopolymers, or cultures of specific cells, specified in head g. above;

(3) **Technology** exclusively for the incorporation of biocatalysts specified in sub-head h.1. above into military carrier substances or military material.

In this entry:

"adapted for use in war" means any modification or selection (such as altering purity, shelf life, virulence, dissemination characteristics, or resistance to ultra violet (UV) radiation) designed to increase the effectiveness in producing casualties in men or animals, degrading equipment or damaging crops or the environment;

"anti-idiotypic antibodies" means antibodies which bind to the specific antigen binding sites of other antibodies;

"biocatalyst" means enzymes and other biological compounds which bind to and accelerate the degradation of chemical warfare (CW) agents;

"biopolymer" means the following biological macromolecules:

a. enzymes;

b. antibodies, monoclonal, polyclonal or anti-idiotypic;

c. specially designed or specially processed receptors;

"enzymes" means biocatalysts for specific chemical or biochemical reactions;

"expression vectors" means carriers including plasmid or virus types, which are used to introduce genetic material into host cells;

"monoclonal antibodies" means proteins which bind to one antigenic site and are produced by a single clone of cells;

"polyclonal antibodies" means a mixture of proteins which bind to the specific antigen and are produced by more than one clone of cells;

"receptors" means biological macromolecular structure capable of binding ligands, the binding of which affects physiological functions;

"riot control agents" means substances which produce temporary, irritating or disabling physical effects which disappear within minutes of removal from exposure. There is no significant risk of permanent injury and medical treatment is rarely required;

"tear gases" means gases which produce temporary irritating or disabling effects which disappear within minutes of removal of exposure.

(ML8) Military explosives and propellants, and related substances, as follows, and devices containing any of the following except those specified elsewhere in this Group:

(a) Substances, as follows, and mixtures therefor:

(1) Spherical aluminium powder with a particle size of 60 micrometres or less, manufactured from material with an aluminium content of 99% or more;

(2) Metal fuels in particle sizes of less than 60 micrometres whether spherical, atomized, spheroidal, flaked or ground, manufactured from material consisting of 99% or more of any of the following:

(a) Zirconium, magnesium and alloys of these;

(b) Beryllium;

(c) Iron powder with average particle size of 3 micrometres or less produced by reduction of iron oxide with hydrogen;

(d) Boron or boron carbide fuels of 85% purity or higher and average particle size of 60 micrometres or less;

(3) Perchlorates, chlorates and chromates composited with powdered metal or other high energy fuel components;

(4) Nitroguanidine (NQ);

(5) Compounds composed of fluorine and any of the following: other halogens, oxygen, nitrogen;

(6) Carboranes; decarborane; pentaborane and derivatives thereof;

(7) Cyclotetramethylenetetranitramine (HMX); octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazine; 1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane; (octogen, octogene);

(8) Hexanitrostilbene (HNS);

(9) Diaminotrinitrobenzene (DATB);

(10) Triaminotrinitrobenzene (TATB);

(11) Triaminoguanidinenitrate (TAGN);

(12) Titanium subhydride of stoichiometry TiH 0.65-1.68;

(13) Dinitroglycoluril (DNGU, DINGU); tetranitroglycoluril(TNGU, SORGUYL);

(14) Tetranitrobenzotriazolobenzotriazole (TACOT);

(15) Diaminohexanitrobiphenyl (DIPAM);

(16) Picrylaminodinitropyridine (PYX);

(17) 3-Nitro-1,2,4-triazol-5-one (NTO or ONTA);

(18) Hydrazine in concentrations of 70% or more; hydrazine nitrate; hydrazine perchlorates; unsymmetrical dimethyl hydrazine; monomethyl hydrazine; symmetrical dimethyl hydrazine;

(19) Ammonium perchlorate;

(20) Cyclotrimethylenetrinitramine (RDX); cyclonite; T4; hexahydro-1,3,5-trinitro-1,3,5-triazine; 1,3,5-trinitro-1,3,5-triaza-cyclohexane (hexogen, hexogene);

(21) Hydroxylammonium nitrate (HAN); hydroxylammonium perchlorate (HAP);

(22) 2-(5-Cyanotetrazolato) pentaamminecobalt(III)perchlorate (or CP);

(23) Cis-bis (5-nitrotetrazolato)pentaaminecobalt(III) perchlorate (or BNCP);

(24) 7-Amino-4, 6-dinitrobenzofurazane-1-oxide (ADNBF); amino dinitrobenzo-furoxan;

(25) 5, 7-Diamino-4, 6-dinitrobenzofurazane-1-oxide, (CL-14) or diamino dinitro-benzofurozan);

(26) 2, 4, 6-Trinitro-2, 4, 6-triazacyclohexanone (K-6 or Keto-RDX);

(27) 2, 4, 6, 8-Tetranitro-2, 4, 6, 8-tetraazabicyclo[3,3,0]octan-3- one (tetranitrosemiglycouril, K-55 or keto-bicyclic HMX);

(28) 1,1,3-Trinitroazetidine (TNAZ);

(29) 1,4,5,8-Tetranitro-1,4,5,8-tetraazadecalin (TNAD);

(30) Hexanitrohexaazaisowurtzitane (CL-20) or HNIW; and clathrates of CL-20);

(31) Polynitrocubanes with more than four nitro groups;

(32) Ammonium dinitramide (ADN or SR 12);

(b) Explosives and propellants that meet the following performance parameters:

(1.8) Any explosive with a detonation velocity exceeding 8,700 m/s or a detonation pressure exceeding 340 kilobars;

(2) Other organic high explosives not listed elsewhere in this entry yielding detonation pressures of 250 kilobars or more that will remain stable at temperatures of 523 K (250°C) or higher for periods of 5 minutes or longer;

(3) Any other United Nations (UN) Class 1.1 solid propellant not listed elsewhere in this entry with a theoretical specific impulse (under standard conditions) of more than 250 seconds for non-metallised, or more than 270 seconds for aluminised compositions;

(4) Any UN Class 1.3 solid propellant with a theoretical specific impulse of more than 230 seconds for non-halogenised, 250 seconds for non-metallised and 266 seconds for metallised compositions;

(5) Any other gun propellants not listed elsewhere in this entry having a force constant of more than 1,200 kJ/kg;

(6) Any other explosive, propellant or pyrotechnic not listed elsewhere in this entry that can sustain a steady-state burning rate of more than 38 mm per second under standard conditions of 68.9 bar pressure and 294 K (21°C);

(7) Elastomer modified cast double based propellants (EMCDB) with extensibility at maximum stress of more than 5% at 233 K (-40°C);

(c) Military pyrotechnics;

(d) Military high-energy solid or liquid fuels, including:

(1) Aircraft fuels specially formulated for military purposes;

(2) Liquid oxidisers comprised of or containing inhibited red fuming nitric acid (IRFNA) or oxygen difluoride;

(3) Military materials containing thickeners for hydrocarbon fuels specially formulated for use in flamethrowers or incendiary munitions, such as metal stearates or palmates (also known as octol) and M1, M2, M3 thickeners;

(e) Additives, precursors and stabilisers, the following:

(1) Azidomethylmethyloxetane (AMMO) and its polymers;

(2) Basic copper salicylate; lead salicylate;

(3) Bis(2,2-dinitropropyl)formal or bis(2,2-dinitropropyl)acetal;

(4) Bis(2-fluoro-2,2-dinitroethyl)formal (FEFO);

(5) Bis(2-hydroxyethyl)glycolamide (BHEGA);

(6) Bis(2-methylaziridinyl) methylaminophosphine oxide (Methyl BAPO);

(7) Bisazidomethyloxetane and its polymers;

(8) Bischloromethyloxetane (BCMO);

(9) Butadienenitrileoxide (BNO);

(10) Butanetrioltrinitrate (BTTN);

(11) Catocene, N-butyl-ferrocene and other ferrocene derivatives;

(12) Cyanoethylated polyamine and its salts;

(13) Cyanoethylated polyamine adducted with glycidol&salt;

(14) Dinitroazetidine-t-butyl salt;

(15) Energetic monomers, plasticisers and polymers containing nitro, azido, nitrate, nitraza or difluoroamino groups;

(16) Poly-2,2,3,3,4,4-hexafluoropentane-1,5-diol formal(FPF-1);

(17) Poly-2,4,4,5,5,6,6-heptafluoro-2-trifluoromethyl-3-oxaheptane-1,7-diol formal (FPF-3);

(18) Glycidylazide Polymer (GAP) and its derivatives;

(19) Guanidine nitrate;

(20) Hexabenzylhexaazaisowurtzitane (HBIW);

(21) Hexanitrostibene;

(22) Hydroxyl terminated polybutadiene (HTPB) with a hydroxyl functionality of less than 2.16, a hydroxyl value of less than 0.77 meq/g, and a viscosity at 30°C of less than 47 poise;

(23) Hydrogen peroxide in concentrations of greater than 85%;

(24) Superfine iron oxide (Fe2O3 hematite) with a specific surface area more than 250 m^2/g and an average particle size of 0.003 micrometre or less;

(25) Lead beta-resorcylate;

(26) Lead stannate, lead maleate, lead citrate;

(27) Lead-copper chelates of beta-resorcylate or salicylates;

(28) Nitratomethylmethyloxetane or poly (3-Nitratomethyl, 3-methyl oxetane); (Poly-NIMMO) (NMMO);

(29) N-methyl-p-nitroaniline.

(30) Organo-metallic coupling agents, specifically:

(a) Neopentyl [diallyl] oxy, tri [dioctyl] phosphato titanate; also known as titanium IV, 2,2[bis 2-propenolato-methyl, butanolate or tris [dioctyl] phosphato-O], or LICA 12;

(b) Titanium IV, [(2-propenolato-1)methyl, N-propanolatomethyl] butanolato-1, also known as tris[dioctyl]pyrophosphato or KR3538;

(c) Titanium IV, [(2-propenolato-1)methyl, N-propanolatomethyl] butanolato-1, also known as tris(dioctyl)phosphate or KR3512;

(31) Polycyanodifluoroaminoethyleneoxide (PCDE);

(32) Polyfunctional aziridine amides: with isophthalic, trimesic (BITA); butylene imine trimesamide isocyanuric; or trimethyladipic backbone structures and 2-methyl or 2-ethyl substitutions on the aziridine ring;

(33) Polyglycidylnitrate or poly (nitratomethyl oxirane); (Poly-GLYN) (PGN);

(34) Polynitroorthocarbonates;

(35) Propyleneimide, 2-methylaziridine;

(36) Tetraacetyldibenzylhexaazaisowurtzitane (TAIW);

(37) Tetraethylenepentamineacrylonitrile (TEPAN); cyanoethylated polyamine and its salts;

(38) Tetraethylenepentamineacrylonitrileglycidol (TEPANOL); cyanoethylated polyamine adducted with glycidol and its salts;

(39) Triphenyl bismuth (TPB);

(40) Tris vinoxy propane adduct (TVOPA);

(41) Tris-1-(2-methyl)aziridinyl phosphine oxide (MAPO); bis(2-methyl aziridinyl) 2-(2-hydroxypropanoxy) propylamino phosphine oxide (BOBBA 8); and other MAPO derivatives;

(43) 1,2,3-Tris[1,2-bis(difluoroamino)ethoxy] propane; tris vinoxy propane adduct (TVOPA);

(44) 1,3,5-Trichlorobenzene;

(45) 1,2,4-Trihydroxybutane (1,2,4-butanetriol);

(46) 1,3,5,7-Tetraacetyl-1,3,5,7-tetraazacyclooctane (TAT);

(47) 1,4,5,8-Tetraazadecalin;

(48) Low (less than 10,000) molecular weight, alcohol-functionalised, poly(epichlorohydrin); poly(epichlorohydrindiol) and triol.

In this entry:

"additives" means substances used in explosive formulations to improve their properties;

"military propellants" means solid, liquid or gaseous substances or mixtures of substances used for propelling projectiles and missiles, or to generate gases for powering auxiliary devices for military equipment which, when ignited, burn or deflagrate to produce quantities of gas capable of performing work, but in their application these quantities are required not to undergo a deflagration to detonation transition.

(ML9) Combatant vessels or vessels (surface or underwater) specially designed or modified for offensive or defensive action, whether or not converted to non-military use, regardless of current state of repair or operating condition, and whether or not they contain weapon delivery systems or armour, and specially designed components therefor(**6**).

(**6**) See also PL5029.

(PL5029) Nuclear power generating or propulsion equipment, including **nuclear reactors,** specially designed for military use and components therefor specially designed or modified for military use.

(ML10) **Aircraft,** unmanned airborne vehicles, aero-engines and **aircraft** equipment, related **goods,** as follows, and components therefor specially designed or modified for military use:

(a) Combat **aircraft;**

(b) Other **aircraft** specially designed or modified for military use;

(c) Aero-engines specially designed or modified for military use;

(d) Unmanned airborne vehicles, including remotely piloted air vehicles (RPVs), and autonomous, programmable vehicles specially designed or modified for military use, and their launchers, ground support and associated equipment for command and control;

(e) Airborne equipment, including airborne refuelling equipment, specially designed for use with the **aircraft** specified in heads a. or b. above or the aero-engines specified in head c. above;

(f) Pressure refuellers, pressure refuelling equipment, equipment specially designed to facilitate operations in confined areas and ground equipment, developed specially for **aircraft** specified in heads a. or b. above, or for aero-engines specified in head c. above;

(g) Pressurised breathing equipment and partial pressure suits for use in **aircraft,**anti-g suits, military crash helmets and protective masks, liquid oxygen converters used for **aircraft** or missiles, and catapults and cartridge actuated devices for emergency escape of personnel from **aircraft;**

(h) Parachutes used for combat personnel, cargo dropping or **aircraft** deceleration, as follows:

(1) Parachutes for:

(a) Pin point dropping of military personnel;

(b) Dropping of paratroopers;

(2) Cargo parachutes;

(3) Paragliders (drag parachutes, drogue parachutes for stabilisation and attitude control of dropping bodies, e.g., recovery capsules, ejection seats, bombs);

(4) Drogue parachutes for use with ejection seat systems for deployment and inflation sequence regulation of emergency parachutes;

(5) Recovery parachutes for guided missiles, RPVs or space vehicles;

(6) Approach parachutes and landing deceleration parachutes;

(7) Other military parachutes;

(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.

(ML11) Electronic equipment not specified elsewhere in this Group specially designed for military use and specially designed components therefor.

(ML13) Armoured or protective **goods** and constructions, as follows:

(a) Armoured plate;

(b) Combinations and constructions of metallic and non-metallic materials specially designed to provide ballistic protection for military systems;

(c) Military helmets, other than those specified in head g. of entry ML10;except:

(a) Conventional steel helmets not equipped with, modified or designed to accept any type of accessory device; or

(b) Helmets manufactured before 1945;

(d) Body armour, bullet-proof or bullet-resistant clothing, and specially designed components therefor;

except:

a. **Goods** specially designed for protection against knife attacks; or

b. Equipment designed for protection for sporting activities.

(PL5014) Specially designed components for the **goods** specified in heads a., b. or c. of entry ML13 in this Group.

(ML14) Specialised equipment for military training or for simulating military scenarios, and specially designed components and accessories therefor.

(ML15) 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;

except:

First generation image intensifier tubes;

(d) Infrared or thermal imaging equipment;

(e) Imaging radar sensor equipment;

(f) Countermeasure or counter-countermeasure equipment for the equipment specified in heads a. to e. above.

(ML16) Forgings, castings and semi-finished products specially designed for **goods** specified in entries ML1, ML2, ML3, ML4, ML6, ML9, ML10, ML23 or ML26.

(PL5020) Forgings, castings and semi-finished products specially designed for **goods** specified in entries PL5006, PL5029 or PL5018.

(ML17) Miscellaneous **goods,** 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;

(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;

(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 and designed to use hydraulic fluids with flash points higher than 839 K (566°C);

(3) Operable at altitudes exceeding 30,000m; or

(4) Specially designed or rated for operating in an electro-magnetic pulse (EMP) environment;

(f) Libraries (parametric technical databases) specially designed for military use with **goods** specified in this Group.

In this entry, "libraries" means collections of technical information of a military nature, reference to which may enhance the performance of military equipment or systems.

(PL5032) **Goods** coated or treated for signature suppression specially designed for military use, other than those specified elsewhere in this Group.

(ML18) Equipment and **technology** for the **production** of **goods** specified in this Group, as follows:

(a) Specially designed or modified **production** equipment for the **production** of products specified in this Group 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 in this Group;

(c) **Production technology,** even if the equipment with which such **technology** is to be used is not specified in this Group;

(d) **Technology** specific to the design of, the assembly of components into, and the operation, maintenance and repair of, complete **production** installations even if the components themselves are not specified in this Group.

(PL5017) Equipment specially designed or modified for the **development** or use of military **goods** specified in this Group.

(ML20) 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 103K (−170°C);

(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; except:

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 component in the generator.

(ML23) Directed energy weapons (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 in heads a., b. or c. above;

(e) Physical test models and related test results for the systems, equipment and components specified in heads a. to d. above.

(ML24) **Software,** as follows:

(a) **Software** specially designed or modified for the **development, production,** or **use** of **goods** specified in this Group;

(b) Specific **software,** as follows:

(1) **Software** specially designed for:

(a) Modelling, simulation or evaluation of military weapon systems;

(b) **Development,** monitoring, maintenance or up-dating of **software** embedded in military weapon systems;

(c) Modelling or simulating military operation scenarios, not specified in entry ML14 in this Group;

(d) Command, Communications, Control and Intelligence (C^3I) applications;

(2) **Software** for determining the effects of conventional, nuclear, chemical or biological warfare weapons.

(ML26) Kinetic energy weapon systems and related equipment, as follows, and specially designed components therefor:

(a) Kinetic energy weapons 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.

(PL5001) Other security and para-military police **goods,** as follows:

(a) Acoustic devices represented by the manufacturers or suppliers thereof as suitable for riot control purposes, and specialised components therefor;

(b) Anti-riot shields, anti riot helmets and components therefor;

(c) Leg-irons, shackles (excluding any pair of handcuffs the maximum dimension of which when locked does not exceed 240 mm) and gangchains, specially designed for restraining human beings;

(d) Portable anti-riot devices for administering an electric shock or an incapacitating substance, and specialised components therefor;

(e) Water cannon and components therefor;

(f) Riot control vehicles which have been specially designed or modified to be electrified to repel boarders.

(PL5027) **Technology** applicable to the **development** or **use** of **goods** specified in entries ML11, ML18, PL5017, PL5029, heads a. or b. of entry ML4, heads a. or b. of entry ML5, head j. of entry ML6, heads a., b., or c. of entry ML10, or heads a., b., d., or e. of entry ML8 of this Group.

(PL5028) **Technology** applicable to the **development** or **use** of **goods** specified in this Group other than that specified in PL 5027.

GROUP 2

ATOMIC ENERGY MINERALS AND MATERIALS AND NUCLEAR FACILITIES, EQUIPMENT, APPLIANCES AND SOFTWARE

Interpretations and definitions

In this Group:

"boron equivalent" (BE) is defined as:

$BE = CF \times$ Concentration of element Z in ppm

$$\text{where CF is the conversion factor} = \frac{\text{gamma}_Z \times A_B}{\text{gamma}_B \times A_Z}$$

and gamma_B and gamma_Z are the thermal neutron capture cross sections (in barns) for boron and element Z respectively; and A_B and A_Z are the atomic weights of boron and element Z respectively;

"depleted uranium" means uranium depleted in the isotope 235 below that occurring in nature;

"effective gramme" of **special fissile material** or **other fissile material** means:

a. for plutonium isotopes and uranium-233, the isotope weight in grammes;

b. for uranium enriched 1 per cent or greater in the isotope U-235, the element weight in grammes multiplied by the square of its enrichment expressed as a decimal weight fraction;

c. for uranium enriched below 1 per cent in the isotope U-235, the element weight in grammes multiplied by 0.0001;

d. for americium-242m, curium-245 and curium-247, californium-249 and californium-251, the isotope weight in grammes multiplied by 10;

"fibrous or filamentary materials" 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;

"laser" means an assembly of components which produce both spatially and temporally coherent light which is amplified by stimulated emission of radiation;

"natural uranium" means uranium containing the mixtures of isotopes occurring in nature;

"nuclear reactor" means 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, come into direct contact with or control the primary coolant of the reactor core;

"other fissile materials" means **previously separated** americium-242m, curium-245 and curium-247, californium-249 and californium-251, isotopes of plutonium other than plutonium-238 and plutonium-239, and any material containing the foregoing;

"previously separated" means the application of any process intended to increase the concentration of the controlled isotope;

"special fissile material" means plutonium-239, uranium-233, **uranium enriched in the isotopes 235 or 233,** and any material containing the foregoing;

"specific modulus" means 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" means 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)[a]wC) and a relative humidity of (50 ± 5)%;

"uranium enriched in the isotopes 235 or 233" means uranium containing the isotopes 235 or 233, or both, in an amount such that the abundance ratio of the sum of these isotopes to the

isotope 238 is more than the ratio of the isotope 235 to the isotope 238 occurring in nature (isotopic ratio 0.72%).

2A Atomic Energy Minerals and Materials

(A10) **Natural uranium** or **depleted uranium** or thorium, in the form of metal, alloy, chemical compound, or concentrate and any other material containing one or more of the foregoing;

except:

a. Four grammes or less of **natural uranium** or **depleted uranium** when contained in a sensing component in instruments;

b. **Depleted uranium** specially fabricated for the following civil non-nuclear applications:

1. Shielding;

2. Packaging;

3. Ballasts;

4. Counter-weights.

(A20) **Special fissile materials** and **other fissile materials;**

except:

Four **effective grammes** or less when contained in a sensing component in instruments.

(a) (A30) (a) Plutonium in any form with a plutonium isotopic assay of plutonium-238 of more than 50%;

except:

Three grammes or less when contained in a sensing component in instruments;

(b) **Previously separated** neptunium-237 in any form;

except:

Shipments with a neptunium-237 content of one gramme or less.

(A40) Deuterium, heavy water, deuterated paraffins and other compounds of deuterium, and mixtures and solutions containing deuterium, in which the isotopic ratio of deuterium to hydrogen exceeds 1:5,000.

(A50) Graphite, nuclear-grade, having a purity level of less than 5 parts per million **boron equivalent** and with a density greater than 1.5 g/cm^3.

(A60) Nickel powder and porous nickel metal, as follows:

(a) Powder with a nickel purity content of 99.9 weight percent or more and a mean particle size of less than 10 micrometres measured by American Society for Testing and Materials (ASTM) B330 standard and a high degree of particle size uniformity;

(b) Porous nickel metal produced from materials specified in head a. above;

except:

Single porous nickel sheets not exceeding 930 cm^2 intended for use in batteries for civil applications.

(A70) Specially prepared compounds or powders, other than nickel, resistant to corrosion by UF_6 (e.g. aluminium oxide and fully fluorinated hydrocarbon polymers), for the manufacture of gaseous diffusion barriers, having a purity content of 99.9 weight percent or more and a mean particle size of less than 10 micrometres measured by American Society for Testing and Materials (ASTM) B330 standard and a high degree of particle size uniformity.

2B Nuclear Facilities, Equipment, Appliances and Software

(B10) Plant for the separation of isotopes of **natural uranium, depleted uranium, special fissile materials** or **other fissile materials,** and specially designed or prepared equipment and components therefor, as follows:

(a) Plant specially designed for separating isotopes of **natural uranium, depleted uranium, special fissile materials** or **other fissile materials,** as follows:

(1) Gaseous diffusion separation plant;

(2) Gas centrifuge separation plant;

(3) Aerodynamic separation plant;

(4) Chemical exchange separation plant;

(5) Ion-exchange separation plant;

(6) Atomic vapour **laser** isotopic separation plant;

(7) Molecular **laser** isotopic separation plant;

(8) Plasma separation plant;

(9) Electromagnetic separation plant;

(b) Equipment and components, as follows, specially designed or prepared for:

(1) Gaseous diffusion separation process:

(a) Valves wholly made of or lined with aluminium, aluminium alloys, nickel or alloy containing 60 weight percent or more nickel, 40 mm or more in diameter, with bellows seals;

(b) Blowers and compressors (turbo, centrifugal and axial flow types) wholly made of or lined with materials resistant to UF_6 (e.g. aluminium, aluminium alloys, nickel or alloy containing 60 weight percent or more nickel), having a capacity of 1,000 litres per minute or more, and seals therefor designed for a buffer gas in-leakage rate of less than 1,000 cm^3/min;

(c) Gaseous diffusion barriers made of porous metallic, polymer or ceramic materials resistant to corrosion by UF_6 with a pore size of less than 100 nm, a thickness of 5 mm or less, and, for tubular forms, a diameter of 25 mm or less;

(d) Gaseous diffuser housings;

(e) Heat exchangers made of aluminium, copper, nickel or alloys containing more than 60 weight percent nickel, or combinations of these metals as clad tubes, designed to operate at sub-atmospheric pressure with a leak rate that limits the pressure rise to less than 10 Pa per hour under a pressure differential of 100 kPa;

(2) Gas centrifuge separation process:

(a) Gas centrifuges;

(b) Complete rotor assemblies;

(c) Rotor tube cylinders with a thickness of 12 mm or less, a diameter of between 75 mm and 400 mm, made from any of the following high strength-to-density ratio materials:

(1) Maraging steel capable of an ultimate tensile strength of 2,050 MPa or more;

(2) Aluminium alloys capable of an ultimate tensile strength of 460 MPa or more; or

(3) **Fibrous or filamentary materials** with a **specific modulus** of more than 3.18×10^6 m and a **specific tensile strength** greater than 76.2×10^3 m;

(d) Magnetic suspension bearings consisting of an annular magnet suspended within a housing containing a damping medium, and having the magnet coupling with a pole piece or second magnet fitted to the top cap of the rotor;

(e) Specially prepared bearings comprising a pivot-cup assembly mounted on a damper;

(f) Rings or bellows with a wall thickness of 3 mm or less and a diameter of between 75 mm and 400 mm and designed to give local support to a rotor tube or to join a number together, made from any of the following high strength-to-density ratio materials:

(1) Maraging steel capable of an ultimate tensile strength of 2,050 MPa or more;

(2) Aluminium alloys capable of an ultimate tensile strength of 460 MPa or more; or

(3) **Fibrous or filamentary materials** with a **specific modulus** of more than 3.18×10^6 m and a **specific tensile strength** greater than 76.2×10^3 m;

(g) Baffles of between 75 mm and 400 mm diameter for mounting inside a rotor tube, made from any of the following high strength-to-density ratio materials:

(1) Maraging steel capable of an ultimate tensile strength of 2,050 MPa or more;

(2) Aluminium alloys capable of an ultimate tensile strength of 460 MPa or more; or

(3) **Fibrous or filamentary materials** with a **specific modulus** of more than 3.18×10^6 m and a **specific tensile strength** greater than 76.2×10^3 m;

(h) Top and bottom caps of between 75 mm and 400 mm diameter to fit the ends of a rotor tube, made from any of the following high strength-to-density ratio materials:

(1) Maraging steel capable of an ultimate tensile strength of 2,050 MPa or more;

(2) Aluminium alloys capable of an ultimate tensile strength of 460 MPa or more; or

(3) **Fibrous or filamentary materials** with a **specific modulus** of more than 3.18×10^6 m and a **specific tensile strength** greater than 76.2×10^3 m;

(i) Molecular pumps comprised of cylinders having internally machined or extruded helical grooves and internally machined bores;

(j) Ring-shaped motor stators for multiphase AC hysteresis (or reluctance) motors for synchronous operation within a vacuum in the frequency range of 600 to 2,000 Hz and a power range of 50 to 1,000 Volt-Amps;

(k) Frequency changers (converters or inverters) specially designed or prepared to supply motor stators for gas centrifuge enrichment, having all of the following characteristics, and specially designed components therefor:

(1) Multiphase output of 600 Hz to 2 kHz;

(2) Frequency control better than 0.1%;

(3) Harmonic distortion of less than 2%; and

(4) An efficiency greater than 80%;

(3) Aerodynamic separation process:

(a) Separation nozzles consisting of slit-shaped, curved channels having a radius of curvature less than 1 mm and having a knife-edge contained within the nozzle which separates the gas flowing through the nozzle into two streams;

(b) Tangential inlet flow-driven cylindrical or conical tubes, specially designed for uranium isotope separation;

(c) UF_6-hydrogen helium compressors wholly made of or lined with aluminium, aluminium alloys, nickel or alloy containing 60 weight percent or more nickel, including compressor seals;

(d) Aerodynamic separation element housings, designed to contain vortex tubes or separation nozzles;

(e) Heat exchangers made of aluminium, copper, nickel, or alloys containing more than 60 weight percent nickel, or combinations of these metals as clad tubes, designed to operate at pressures of 600 kPa or less;

(4) Chemical exchange separation process:

(a) Fast-exchange liquid-liquid centrifugal contactors or fast exchange liquid-liquid pulse columns made of fluorocarbon lined materials;

(b) Electrochemical reduction cells designed to reduce uranium from one valence state to another;

(5) Ion-exchange separation process including fast reacting ion-exchange resins, pellicular and reticulated resins in which the active chemical exchange groups are limited to a coating on the surface of an inert particle or fibre;

(6) Atomic vapour **laser** isotopic separation process:

(a) High power electron beam guns with total power of more than 50 kW and strip or scanning electron beam guns with a delivered power of more than 2.5 kW/cm for use in uranium vaporization systems;

(b) Trough shaped crucible and cooling equipment for molten uranium;

(c) Product and tails collector systems made of or lined with materials resistant to the heat and corrosion of uranium vapour, such as yttria-coated graphite;

(7) Molecular **laser** isotopic separation process:

(a) Supersonic expansion nozzles designed for UF_6 carrier gas;

(b) Uranium fluoride (UF5) product filter collectors;

(c) Equipment for fluorinating UF5 to UF6;

(d) UF_6 carrier gas compressors wholly made of or lined with aluminium, aluminium alloys, nickel or alloy containing 60 weight percent or more nickel, including compressor seals;

(8) Plasma separation process:

(a) Product and tails collectors made of or lined with materials resistant to the heat and corrosion of uranium vapour such as yttria-coated graphite;

(b) Radio frequency ion excitation coils for frequencies of more than 100 kHz and capable of handling more than 40 kW power.

(B20) Specially designed or prepared auxiliary systems, equipment and components, as follows, for gas centrifuge or gaseous diffusion enrichment plants, made from or lined with UF_6 resistant materials:

(a) Feed autoclaves, for passing UF_6 to gaseous diffusion or centrifuge cascades, capable of operating at pressures of 300 kPa or less;

(b) Desublimers or cold traps, used to remove UF_6 from gaseous diffusion or centrifuge cascades, capable of operating at pressures of 300 kPa or less;

(c) Product and tails stations for trapping and transferring UF_6 into containers;

(d) Liquefaction stations, where UF_6 gas from gaseous diffusion or centrifuge cascades is compressed and cooled to form liquid UF_6, capable of operating at pressures of 300 kPa or less;

(e) Piping systems and header systems specially designed for handling UF_6 within gaseous diffusion or centrifuge cascades;

(f) Specially designed vacuum manifolds or vacuum headers having a suction capacity of 5 m^3/minute or more or specially designed vacuum pumps;

(g) UF_6 mass spectrometers/ion sources specially designed or prepared for taking on-line samples of feed, product or tails from UF_6 gas streams and having all of the following characteristics:

(1) Unit resolution for mass of more than 320 amu;

(2) Ion sources constructed of or lined with nichrome or monel, or nickel plated; and

(3) Electron bombardment ionization sources.

(B30) Plant for the production of uranium hexafluoride (UF_6) and specially designed or prepared equipment and components therefor, as follows:

(a) Plant for the production of UF_6;

(b) Equipment and components, as follows, specially designed or prepared for UF_6 production:

(1) Fluorination and hydrofluorination screw and fluid bed reactors and flame towers;

(2) Distillation equipment for the purification of UF_6.

(B40) Plant for the production of heavy water, deuterium or deuterium compounds, and specially designed or prepared equipment and components therefor, as follows:

(a) Plant for the production of heavy water, deuterium or deuterium compounds, as follows:

(1) Hydrogen sulphide-water exchange plant;

(2) Ammonia-hydrogen exchange plant;

(3) Hydrogen distillation plant;

(b) Equipment and components, as follows, designed for:

(1) Hydrogen sulphide-water exchange process:

(a) Tray exchange towers;

(b) Hydrogen sulphide gas compressors;

(2) Ammonia-hydrogen exchange process:

(a) High-pressure ammonia-hydrogen exchange towers;

(b) High-efficiency stage contactors;

(c) Submersible stage recirculation pumps;

(d) Ammonia crackers designed for pressures of more than 3 MPa;

(3) Hydrogen distillation process:

(a) Hydrogen cryogenic distillation towers and cold boxes designed for operation below 35 K (-238°C);

(b) Turboexpanders or turboexpander-compressor sets designed for operation below 35 K (-238°C);

(4) Heavy water concentration process to reactor grade level (99.75 weight percent deuterium oxide):

(a) Water distillation towers containing specially designed packings;

(b) Ammonia distillation towers containing specially designed packings;

(c) Catalytic burners for conversion of fully enriched deuterium to heavy water;

(d) Infrared absorption analysers capable of on-line hydrogen-deuterium ratio analysis where deuterium concentrations are equal to or more than 90 weight per cent.

(B50) **Nuclear reactors,** i.e. reactors capable of operation so as to maintain a controlled, self-sustaining fission chain reaction, and equipment and components specially designed or prepared for use in connection with a **nuclear reactor,** including:

(a) Pressure vessels, i.e. metal vessels as complete units or parts therefor, which are specially designed or prepared to contain the core of a **nuclear reactor** and are capable of withstanding the operating pressure of the primary coolant, including the top plate for a reactor pressure vessel;

(b) Fuel element handling equipment, including reactor fuel charging and discharging machines;

(c) Control rods specially designed or prepared for the control of the reaction rate in a **nuclear reactor,** including the neutron absorbing part and the support or suspension structures therefor, and control rod guide tubes;

(d) Electronic controls for controlling the power levels in **nuclear reactors,** including reactor control rod drive mechanisms and radiation detection and measuring instruments to determine neutron flux levels;

(e) Pressure tubes specially designed or prepared to contain fuel elements and the primary coolant in a **nuclear reactor** at an operating pressure in excess of 5.1 MPa;

(f) Tubes, or assemblies of tubes, made from zirconium metal or alloy in which the ratio of hafnium to zirconium is less than 1:500 parts by weight, specially designed or prepared for use in a **nuclear reactor;**

(g) Coolant pumps specially designed or prepared for circulating the primary coolant of **nuclear reactors;**

(h) Internal components specially designed or prepared for the operation of a **nuclear reactor,** including core support structures, thermal shields, baffles, core grid plates and diffuser plates;

(i) Heat exchangers.

(B60) Plant specially designed for the fabrication of **nuclear reactor** fuel elements and specially designed equipment therefor, including equipment which:

(a) Normally comes into direct contact with or directly processes or controls the production flow of nuclear materials;

(b) Seals the nuclear material within the cladding;

(c) Checks the integrity of the cladding or the seal; and

(d) Checks the finish treatment of the solid fuel.

(B70) Plant for the reprocessing of irradiated **nuclear reactor** fuel elements, and specially designed or prepared equipment and components therefor, including:

(a) Fuel element chopping or shredding machines, i.e. remotely operated equipment to cut, chop, shred or shear irradiated **nuclear reactor** fuel assemblies, bundles or rods;

(b) Dissolvers, critically safe tanks (e.g. small diameter, annular or slab tanks) specially designed or prepared for the dissolution of irradiated **nuclear reactor** fuel, which are capable of withstanding hot, highly corrosive liquids, and which can be remotely loaded and maintained;

(c) Counter-current solvent extractors and ion-exchange processing equipment, specially designed or prepared for use in a plant for the reprocessing of irradiated **natural uranium, depleted uranium, special fissile materials** or **other fissile materials;**

(d) Process control instrumentation specially designed or prepared for monitoring or controlling the reprocessing of irradiated **natural uranium, depleted uranium, special fissile materials** or **other fissile materials;**

(e) Holding or storage vessels specially designed to be critically safe and resistant to the corrosive effects of nitric acid;

(f) Systems specially designed or prepared for the conversion of plutonium nitrate to plutonium oxide;

(g) Systems specially designed or prepared for the production of plutonium metal.

(B80) Power generating or propulsion equipment specially designed for use with space, marine or mobile **nuclear reactors.**

(B90) Equipment, as follows, specially designed or prepared for the separation of isotopes of lithium:

(a) Packed liquid-liquid exchange columns specially designed for lithium amalgams;

(b) Amalgam pumps;

(c) Amalgam electrolysis cells;

(d) Evaporators for concentrated lithium hydroxide solution.

(B100) Equipment for **nuclear reactors,** as follows:

(a) Simulators specially designed for **nuclear reactors;**

(b) Ultrasonic or eddy current test equipment specially designed for **nuclear reactors.**

(B110) **Software** specially designed or modified for the **development, production** or **use** of equipment or materials specified in this Group.

(E10) **Technology** applicable to the **development, production** or **use** of **goods** specified in entries A30, B30, B80 to B110, head b. of entry A60, sub-heads b.4. to b.8. of entry B10, head d. of entry B50, head i. of entry B50, or head d. of entry B70 in this Group.

(E20) **Technology** applicable to the **development, production** or **use** of **goods** specified in this Group other than that specified in entry E10.

GROUP 3

INDUSTRIAL GOODS

Interpretations, exclusions and definitions

1. Where notes are included in any entry of this Group they are to be treated as part of the entry.

2. This Group does not specify **software** which is either:

(a) generally available to the public or

(b) (1) sold from stock at retail selling points, without restriction, by means of:

(a) over-the-counter transactions;

(b) mail order transactions;

(c) telephone order transactions; and

(2) is designed for installation by the user without further substantial support by the supplier.

3. In this Group:

"3-D vector rate" means the number of vectors generated per second which have 10 pixel poly line vectors, clip tested, randomly oriented, with either integer or floating point X-Y-Z coordinate values, whichever produces the maximum rate;

"accuracy", usually measured in terms of inaccuracy, means the maximum deviation, positive or negative, of an indicated value from an accepted standard or true value;

"active flight control systems" means systems whose function is to prevent undesirable **aircraft** motions, rocket motions or structural loads by autonomously processing outputs from multiple sensors and then providing necessary preventive commands to effect automatic control;

"active pixel" means a minimum (single) element of the solid state array which has a photoelectric transfer function when exposed to light;

"adaptive control" means a control system that adjusts the response from conditions detected during the operation;

"angular position deviation" means 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;

"ASTM" means the American Society for Testing and Materials;

"asynchronous transfer mode (ATM)" means a transfer mode in which the information is organised into cells; it is asynchronous in the sense that the recurrence of cells depends on the required or instantaneous bit rate;

"automatic target tracking" means a processing technique that automatically determines and provides as output an extrapolated value of the most probable position of the target in real time;

"bandwidth of one voice channel", in the case of data communication equipment, means designed to operate in one voice channel of 3,100 Hz, as defined in CCITT Recommendation G.151;

"basic gate propagation delay time" means the propagation delay time value corresponding to the basic gate used within a **family** of **monolithic integrated circuits;** this may be specified, for a given **family,** either as the propagation delay time per typical gate or as the typical propagation delay time per gate;

"beat length" means the distance over which two orthogonally polarised signals, initially in phase, must pass in order to achieve a 2 Pi radian(s) phase difference;

"bias" means an accelerometer output when no acceleration is applied;

"camming" (axial displacement) means 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;

"CCITT" means International Telegraph and Telephone Consultative Committee;

"CEP" (circle of equal probability) means a measure of accuracy defined as the radius of the circle centred at the target, at a specific range, in which 50% of the payloads impact;

"chemical laser" means a **laser** in which the excited species is produced by the output energy from a chemical reaction;

"circuit element" means a single active or passive functional part of an electronic circuit which may be a diode, a transistor, a resistor or a capacitor;

"circulation-controlled anti-torque or circulation-controlled directional control systems" means systems that use air blown over aerodynamic surfaces to increase or control the forces generated by the surfaces;

"commingled" means the filament to filament blending of thermoplastic fibres and reinforcement fibres in order to produce a fibre reinforcement **matrix** mix in total fibre form;

"comminution" means a process to reduce a material to particles by crushing or grinding;

"common channel signalling" means 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" means 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;

"composite" means 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;

"composite theoretical performance" (CTP) means a measure of computational performance given in millions of theoretical operations per second (Mtops), calculated using the aggregation of **computing elements** (CE);

Note to **composite theoretical performance** (CTP)

Abbreviations used in this Note

CE	**computing element** (typically an arithmetic logical unit)
FP	floating point
XP	fixed point
t	execution time
XOR	exclusive OR
CPU	central processing unit
TP	theoretical performance (of a single CE)
CTP	**composite theoretical performance** (multiple CEs)
Mtops	millions of theoretical operations per second
R	effective calculating rate
WL	word length
L	word length adjustment
*	multiply
	Execution time 't' is expressed in microseconds, TP and CTP are expressed in millions of theoretical operations per second (Mtops) and WL is expressed in bits.

Outline of the CTP calculation method

CTP is a measure of computational performance given in Mtops. In calculating the CTP of an aggregation of CEs the following three steps are required:

1. Calculate the effective calculating rate R for each CE;
2. Apply the word length adjustment (L) to the effective calculating rate (R), resulting in a Theoretical Performance (TP) for each CE.;

3. If there is more than one CE, combine the TPs resulting in a CTP for the aggregation.

Details for these steps are given in the following sections.

Note 1. For aggregations of multiple CEs which have both shared and unshared memory subsystems, the calculation of CTP is completed hierarchically, in two steps: first, aggregate the group of CEs sharing memory, second calculate the CTP of the groups using the calculation method for multiple CEs not sharing memory.

Note 2. CEs that are limited to input/output and peripheral functions (e.g. disk drive, communication and video display controllers) are not aggregated into the CTP calculation.

The following table shows the method of calculating the effective calculating rate (R) for each CE:

(Step 1) The effective calculating rate R

For CEs implementing Note: Every CE must be evaluated independently	*Effective calculating rate, R*
XP only (R_{xp})	$\frac{1}{3 * (t_{xp\ add})}$ if no add is implemented use: $\frac{1}{(t_{xp\ multi})}$ If neither add nor multiply is implemented use the fastest available arithmetic operation as follows: $\frac{1}{3 * t_{xp}}$ See Notes X & Y
FP only (R_{fp})	Max $\frac{1}{t_{fp\ add}}, \frac{1}{t_{fp\ multi}}$ See Notes X & Z
Both FP and XP (R)	Calculate both R_{xp}, R_{fp}
For simple logic processors not implementing any of the specified arithmetic operations.	$\frac{1}{3 * t_{log}}$ Where t_{log} is the execute time of the XOR, or for logic hardware not implementing the XOR, the fastest simple logic operation. See Notes X & Z

For CEs implementing Note: Every CE must be evaluated independently	*Effective calculating rate, R*
For special logic processors not using any of the specified arithmetic or logic operations.	$R = R' * WL/64$ Where R' is the number of results per second, WL is the number of bits upon which the logic operation occurs, and 64 is a factor to normalize to a 64 bit operation.

Note W: For a pipelined CE capable of executing up to one arithmetic or logic operation every clock cycle after the pipeline is full, a pipelined rate can be established. The effective calculating rate (R) for such a CE is the faster of the pipelined rate or non-pipelined execution rate.

Note X: For CEs which perform multiple operations of a specific type in a single cycle (e.g., two additions per cycle or two identical logic operations per cycle), the execution time t is given by:

$$t = \frac{\text{cycle time}}{\text{the number of identical arithmetic operations per machine cycle}}$$

CEs which perform different types of arithmetic or logic operations in a single machine cycle are to be treated as multiple separate CEs performing simultaneously (e.g., a CE performing an addition and a multiplication in one cycle is to be treated as two CEs, the first performing an addition in obne cycle and the second performing a multiplication in one cycle).

If a single CE has both scalar function and vector function, use the shorter execution time value.

Note Y: For the CE that does not implement FP add or FP multiply, but that performs FP divide:

$$R_{fp} = \frac{1}{t_{fpdivide}}$$

If the CE implements FP reciprocal but not FP add, FP multiply or FP divide, then

$$R_{fp} = \frac{1}{t_{fpreciprocal}}$$

If none of the specified instructions is implemented, the effective FP rate is 0.

Note Z: In simple logic operations, a single instruction performs a single logic manipulation of no more than two operands of given lengths. In complex logic operations, a single instruction performs multiple logic manipulations to produce one or more results from two or more operands.

Rates should be calculated for all supported operand lengths considering both pipelined operations (if supported), and non-pipelined operations using the fastest executing instruction for each operand length based on:

(1) Pipelined or register-to-register operations. Exclude extraordinarily short execution times generated for operations on a predetermined operand or operands (for example, multiplication by 0 or 1). If no register-to-register operations are implemented, continue with (2).

(2) The faster of register-to-memory or memory-to-register operations; if these also do not exist, then continue with (3).

(3) Memory-to-memory.

In each case above, use the shortest execution time certified by the manufacturer.

Step 2: TP for each supported operand length WL

Adjust the effective rate R (or R') by the word length adjustment L as follows:

TP = R * L,

where L = (1/3 + WL/96)

Note: The word length WL used in these calculations is the operand length in bits. (If an operation uses operands of different lengths, select the largest word length.)

The combination of a mantissa ALU and an exponent ALU of a floating point processor or unit is considered to be one CE with a Word Length (WL) equal to the number of bits in the data representation (typically 32 or 64) for purposes of the CTP calculation.

This adjustment is not applied to specialized logic processors which do not use XOR instructions. In this case TP = R.

Select the maximum resulting value of TP for:

Each XP-only CE (R_{xp});

Each FP-only CE (R_{fp});

Each combined FP and XP CE (R);

Each simple logic processor not implementing any of the specified arithmetic operations; and

Each special logic processor not using any of the specified arithmetic or logic operations.

(Step 3) CTP for aggregations of CEs, including CPUs

For a CPU with a single CE,

CTP = TP

(for CEs performing both fixed and floating point operations

TP = max (TP_{fp}, TP_{xp}))

CTP for aggregations of multiple CEs operating simultaneously is calculated as follows:

Note 1: For aggregations that do not allow all of the CEs to run simultaneously, the possible combination of CEs that provides the largest CTP should be used. The TP of each contributing CE is to be calculated at its maximum value theoretically possible before the CTP of the combination is derived.

N.B. To determine the possible combinations of simultaneously operating CEs, generate an instruction sequence that initiates operations in multiple CEs, beginning with the slowest CE (the one needing the largest number of cycles to complete its operation) and ending with the fastest CE. At each cycle of the sequence, the combination of CEs that are in operation during that cycle is a possible combination. The instruction sequence must take into account all hardware and/or architectural constraints on overlapping operations.

Note 2: A single integrated circuit chip or board assembly may contain multiple CEs.

Note 3: 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: CTP values are not to be aggregated for CE combinations (inter)connected by **local area networks,** Wide Area Networks, Input/Output shared connections/ devices, Input/Output controllers and any communication interconnection implemented by software.

Note 5: CTP values must be aggregated for multiple CEs specially designed to enhance performance by aggregation, operating simultaneously and sharing memory, — or

multiple memory/CE — combinations operating simultaneously utilising specially designed hardware.

This aggregation does not apply to assemblies described by entry 4A003c

$CTP = TP_1 + C_2 * TP_2 + \ldots + C_n * TP_n$,

where the TPs are ordered by value, with TP_1 being the highest, TP_2 being the second highest,…, and TP_n being the lowest. C_i is a coefficient determined by the strength of the interconnection between CEs, as follows:

For multiple CEs operating simultaneously and sharing memory: $C_2 = C_3 = C_4 = \ldots = C_n = 0.75$

Note 1: When the CTP calculated by the above method does not exceed 194 Mtops, the following formula may be used to calculate C_i:

$$C_i = \frac{0.75}{(m)^{x}\,(i = 2, \ldots, n)}$$

where

m = number of CEs or groups of CEs sharing access.

provided:

1. The TPi of each CE or group of CEs does not exceed 30 Mtops
2. The CEs or groups of CEs share access to main memory (excludingcache memory) over a single channel; and
3. Only one CE or group of CEs can have use of the channel at any given time.

N.B. This does not apply to items controlled under Category 3.

Note 2: CEs share memory if they access a common segment of solid state memory. This memory may include cache memory, main memory, or other internal memory. Peripheral memory devices such as disk drives, tape drives or RAM disks are not included.

For Multiple CEs or groups of CEs not sharing memory, interconnected by one or more data channels:

$C_i = 0.75 * k_i$ (i = 2,…,32) (see note below)

$= 0.60 * k_i$ (i = 33,…,64)

$= 0.45 * k_i$ (i = 65,…,256)

$= 0.30 * k_i$ (i > 256)

The value of C_i is based on the number of CEs, not the number of nodes.

where

$k_i = \min (S_i/K_r, 1)$, and

K_r = normalizing factor of 20 MByte/s

S_i = sum of the maximum data rates (in units of MByte/s) for all data channels connected to the i^{th} CE or group of CEs sharing memory.

When calculating a C_i for a group of CEs, the number of the first CE in a group determines the proper limits for C_i. For example, in an aggregation of groups consisting of 3 CEs each, the 22^{nd} group will contain CE_{64}, CE_{65} and CE_{66}. The proper limit for C_i for this group is 0.60.

Aggregation (of CEs or groups of CEs) should be from fastest-to-slowest; i.e.:

$TP_1 \geq TP_2 \geq \ldots \geq TP_n$, and

in the case of $TP_i + TP_{i+1}$ from the largest to smallest; i.e.:

$C_i \geq C_{i+1}$

Note: The k_i factor is not applied to CEs 2 to 12 if the TP_i of the CE or group of CEs is more than 50 Mtops; i.e., C_i for CEs 2 to 12 is 0.75;

"compound rotary table" means a table allowing the workpiece to rotate and tilt about two non-parallel axes, which can be coordinated simultaneously for **contouring control;**

"computing element" (CE) means the smallest computational unit that produces an arithmetic or logic result;

"contouring control" means 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;

"critical temperature" (sometimes referred to as the transition temperature) of a specific superconductive material means the temperature at which the specific material loses all resistance to the flow of direct electrical current;

"cryptography" means 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 or associated key management; for this purpose, "secret parameter" means a constant or key kept from the knowledge of others or shared only within a group;

"datagram" means a self-contained, independent entity of data carrying sufficient information to be routed from the source to the destination data terminal equipment without reliance on earlier exchanges between this source or destination data terminal equipment and the transporting network;

"data signalling rate" means the maximum one-way rate, i.e., the maximum rate in either transmission or reception, whichever is the greater, as defined in ITU Recommendation 53-36, taking into account that, for non-binary modulation, baud and bit per second are not equal; binary digits for coding, checking and synchronisation functions are included;

"deformable mirrors" (also known as adaptive optic mirrors) means mirrors having:

a. 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. multiple optical reflecting elements that can be individually and dynamically be repositioned by the application of torques or forces to compensate for distortions in the optical waveform incident upon the mirror;

"diffusion bonding" means 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" means equipment which can, in the form of one or more discrete variables:

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 (including by replacement of fixed storage devices, but not by a physical change in wiring or interconnections); and

d. provide output of data;

"digital transfer rate" means the total bit rate of the information that is directly transferred on any type of medium;

"direct-acting hydraulic pressing" means a deformation process which uses a fluid-filled flexible bladder in direct contact with the workpiece;

"discrete component" means a separately packaged **circuit element** with its own external connections;

"drift rate", as it relates to gyros, means the time rate of output deviation from the desired output; it consists of random and systematic components and is expressed as an equivalent input angular displacement per unit time with respect to inertial space;

"dynamic adaptive routing" means automatic rerouting of traffic based on sensing and analysis of current actual network conditions;

"dynamic signal analysers" means **signal analysers** which use digital sampling and transformation techniques to form a Fourier spectrum display of the given waveform including amplitude and phase information;

"electronically steerable phased array antenna" means an antenna which forms a beam by means of phase coupling, where the beam direction is controlled by the complex excitation coefficients of the radiating elements and the direction of that beam can be varied in azimuth or in elevation, or both, by application, both in transmission and reception, of an electrical signal;

"electronic assemblies" mean a number of electronic components (including **circuit elements, discrete components** and integrated circuits) connected together to perform a specific function, which are replaceable as an entity and are normally capable of being disassembled;

"end-effectors" include grippers, active tooling units and any other tooling that is attached to the baseplate on the end of a **robot** manipulator arm; for this purpose, "active tooling unit" means a device for applying motive power, process energy or sensing to the workpiece;

"equivalent density" means the mass of an optic per unit optical area projected onto the optical surface;

"expert systems" means 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);

"family" means a group of microprocessor or microcomputer microcircuits which have:

a. the same architecture;

b. the same basic instruction set; and

c. the same basic technology (e.g., only N-channel Metal Oxide Semiconductor (NMOS) or only Complementary Metal Oxide Semiconductor (CMOS));

"fast select" means a facility applicable to virtual calls which allows a data terminal equipment to expand the possibility of transmitting data in call set-up and clearing packets beyond the basic capabilities of a virtual call; for this purpose, "packet" means a group of binary digits (including call control signals and data) which is switched as a composite whole, the call control signals, data and if present error control information being arranged in a specified format;

"fault tolerance" means the ability 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" 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" means an array of **circuit elements** and metallic interconnections formed by deposition of a thick or thin film on an insulating **substrate;**

"fixed", as it relates to **information security,** means that the coding or compression algorithm cannot accept externally supplied parameters (e.g., cryptographic or key variables) and cannot be modified by the user;

"flexible manufacturing unit" (FMU), (sometimes also referred to as flexible manufacturing system (FMS) or flexible manufacturing cell (FMC)) means a combination of at least:

a. a **digital computer** including its own **main storage** and its own related equipment; and

b. two or more of the following:

    1. a machine tool specified in head c. of entry 2B001;

    2. a dimensional inspection machine or another digitally controlled measuring machine specified in Category 2;

    3. a **robot** specified in Categories 2 or 8;

    4. digitally controlled equipment specified in entries 1B003, 2B003 or 9B001;

    5. **Stored programme controlled** equipment specified in head a. of entry 3B001;

    6. digitally controlled equipment specified in entry 1B001;

    7. digitally controlled electronic equipment specified in head c. of entry 3A002;

"fluoride fibres" means fibres manufactured from bulk fluoride compounds;

"focal plane array" means 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; this is not intended to 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;

"frequency agility" means a system in which the transmission frequency of a single communication channel is made to change by discrete steps (sometimes known as frequency hopping);

"frequency switching time" means the maximum time (i.e., delay), taken by a signal, when switched from one selected output frequency to another selected output frequency, to reach:

a. a frequency within 100 Hz of the final frequency; or

b. an output level within 1 dB of the final output level;

"frequency synthesiser" means any kind of frequency source or signal generator, 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;

"gas atomisation" means a process to reduce a molten stream of metal alloy to droplets of 500 micrometre diameter or less by a high pressure gas stream;

"gateway" means the function, realised by any combination of equipment and **software,** to carry out the conversion of conventions for representing, processing or communicating information used in one system into the corresponding but different conventions used in another system;

"generic software" means a set of instructions for a **stored programme controlled** switching system that is the same for all switches using that type of switching system, the database portion is not considered to be part of the **generic software;**

"geographically dispersed" means where each sensor location is distant from any other by more than 1,500m in any direction; mobile sensors are always considered **geographically dispersed;**

"global interrupt latency time" means the time taken by a computer system to recognize an interrupt due to an event, service the interrupt and perform a context switch to an alternate memory-resident task waiting on the interrupt;

"guidance set" means systems that integrate the process of measuring and computing a vehicles position and velocity (i.e. navigation) with that of computing and sending commands to the vehicles flight control systems to correct the trajectory;

"hot isostatic densification" means the process of pressurising a casting at temperatures exceeding 375 K (102°C) in a closed cavity through various media (including gas, liquid or solid particles) to create equal force in all directions to reduce or eliminate internal voids in the casting;

"hybrid computer" means equipment which can:

a. accept data;

b. process data, in both analogue and digital representations; and

c. provide output of data;

"hybrid integrated circuit" means any combination of integrated circuit(s), integrated circuits with **circuit elements** or **discrete components** connected together to perform a specific function and having all the following characteristics:

a. containing at least one unencapsulated device;

b. connected together using typical integrated circuit production methods

c. replaceable as an entity; and

d. not normally capable of being disassembled;

"image enhancement" means 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;

"improvised explosive devices" means devices placed or fabricated in an improvised manner incorporating destructive, lethal, noxious, pyrotechnic or incendiary chemicals, designed to destroy, disfigure or harass; they may incorporate military stores, but are normally devised from non-military components;

"information security" means 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,** cryptanalysis, protection against compromising emanations and computer security; for this purpose, "cryptanalysis" is the analysis of a cryptographic system or its inputs and outputs to derive confidential variables or sensitive data, including clear text;

"instantaneous bandwidth" means the bandwidth over which output power remains constant within 3 dB without adjustment of other operating parameters;

"instrumented range" means the specified unambiguous display range of a radar;

"insulation" means material intended to provide protection from the effects of heat during the operation of rocket motors. The material includes cured or semi-cured compounded rubber sheet stock containing an insulating or refractory material. It is applied to the components of a rocket motor, i.e. the case, nozzle, inlets, case closures.

"Integrated Services Digital Network" (ISDN) means a unified end-to-end digital network, in which data originating from all types of communication (e.g., voice, text, data, still and moving pictures) are transmitted from one port (terminal) in the exchange (switch) over one access line to and from the subscriber;

"interconnected radar sensors" means two or more radar sensors which mutually exchange data in real time;

"intrinsic magnetic gradiometer" means a single magnetic field gradient sensing element and associated electronics, the output of which is a measure of magnetic field gradient;

"ISO" means the International Standards Organisation;

"isostatic presses" means equipment capable of pressurising a closed cavity through various media (including gas, liquid and solid particles) to create equal pressure in all directions within the cavity upon a workpiece or material;

"ITU" means International Telecommunications Union;

"laser" means an assembly of components which produce both spatially and temporally coherent light which is amplified by stimulated emission of radiation;

"linearity" (usually measured in terms of non-linearity) means 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" means a data communication system which:

a. allows any 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);

"magnetic gradiometers" means instruments designed to detect the spatial variation of magnetic fields from external sources; they consist of multiple **magnetometers** and associated electronics, the output of which is a measure of magnetic field gradient;

"magnetometers" means instruments designed to detect magnetic fields from external sources; 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" means 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" means a substantially continuous phase that fills the space between particles, whiskers or fibres;

"maximum bit transfer rate" of:

a. solid state storage equipment means the number of data bits per second transferred between the equipment and its controller;

b. a disk drive means the internal data transfer rate calculated as B×R×T (bits per second)

where:

B=maximum number of data bits per track available to read or write in a single revolution;

R=revolutions per second;

T=number of tracks which can be read or written simultaneously;

"mechanical alloying" means 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;

"media access unit" means equipment which contains one or more communication interfaces **(network access controller, communications channel controller,** modem or computer bus) to connect terminal equipment to a network;

"melt extraction" means 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" means 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" means a **monolithic integrated circuit** or **multichip integrated** circuit containing an arithmetic logic unit (ALU) capable of executing general purpose instructions from an internal storage (or on an internal storage augmented by an external storage), on data contained in the internal storage;

"microprocessor microcircuit" means 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: this includes chip sets which are designed to operate together to provide the function of a **microprocessor microcircuit;**

"missiles" means complete rocket systems and unmanned air vehicle systems, capable of a range of at least 300 km;

"monolithic integrated circuit" means 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;

b. can be considered as indivisibly associated; and

c. performs the function of a circuit;

"motion control board" means an **electronic assembly** specially designed to provide a computer system with the capability to coordinate simultaneously the motion of axes of machine tools for **contouring control;**

"multichip integrated circuit" means two or more **monolithic integrated circuits** bonded to a common substrate;

"multi-data-stream processing" means the **microprogramme** or equipment architecture technique which permits simultaneous processing of two or more data sequences under the control of one or more instruction sequences by means such as:

a. Single Instruction Multiple Data (SIMD) architectures such as vector or array processors;

b. Multiple Single Instruction Multiple Data (MSIMD) architectures;

c. Multiple Instruction Multiple Data (MIMD) architectures, including those which are tightly coupled, closely coupled or loosely coupled; or

d. Structured arrays of processing elements, including systolic arrays;

"multilevel security" means a class of system containing information with different sensitivities that simultaneously permits access by users with different security clearances, but prevents users from obtaining access to information for which they lack authorization;

"multispectral imaging sensors" means sensors 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" means a physical interface to a distributed switching network which:

a. uses a common medium operating throughout at the same **digital transfer rate;**

b. uses arbitration (e.g., token or carrier sense) for transmission control;

c. independently from any other, selects data packets or data groups addressed to it; and

d. is an assembly that can be integrated into computer or telecommunications equipment to provide communications access;

"neural computer" means 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;

"noise level" means an electrical signal given in terms of power spectral density; the relation between noise level expressed in peak-to-peak is given by $S^2_{pp} = 8N_0(f_2-f_1)$, where S_{pp} is the peak-to-peak value of the signal (e.g., nanoteslas), N_0 is the power spectral density (e.g., (nanotesla)^2/Hz) and (f_2-f_1) defines the bandwidth of interest;

"numerical control" means the automatic control of a process performed by a device that makes use of numeric data usually introduced as the operation is in progress;

"object code" (sometimes referred to as object language) means an equipment executable form of a convenient expression of one or more processes **(source code)** which has been converted by a programming system;

"operate autonomously" means operating fully submerged, without snorkel, all systems working and cruising at the 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;

"optical amplification", in optical communications, means an amplification technique that introduces a gain of optical signals that have been generated by a separate optical source, without conversion to electrical signals, using semiconductor optical amplifiers or optical fibre luminescent amplifiers;

"optical computer" means a computer designed or modified to use light to represent data and whose computational logic elements are based on directly coupled optical devices;

"optical fibre preforms" means bars, ingots, or rods of glass, plastic or other materials which have been specially processed for use in fabricating optical fibres; the characteristics of an **optical fibre preform** determine the basic parameters of the resultant drawn optical fibres;

"optical integrated circuit" means 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;

"optical switching" means the routing of, or switching of, signals in optical form without conversion to electrical signals;

"overall current density" means 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", as it relates to **lasers,** means energy per pulse in joules divided by the pulse duration in seconds;

"personalized smart card" means a smart card containing a microcircuit, in accordance with ISO/IEC 7816, which has been programmed by the issuer and cannot be changed by the user;

"power management" means 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;

"principal element" means an element whoose replacement value is more than 35% of the total value of the system of which it is an element; element value is the cost of the element for 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 equipment" means tooling, templates, jigs, mandrels, moulds, dies, fixtures, alignment mechanisms, test equipment, other machinery and components therefor, limited to those specially designed or modified for **development** or for one or more phases of **production;**

"production facilities" means equipment and specially designed software therefor integrated into installations for **development** or for one or more phases of **production**;

"pulse compression" means 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" means the duration of a **laser** pulse measured at Full Width Half Intensity (FWHI) levels;

"Q-switched laser" means a **laser** in which the energy is stored in the population inversion or in the optical resonator and subsequently emitted in a pulse;

"radar frequency agility" means 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" means 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;

"range" means half the maximum distance a submersible vehicle can cover;

"real time bandwidth" for **dynamic signal analysers** means 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" means processing of data by an electronic computer in response to an external event according to time requirements imposed by the external event;

"required", as applied to **technology** or **software,** means only that portion of **technology** or **software** which is peculiarly responsible for achieving or exceeding the specified performance levels, characteristics or functions; such **required technology** or **software** may be shared by different products;

"resolution" means the least increment of a measuring device; on digital instruments, the least significant bit;

"robot" means a manipulation mechanism, which may be of the continuous path or of the point-to-point variety, may use sensors, and which:

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;

except:

a. manipulation mechanisms which are only manually/teleoperator controllable;

b. fixed sequence manipulation mechanisms, which are automated moving devices, operating according to programmes where the motions are limited by fixed stops, such as pins or cams and the sequence of motions and the selection of paths or angles are not variable or changeable by mechanical, electronic or electrical means;

c. mechanically controlled variable sequence manipulation mechanisms, which are automated moving devices, operating according to programmes where the motions are limited by fixed, but adjustable stops, such as pins or cams and 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;

d. 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;

e. 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" means a process to reduce a stream or pool of molten metal to droplets to a diameter of 500 micrometre or less by centrifugal force;

"run out" (out-of-true running) means 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;

"scale factor" means 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" means 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;

"signal analysers" means apparatus capable of measuring and displaying basic properties of the single-frequency components of multi-frequency signals;

"signal processing" means 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);

"simple educational devices" means devices designed for use in teaching basic scientific principles and demonstrating the operation of those principles in educational institutions;

"solidify rapidly" means solidification of molten material at cooling rates exceeding 1,000 K/ sec;

"source code" (sometimes referred to as source language) means a convenient expression of one or more processes which may be turned by a programming system into equipment executable form **(object code);**

"spacecraft" means active and passive satellites and space probes;

"space qualified" means products which are stated by the manufacturer as designed and tested to meet the special electrical, mechanical or environmental requirements for use in rockets, satellites or high-altitude flight systems operating at altitudes of 100 km or more;

"specific modulus" means 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" means 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)%;

"spectral efficiency" means a figure of merit which characterizes the efficiency of transmission systems which use complex modulation schemes including QAM (quadrature amplitude modulation), Trellis coding and QPSK (Q-phased shift key); it is calculated as follows:

$$\text{spectral efficiency} = \frac{\textbf{digital transfer rate (bit/second)}}{\text{6 dB spectrum bandwidth (Hz)}}$$

"splat quenching" means a process to **solidify rapidly** a molten metal stream impinging upon a chilled block, forming a flake-like product;

"spread spectrum" means the technique whereby energy in a relatively narrow-band communication channel is spread over a much wider energy spectrum;

"sputtering" means an overlay coating process wherein positively charged 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 the substrate; triode, magnetron or radio frequency sputtering to increase adhesion of coating and rate of deposition are ordinary modifications of the process;

"stability" means the 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;

"stored programme controlled" means controlled by using instructions stored in an electronic storage which a processor can execute in order to direct the performance of predetermined functions;

"substrate" means 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" means monolithic compounds with dimensions suitable for the production of optical elements such as mirrors or optical windows;

"superalloys" means nickel-, cobalt- or iron-base alloys having strengths superior to any alloys in the American Iron and Steel Society (AISI) 300 series at temperatures over 922 K (649°C) under severe environmental and operating conditions;

"superconductive" 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); the superconductive state of a material is individually characterized by a **critical temperature**, a critical magnetic field, which is a function of temperature, and a critical current density which is a function of both magnetic field and temperature;

"Super High Power Laser" (SHPL) means a **laser** capable of delivering (the total or any portion of) an output energy exceeding 1 kJ within 50 ms or having an average or CW power exceeding 20 kW;

"superplastic forming" means 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;

"swept frequency network analysers" means analysers which involve the automatic measurement of equivalent circuit parameters over a range of frequencies, involving swept frequency measurement techniques but not continuous wave point-to-point measurements;

"switch fabric" means that hardware and associated **software** which provides the physical or virtual connection path for in-transit message traffic being switched;

"Synchronous Digital Hierarchy (SDH)" means a digital hierarchy providing a means to manage, multiplex and access various forms of digital traffic using a synchronous transmission format on different types of media; the format is based on the Synchronous Transport Module (STM) which is defined by CCITT Recommendation G.703, G.707, G.708, G.709; the first level rate of SDH is 155.52 Mbit/s;

"Synchronous Optical Network (SONET)" means a network providing a means to manage, multiplex and access various forms of digital traffic using a synchronous transmission format on fibre optics; the format is the North America version of SDH and also uses the Synchronous Transport Module (STM); however, it uses the Synchronous Transport Signal (STS) as the basic transport module with a first level rate of 51.81 Mbit/s; the SONET standards are being integrated into those of SDH;

"systems tracks" means processed, correlated (fusion of radar target data to flight plan position) and updated aircraft flight position reports available to the Air Traffic Control centre controllers;

"systolic array computer" means a computer where the flow and modification of the data is dynamically controllable at the logic gate level by the user;

"terminal interface equipment" means equipment at which information enters or leaves the telecommunication system, including telephone, data device, computer and facsimile device;

"tilting spindle" means 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" means 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);

"total digital transfer rate" means the number of bits, including line coding, overhead and so forth per unit time passing between corresponding equipment in a digital transmission system;

"transfer laser" means 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" means 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**;

"user-accessible programmability" means 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" means a process to reduce a molten stream of metal to droplets of a diameter of 500 micrometre or less by the rapid evolution of a dissolved gas upon exposure to a vacuum;

"variable geometry airfoils" means the use of trailing edge flaps or tabs, or leading edge slats or pivoted nose droop, the position of which can be controlled in flight.

Category 1—Materials, Chemicals, Microorganisms & Toxins

Equipment, Assemblies and Components

1A.—(1A001) 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% of any of the materials specified in heads b. or c. of entry 1C009;

(b) Piezoelectric polymers and copolymers made from vinylidene fluoride:

(1) In sheet or film form; and

(2) With a thickness exceeding 200 micrometre;

(c) Seals, gaskets, valve seats, bladders or diaphragms made from fluoroelastomers containing at least one vinylether monomer, specially designed for aircraft, aerospace or missile use.

In this sub-head, "missile" means complete rocket systems and unmanned air vehicle systems.

(1A002) **Composite** structures or laminates, as follows(**7**):

(a) Having an organic **matrix** and made from materials specified in heads c., d. or e. of entry 1C010; or

(b) Having a metal or carbon **matrix** and made from:

(1) Carbon **fibrous or filamentary materials** with:

(a) A **specific modulus** exceeding 10.15×10^6m; and

(b) A **specific tensile strength** exceeding 17.7×10^4m; or

(2) Materials specified in head c. of entry 1C010.

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

(1A003) Manufactures of non-fluorinated polymeric substances specified in head a. of entry 1C008, in film, sheet, tape or ribbon form:

(a) With a thickness exceeding 0.254 mm; or

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

(1A102) Resaturated pyrolized carbon-carbon materials designed for systems specified in entries 9A004 or 9A104.

(1A202) Composite structures, other than those specified in entry 1A002, in the form of tubes with an inside diameter of between 75 mm and 400 mm made with **fibrous or filamentary materials** specified in heads a. or b. of entry 1C010 or entry 1C210(**8**).

(**7**) See also entries 1A202, 9A010 and 9A110.
(**8**) See also entry 9A110.

(1A225) Platinized catalysts specially designed or prepared for promoting the hydrogen isotope exchange reaction between hydrogen and water for the recovery of tritium from heavy water or for the production of heavy water.

(1A226) Specialized packings for use in separating heavy water from ordinary water and made of phosphor bronze mesh or copper (both chemically treated to improve wettability) and designed for use in vacuum distillation towers.

(1A227) High-density (lead glass or other) radiation shielding windows greater than 0.3 m on a side and with a density greater than 3 g/cm^3 and a thickness of 100 mm or greater and specially designed frames therefor.

1B Test, Inspection and Production Equipment

(1B001) Equipment for the production of fibres, prepregs, preforms or **composites** specified in entries 1A002 or 1C010, as follows, and specially designed components and accessories therefor(**9**):

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

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

(c) Multidirectional, multidimensional weaving machines or interlacing machines, including adapters and modification kits, for weaving, interlacing or braiding fibres to manufacture **composite** structures;

except:

Textile machinery not modified for the above end-uses;

(d) Equipment specially designed or adapted for the production of reinforcement fibres, as follows:

(1) Equipment for converting polymeric fibres (such as polyacrylonitrile, rayon, pitch or polycarbosilane) into carbon fibres or silicon carbide fibres, including special equipment to strain the fibre during heating;

(2) Equipment for the chemical vapour deposition of elements or compounds on heated filamentary substrates to manufacture silicon carbide fibres;

(3) Equipment for the wet-spinning of refractory ceramics (such as aluminium oxide);

(4) Equipment for converting aluminium containing precursor fibres into alumina fibres by heat treatment;

(e) Equipment for producing prepregs specified in head e. of entry 1C010 by the hot melt method;

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

In this entry, "missile" means complete rocket systems and unmanned air vehicle systems.

(1B002) Systems and components therefor specially designed for producing metal alloys, metal alloy powder or alloyed materials specified in sub-head a.2. of entry 1C002, head b. of entry 1C002 or head c. of entry 1C002.

(1B003) Tools, dies, moulds or fixtures, for **superplastic forming** or **diffusion bonding** titanium or aluminium or their alloys, specially designed for the manufacture of:

(a) Airframe or aerospace structures;

(**9**) See also entries 1B101 and 1B201.

(b) Aircraft or aerospace engines; or

(c) Specially designed components for those structures or engines.

(1B101) Equipment, other than that specified in entry 1B001, for the production of structural composites as follows; and specially designed components and accessories therefor(**10**):

Note: Components and accessories specified in this entry include moulds, mandrels, dies, fixtures and tooling for the preform pressing, curing, casting, sintering or bonding of composite structures, laminates and manufactures thereof.

(a) Filament winding machines of which the motions for positioning, wrapping and winding fibres can be coordinated and programmed in three or more axes, designed to fabricate composite structures or laminates from fibrous or filamentary materials, and coordinating and programming controls;

(b) Tape-laying machines of which the motions for positioning and laying tape and sheets can be coordinated and programmed in two or more axes, designed for the manufacture of composite airframe and **missile** structures;

(c) Multi-directional, multi-dimensional weaving machines or interlacing machines, including adapters and modification kits for weaving, interlacing or braiding fibres to manufacture composite structures;

except:

Textile machinery which has not been modified for the above end uses;

(d) Equipment designed or modified for the production of fibrous or filamentary materials as follows:

(1) Equipment for converting polymeric fibres (such as polyacrylonitrile, rayon or polycarbosilane) including special provision to strain the fibre during heating;

(2) Equipment for the vapour deposition of elements or compounds on heated filament substrates; and

(3) Equipment for the wet-spinning of refractory ceramics (such as aluminium oxide);

(e) Equipment designed or modified for special fibre surface treatment or for producing prepregs and preforms specified in entry 9A110.

Note: Equipment covered by this sub-head includes rollers, tension stretchers, coating equipment, cutting equipment and clicker dies.

(1B115) Equipment for the production, handling and acceptance testing of **goods** specified in entry 1C115, and specially designed components therefor.

Note: The only mixers specified in this entry are those which have provision for mixing under vacuum in the range of zero to 13.326 kPa and with temperature control capability of the mixing chamber:

(a) Batch mixers having a total volumetric capacity of 110 litres or more and at least one mixing/kneading shaft mounted off centre;

(b) Continuous mixers having two or more mixing/kneading shafts and capability to open the mixing chamber.

(1B116) Specially designed nozzles for producing pyrolitically derived materials formed on a mould, mandrel or other substrate from precursor gases which decompose in the 1573 K (1300°C) to 3173 K (2900°C) temperature range at pressures of 130 Pa to 20 kPa.

(1B201) Filament winding machines, other than those specified in entries 1B001 or 1B101, in which the motions for positioning, wrapping, and winding fibres are coordinated and programmed

(**10**) See also entry 1B201.

in two or more axes, specially designed to fabricate composite structures or laminates from **fibrous or filamentary materials** and capable of winding cylindrical rotors of diameter between 75 mm and 400 mm and lengths of 600 mm or greater and coordinating and programming controls and precision mandrels therefor.

(1B225) Electrolytic cells for fluorine production with a production capacity greater than 250g of fluorine per hour.

(1B226) Electromagnetic isotope separators, designed for or equipped with, single or multiple ion sources capable of providing a total ion beam current of 50 mA or greater.

Note: This entry includes separators:

(a) Capable of enriching stable isotopes;

(b) With the ion sources and collectors both in the magnetic field and those configurations in which they are external to the field.

(1B227) Ammonia synthesis converters, ammonia synthesis units in which the synthesis gas (nitrogen and hydrogen) is withdrawn from an ammonia/hydrogen high-pressure exchange column and the synthesized ammonia is returned to that column.

(1B228) Hydrogen-cryogenic distillation columns having all of the following characteristics:

(a) Designed to operate with internal temperatures of 35 K (-238°C) or less;

(b) Designed to operate at an internal pressure of 0.5 to 5 MPa (5 to 50 atmospheres);

(c) Constructed of fine-grain stainless steels of the 300 series with low sulphur content or equivalent cryogenic and H_2-compatible materials; and

(d) With internal diameters of 1 m or greater and effective lengths of 5 m or greater.

(1B229) Water-hydrogen sulphide exchange tray columns constructed from fine carbon steel with a diameter of 1.8 m or greater to operate at a nominal pressure of 2 MPa or greater.

Notes:

(1) For columns which are specially designed or prepared for the production of heavy water see entry B40 of Group 2 of Part III of this Schedule.

(2) This entry includes internal contactors of the columns, which are segmented trays with an effective assembled diameter of 1.8 m or greater, such as sieve trays, valve trays, bubble cap trays, and turbogrid trays designed to facilitate countercurrent contacting and constructed of materials resistant to corrosion by hydrogen sulphide/water mixtures, such as 304L or 316 stainless steel.

(3) Fine Carbon steels include steels such as specified by ASTM A516.

(1B230) Pumps circulating solutions of diluted or concentrated potassium amide catalyst in liquid ammonia (KNH_2/NH_3), with all of the following characteristics:

(a) Airtight (i.e., hermetically sealed);

(b) For concentrated potassium amide solutions (1% or greater), operating pressure of 1.5-60 MPa (15-600 atmospheres); for dilute potassium amide solutions (less than 1%), operating pressure of 20-60 MPa (200-600 atmospheres); and

(c) A capacity greater than 8.5 m^3/hr.

(1B231) Facilities or plants for the production, recovery, extraction, concentration, or handling of tritium, and equipment as follows:

(a) Hydrogen or helium refrigeration units capable of cooling to 23 K (-250°C) or less, with heat removal capacity greater than 150 Watts; or

(b) Hydrogen isotope storage and purification systems using metal hydrides as the storage, or purification medium.

1C Materials

(1C001) Materials specially designed for use as absorbers of electromagnetic waves, or intrinsically conductive polymers, as follows(**11**):

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

Materials as follows:

Note: Nothing in head a. of this entry releases magnetic materials to provide absorption when contained in paint.

1. Hair type absorbers, constructed of natural or synthetic fibres, with non-magnetic loading to provide absorption;
2. Absorbers having no magnetic loss and whose incident surface is non-planar in shape, including pyramids, cones, wedges and convoluted surfaces;
3. Planar absorbers:
   a. Made from:
   1. 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
   2. 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);

   Note: Absorption test samples for sub-head a.3.a. of this entry should be a square of side of length at least 5 wavelengths of the centre frequency, and should be positioned in the far field of the radiating element.

   b. Tensile strength less than 7×10^6 N/m^2; and
   c. Compressive strength less than 14×10^6 N/m^2;
4. Planar absorbers made of sintered ferrite, with:
   a. A specific gravity exceeding 4.4; and
   b. A maximum operating temperature of 548 K (275°C);

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

(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.

Note: Bulk electrical conductivity and sheet (surface) resistivity should be determined using ASTM D-257.

(**11**) See also entry 1C101.

(1C002) Metal alloys, metal alloy powder or alloyed materials, as follows(**12**):

Note: Entry 1C002 does not specify metal alloys, metal alloy powder or alloyed materials for coating substrates.

(a) Metal alloys, as follows:

(1) Nickel or titanium-based alloys in the form of aluminides, as follows, in crude or semi-fabricated forms:

(a) Nickel aluminides containing 10 weight per cent or more aluminium;

(b) Titanium aluminides containing 12 weight per cent or more aluminium;

(2) Metal alloys, as follows, made from metal alloy powder or particulate material specified in head b. of this entry:

(a) Nickel alloys with:

(1) A stress-rupture life of 10,000 hours or longer at 923 K (650°C) at a stress of 550 MPa; or

(2) A low cycle fatigue life of 10,000 cycles or more at 823 K (550°C) at a maximum stress of 700 MPa;

(b) Niobium alloys with:

(1) A stress-rupture life of 10,000 hours or longer at 1,073 K (800°C) at a stress of 400 MPa; or

(2) A low cycle fatigue life of 10,000 cycles or more at 973 K (700°C) at a maximum stress of 700 MPa;

(c) Titanium alloys with:

(1) A stress-rupture life of 10,000 hours or longer at 723 K (450°C) at a stress of 200 MPa; or

(2) A low cycle fatigue life of 10,000 cycles or more at 723 K (450°C) at a maximum stress of 400 MPa;

(d) Aluminium alloys with a tensile strength of:

(1) 240 MPa or more at 473 K (200°C); or

(2) 415 MPa or more at 298 K (25°C);

(e) Magnesium alloys with a tensile strength of 345 MPa or more and a corrosion rate of less than 1 mm/year in 3% sodium chloride aqueous solution measured in accordance with ASTM standard G-31;

Notes:

(1) The metal alloys specified in head a. of this entry 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.

(3) Low cycle fatigue life should be measured in accordance with ASTM Standard E-606 'Recommended Practice for Constant-Amplitude Low-Cycle Fatigue Testing'. Testing should be axial with an average stress ratio equal to 1 and a stress-concentration factor (Kt) equal to 1. The average stress is defined as maximum stress minus minimum stress divided by maximum stress.

(**12**) See also entry 1C202.

(b) Metal alloy powder or particulate material for materials specified in head a. of this entry, as follows:

(1) Made from any of the following composition systems:

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 micrometre in 10^9 alloy 15 particles;

(b) Niobium alloys (Nb-Al-X or Nb-X-Al, Nb-Si-X or Nb-X-Si, Nb-Ti-X or Nb-X-Ti);

(c) Titanium alloys (Ti-Al-X or Ti-X-Al);

(d) Aluminium alloys (Al-Mg-X or Al-X-Mg, Al-Zn-X or Al-X-Zn, Al-Fe-X or Al-X-Fe); or

(e) Magnesium alloys (Mg-Al-X or Mg-X-Al); and

(2) Made in a controlled environment by any of the following processes:

(a) **Vacuum atomisation;**

(b) **Gas atomisation;**

(c) **Rotary atomisation;**

(d) **Splat quenching;**

(e) **Melt spinning** and **comminution;**

(f) **Melt extraction** and **comminution;** or

(g) **Mechanical alloying;**

(c) Alloyed materials, in the form of uncomminuted flakes, ribbons or thin rods produced in a controlled environment by **splat quenching, melt spinning** or **melt extraction,** used in the manufacture of metal alloy powder or particulate material specified in head b. of this entry.

(1C003) Magnetic metals, of all types and of whatever form, having any of the following characteristics:

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

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

(b) Magnetostrictive alloys with:

(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 alloy strips having both of the following characteristics:

(1) A composition having a minimum of 75 weight percent of iron, cobalt or nickel; and

(2) A saturation magnetic induction (B_s) of 1.6 T or more, and:

(a) A strip thickness of 0.02 mm or less; or

(b) An electrical resistivity of 2×10^{-4} ohm cm or more.

(1C004) Uranium titanium alloys or tungsten alloys with a **matrix** based on iron, nickel or copper, with:

(a) A density exceeding 17.5 g/cm^3;

(b) An elastic limit exceeding 1,250 MPa;

(c) An ultimate tensile strength exceeding 1,270 MPa; and

(d) An elongation exceeding 8%.

(1C005) **Superconductive composite** conductors in lengths exceeding 100 m or with a mass exceeding 100 g, as follows:

(a) Multifilamentary **superconductive composite** conductors containing one or more niobium-titanium filaments:

(1) Embedded in a **matrix** other than a copper or copper-based mixed **matrix**; or

(2) With a cross-section area less than 0.28×10^{-4} mm^2 (6 micrometre in diameter for circular filaments);

(b) **Superconductive composite** conductors consisting of one or more **superconductive** filaments other than niobium-titanium:

(1) With a **critical temperature** at zero magnetic induction exceeding 9.85 K (-263.31°C) but less than 24 K (-249.16°C);

(2) With a cross-section area less than 0.28×10^{-4} mm^2; and

(3) Which remain in the **superconductive** state at a temperature of 4.2 K (-268.96°C) when exposed to a magnetic field corresponding to a magnetic induction of 12 T.

(1C006) Fluids and lubricating materials, as follows:

(a) Hydraulic fluids containing, as their principal ingredients, any of the following compounds or materials:

(1) Synthetic hydrocarbon oils or silahydrocarbon oils with:

(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

Note: For the purpose of this sub-head, silahydrocarbon oils contain exclusively silicon, hydrogen and carbon.

(2) Chlorofluorocarbons with:

(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;

Note: For the purpose of this sub-head, chlorofluorocarbons contain exclusively carbon, fluorine and chlorine.

(b) Lubricating materials containing, as their principal ingredients, any of the following compounds or materials:

(1) Phenylene or alkylphenylene ethers or thio-ethers, or their mixtures, containing more than two ether or thio-ether functions or mixtures thereof; or

(2) Fluorinated silicone fluids with a kinematic viscosity of less than 5,000 mm^2/s (5,000 centistokes) measured at 298 K (25°C);

(c) Damping or flotation fluids with a purity exceeding 99.8%, containing less than 25 particles of 200 micrometre or larger in size per 100 ml and made from at least 85% of any of the following compounds or materials:

(1) Dibromotetrafluoroethane;

(2) Polychlorotrifluoroethylene (oily and waxy modifications only); or

(3) Polybromotrifluoroethylene.

Notes:

(1) Flash point is determined using the Cleveland Open Cup Methoddescribed in ASTM D-92.

(2) Pour point is determined using the method described in ASTM D-97.

(3) Viscosity index is determined using the method described in ASTM D-2270.

(4) Thermal stability is determined by the following test procedure: 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 ± 6C) 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 methoddescribed in ASTM E-659.

(1C007) Ceramic base materials, non-**composite** ceramic materials, ceramic-**matrix** composite materials and precursor materials, as follows(**13**):

(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 micrometre and no more than 10% of the particles larger than 10 micrometre;

(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; except: Abrasives;

(c) Ceramic-ceramic **composite** materials with a glass or oxide-**matrix** and reinforced with fibres from any of the following systems:

(1) Si-N;

(2) Si-C;

(3) Si-Al-O-N; or

(4) Si-O-N;

(d) Ceramic-ceramic **composite** materials, with or without a continuous metallic phase, containing finely dispersed particles or phases of any fibrous or whisker-like material, 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 in head c. of this entry, as follows:

(**13**) See also entry 1C107.

(1) Polydiorganosilanes (for producing silicon carbide);

(2) Polysilazanes (for producing silicon nitride);

(3) Polycarbosilazanes (for producing ceramics with silicon, carbon and nitrogen components).

(1C008) Non-fluorinated polymeric substances, as follows:

(a) (1) Bismaleimides;

(2) Aromatic polyamide-imides;

(3) Aromatic polyimides;

(4) Aromatic polyetherimides having a glass transition temperature (T_g) exceeding 503 K (230°C) as measured by the wet method;

Note: This head does not specify non-fusible compression moulding powders or moulded forms.

(b) Thermoplastic liquid crystal copolymers having a heat distortion temperature exceeding 523 K (250°C) measured according to ASTM D-648, method A, with a load of 1.82 N/mm^2 and composed of:

(1) Either of the following:

(a) Phenylene, biphenylene or naphthalene; or

(b) Methyl, tertiary-butyl or phenyl substituted phenylene, biphenylene or naphthalene; and

(2) Any of the following acids:

(a) Terephthalic acid;

(b) 6-hydroxy-2 naphthoic acid; or

(c) 4-hydroxybenzoic acid;

(c) Polyarylene ether ketones, as follows:

(1) Polyether ether ketone (PEEK);

(2) Polyether ketone ketone (PEKK);

(3) Polyether ketone (PEK);

(4) Polyether ketone ether ketone ketone (PEKEKK);

(d) Polyarylene ketones;

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

(f) Polybiphenylenethersulphone.

(1C009) Unprocessed fluorinated compounds, as follows:

(a) Copolymers of vinylidene fluoride having 75% or more beta crystalline structure without stretching;

(b) Fluorinated polyimides containing 30% or more of combined fluorine;

(c) Fluorinated phosphazene elastomers containing 30% or more of combined fluorine.

(1C010) **Fibrous or filamentary materials** which may be used in organic **matrix,** metallic **matrix** or carbon **matrix composite** structures or laminates, as follows(**14**):

(a) Organic **fibrous or filamentary materials** (except polyethylene) with:

(**14**) See also entry 1C210.

(1) A **specific modulus** exceeding 12.7×10^6m; and

(2) A **specific tensile strength** exceeding 23.5×10^4m;

(b) Carbon **fibrous or filamentary materials** with:

(1) A **specific modulus** exceeding 12.7×10^6m; and

(2) A **specific tensile strength** exceeding 23.5×10^4m;

Notes:

(1) Properties for materials described in this head should be determined using Suppliers of Advance Composite Materials Association (SACMA) recommended methods SRM 12 to 17 or Japanese Industrial Standard JIS-R-7601, Paragraph 6.6.2., and based on lot average.

(2) This head does not specify fabric made from **fibrous or filamentary materials** for the repair of aircraft structures or laminates in which the size of individual sheets does not exceed 50 cm × 90 cm.

(c) Inorganic **fibrous or filamentary materials** with:

(1) A **specific modulus** exceeding 2.54×10^6m; and

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

Note: This head does not specify:

(a) Discontinuous, multiphase, polycrystalline alumina fibres in chopped fibre or random mat form, containing 3 weight percent or more silica, with a **specific modulus** of less than 10×10^6m;

(b) Molybdenum and molybdenum alloy fibres;

(c) Boron fibres;

(d) Discontinuous ceramic fibres with a melting, decomposition or sublimation point lower than 2,043 K (1,770°C) in an inert environment.

(d) **Fibrous or filamentary materials:**

(1) Composed of any of the following:

(a) Polyetherimides specified in head a. of entry 1C008; or

(b) Materials specified in heads b., c., d., e. or f. of entry 1C008; or

(2) Composed of materials specified in sub-head d.1. of this entry and **commingled** with other fibres specified in heads a., b. or c. of this entry;

(e) Resin- or pitch-impregnated fibres (prepregs), metal or carbon-coated fibres (preforms) or carbon fibre preforms, as follows:

(1) Made from **fibrous or filamentary materials** specified in heads a., b. or c. of this entry;

(2) Made from organic or carbon **fibrous or filamentary materials:**

(a) With a **specific tensile strength** exceeding 17.7×10^4 m;

(b) With a **specific modulus** exceeding 10.15×10^6m;

(c) Not specified in heads a. or b. of this entry; and

(d) When impregnated with materials specified in entry 1C008 or head b. of entry 1C009, or with phenolic or epoxy resins, having a glass transition temperature (T_g) exceeding 383 K (110°C).

Note: This head does not specify epoxy resin matrix impregnated carbon **fibrous or filamentary materials** (prepregs) for the repair of aircraft structures or laminates, in which the size of individual sheets of prepreg does not exceed 50 cm × 90 cm.

(1C101) Materials and devices for reduced observables such as radar reflectivity, ultraviolet/ infrared signatures and acoustic signatures (i.e. stealth technology), other than those specified in entry 1C001, usable in **missiles** and their subsystems.

Notes:

(1) This entry includes:

(a) Structural materials and coatings specially designed for reduced radar reflectivity;

(b) Coatings, including paints, specially designed for reduced or tailored reflectivity or emissivity in the microwave, infra red or ultra violet regions of the electromagnetic spectrum.

(2) This entry does not include coatings when specially used for the thermal control of satellites.

(1C107) Graphite and ceramic materials, as follows:

(a) Fine grain recrystallised bulk graphites, having a bulk density of 1.72 g/cm^3 or greater, measured at 288 K (15°C), and having a particle size of 100 micrometres or less, pyrolytic or fibrous reinforced graphites, usable for rocket nozzles and reentry vehicle nose tips;

(b) Ceramic composite materials (dielectric constant less than 6 at frequencies from 100 Hz to 10,000 MHz), usable for radomes, and bulk machinable silicon-carbide reinforced unfired ceramic, usable for nose tips.

(1C115) Propellants and constituent chemicals for propellants, as follows:

(a) Propulsive substances:

(1) Spherical aluminium powder, other than that specified in ML8 of Group 1 of Part III of this Schedule, with particles of uniform diameter of less than 500 micrometre and an aluminium content of 97% by weight or greater;

(2) Metal fuels, other than that specified in ML8 of Group 1 of Part III of this Schedule, in particle sizes less than 500 micrometres, whether spherical, atomized, spheroidal, flaked or ground, consisting of 97% by weight or more of any of the following:

(a) Zirconium;

(b) Beryllium;

(c) Boron;

(d) Magnesium;

(e) Zinc;

(f) Alloys of the metals specified by a. to e. above; or

(g) Misch metal;

(3) Liquid oxidisers, the following:

(a) Dinitrogen trioxide;

(b) Nitrogen dioxide/dinitrogen tetroxide;

(c) Dinitrogen pentoxide;

(b) Polymeric substances:

(1) Carboxy-terminated polybutadiene (CTPB);

(2) Hydroxy-terminated polybutadiene (HTPB), other than that specified in ML8 of Group 1 of Part III of this Schedule;

(3) Polybutadiene-acrylic acid (PBAA);

(4) Polybutadiene-acrylic acid-acrylonitrile (PBAN);

(c) Other propellant additives and agents:

(1) Butacene;

(2) Triethylene glycol dinitrate (TEGDN);

(3) 2-Nitrodiphenylamine.

Note: For propellants and constituent chemicals for propellants not specified here, see ML8 of Group 1 of Part III of this Schedule.

(1C116) Maraging steels (steels generally characterised by high nickel, very low carbon content and the use of substitutional elements or precipitates to produce age-hardening) having an ultimate tensile strength of 1500 MPa or greater, measured at 293 K (20°C), in the form of sheet, plate or tubing with a wall or plate thickness equal to or less than 5 mm(**15**).

(1C117) Tungsten, molybdenum and alloys of these metals in the form of uniform spherical or atomized particles of 500 micrometre diameter or less with a purity of 97% or greater for fabrication of rocket motor components i.e. heat shields, nozzle substrates, nozzle throats and thrust vector control surfaces.

(1C202) Alloys, other than those specified in sub-head a.2.c. or head d. of entry 1C002, as follows:

(a) Aluminium alloys capable of an ultimate tensile strength of 460 MPa or more at 293 K (20°C), in the form of tubes or solid forms (including forgings) with an outside diameter of more than 75 mm;

(b) Titanium alloys capable of an ultimate tensile strength of 900 MPa or more at 293 K (20°C) in the form of tubes or solid forms (including forgings) with an outside diameter of more than 75 mm.

In this entry, "alloys capable of" means alloys before or after heat treatment.

(1C210) **Fibrous or filamentary materials,** other than those specified in heads a. or b. of entry 1C010, as follows:

(a) Carbon or aramid **fibrous or filamentary materials** having a **specific modulus** of 12.7 $\times 10^6$ m or greater or a **specific tensile strength** of 23.5 $\times 10^4$ m or greater; or

(b) Glass **fibrous or filamentary materials** having a **specific modulus** of 3.18 $\times 10^6$ m or greater and a **specific tensile strength** of 7.62 $\times 10^4$ m or greater.

(1C216) Maraging steel, other than that specified in entry 1C116, capable of an ultimate tensile strength of 2,050 MPa or more, at 293 K (20°C);

except:

Forms in which no linear dimension exceeds 75 mm.

In this entry, "maraging steel capable of" means maraging steel before or after heat treatment.

(1C225) Boron and boron compounds, mixtures and loaded materials in which the boron-10 isotope is more than 20% by weight of the total boron content.

(1C226) Tungsten, as follows: parts made of tungsten, tungsten carbide, or tungsten alloys (greater than 90% tungsten) having a mass greater than 20 kg and a hollow cylindrical symmetry (including cylinder segments) with an inside diameter greater than 100 mm but less than 300 mm;

(**15**) See also entry 1C216.

except:

Parts specially designed for use as weights or gamma-ray collimators.

(1C227) Calcium (high purity) containing both less than 1,000 parts per million by weight of metallic impurities other than magnesium and less than 10 parts per million of boron.

(1C228) Magnesium (high purity) containing both less than 200 parts per million by weight of metallic impurities other than calcium and less than 10 parts per million of boron.

(1C229) High purity (99.99% or greater) bismuth with very low silver content (less than 10 parts per million).

(1C230) Beryllium metal, alloys containing more than 50% of beryllium by weight, compounds containing beryllium, and manufactures thereof; except:

(a) Metal Windows for X-ray machines;

(b) Oxide shapes in fabricated or semi-fabricated forms specially designed for electronic component parts or as substrates for electronic circuits.

Note: This entry includes waste and scrap containing beryllium as defined here.

(1C231) Hafnium metal, alloys and compounds of hafnium containing more than 60% hafnium by weight and manufactures thereof.

(1C232) Helium in any form isotopically enriched in the helium-3 isotope, whether or not mixed with any other materials or contained in any equipment or device;except:

Products or devices containing less than 1 g of helium-3.

(1C233) Lithium, as follows:

(a) Metal, hydrides or alloys containing lithium enriched in the 6 isotope (^{6}Li) to a concentration higher than the one existing in nature (7.5 % weight percent);

(b) Any other materials containing lithium enriched in the 6 isotope (including compounds, mixtures and concentrates);

except:

^{6}Li incorporated in thermoluminescent dosimeters.

(1C234) Zirconium as follows: metal, alloys containing more than 50% zirconium by weight, and compounds in which the ratio of hafnium content to zirconium content is less than 1 part to 500 parts by weight, and manufactures wholly thereof;

except:

Zirconium in the form of foil having a thickness not exceeding 0.10 mm.

Notes

1. This entry includes waste and scrap containing zirconium as defined here.
2. For zirconium pressure tubes specially designed or prepared for a nuclear reactor see entry B50 of Group 2 of Part III of this Schedule.

(1C235) Tritium, tritium compounds, and mixtures containing tritium in which the ratio of tritium to hydrogen by atoms exceeds 1 part in 1000;

except:

A product or device containing not more than 40 Ci of tritium in any chemical or physical form.

(1C236) Alpha-emitting radionuclides having an alpha half-life of 10 days or greater but less than 200 years, including equipment, compounds and mixtures containing these radionuclides with a total alpha activity of 1 curie per kilogram (37 GBq/kg) or greater;

except:

Devices containing less than 100 millicuries (3.7 GBq) of alpha activity per device.

(1C237) Radium-226;

except:

Radium contained in medical applicators.

(1C238) Chlorine trifluoride (ClF_3).

(1C239) High explosives(**16**), other than those specified in ML8 of Group 1 of Part III of this Schedule, or substances or mixtures containing more than 2% thereof, with a crystal density greater than 1.8 gm/cm^3 and having a detonation velocity greater than 8,000 m/s.

(1C350) Chemicals, which may be used as precursors for toxic chemical agents, as follows, and preparations thereof(**17**):

(a) (1) Ammonium hydrogen fluoride;

(2) Arsenic trichloride;

(3) Benzilic acid;

(4) 2-Chloroethanol;

(5) Diethylaminoethanol;

(6) Diethyl ethylphosphonate;

(7) Diethyl methylphosphonite;

(8) Diethyl-N,N-dimethylphosphoramidate;

(9) Diethyl phosphite;

(10) Diisopropylamine;

(11) N,N-Diisopropyl-(beta)-aminoethane thiol;

(12) N,N-Diisopropyl-(beta)-amino ethanol;

(13) N,N-Diisopropyl-(beta)-aminoethyl chloride;

(14) N,N-Diisopropyl-(beta)-aminoethyl chloride hydrochloride;

(15) Dimethyl ethylphosphonate;

(16) Dimethyl methylphosphonate;

(17) Dimethyl phosphite;

(18) Dimethylamine;

(19) Dimethylamine hydrochloride;

(20) Ethyl phosphinyl dichloride;

(21) Ethyl phosphinyl difluoride;

(22) Ethyl phosphonyl dichloride;

(23) Ethyl phosphonyl difluoride;

(24) Hydrogen fluoride;

(25) 3-Hydroxy-1-methylpiperidine;

(26) Methyl benzilate;

(27) Methyl phosphinyl dichloride;

(28) Methyl phosphinyl difluoride;

(**16**) See also entry 1C991.
(**17**) See also ML7 of Group 1 of Part III of this Schedule.

(29) Methyl phosphonyl dichloride;

(30) Phosphorus oxychloride;

(31) Phosphorus pentachloride;

(32) Phosphorus pentasulphide;

(33) Phosphorus trichloride;

(34) Pinacolone;

(35) Pinacolyl alcohol;

(36) Potassium fluoride;

(37) Potassium cyanide;

(38) Potassium hydrogen fluoride;

(39) 3-Quinuclidinol;

(40) 3-Quinuclidone;

(41) Sodium bifluoride;

(42) Sodium cyanide;

(43) Sodium fluoride;

(44) Sodium sulphide;

(45) Sulphur dichloride;

(46) Sulphur monochloride;

(47) Thiodiglycol;

(48) Thionyl chloride;

(49) Triethanolamine;

(50) Triethanolamine hydrochloride;

(51) Triethyl phosphite;

(52) Trimethyl phosphite;

except:

Preparations which include any of the above chemicals, which;

1. Are put up for retail sale and intended for individual personal use or consumption; or
2. Contain the chemical in such a way that it cannot be easily recovered by standard processes.

(1C351) Human pathogens, zoonoses and toxins (**18**):

(a) Viruses, whether natural, enhanced or modified, either in the form of isolated live cultures or as material including living material which has been deliberately inoculated or contaminated with such cultures, as follows:

(1) Chikungunya virus;

(2) Congo-Crimean haemorrhagic fever virus;

(3) Dengue fever virus;

(4) Eastern equine encephalitis virus;

(5) Ebola virus;

(**18**) See also ML7 of Group 1 of Part III of this Schedule.

(6) Hantaan virus;

(7) Junin virus;

(8) Lassa fever virus;

(9) Lymphocytic choriomeningitis virus;

(10) Machupo virus;

(11) Marburg virus;

(12) Monkey pox virus;

(13) Rift Valley fever virus;

(14) Russian Spring-Summer encephalitis virus;

(15) Variola virus;

(16) Venezuelan equine encephalitis virus;

(17) Western equine encephalitis virus;

(18) White pox;

(19) Yellow fever virus;

(20) Japanese encephalitis virus;

(b) Rickettsiae, whether natural, enhanced or modified, either in the form of isolated live cultures or as material including living material which has been deliberately inoculated or contaminated with such cultures, as follows:

(1) Coxiella burnetii;

(2) Rickettsia quintana;

(3) Rickettsia prowasecki;

(4) Rickettsia rickettsii;

(c) Bacteria, whether natural, enhanced or modified, either in the form of isolated live cultures or as material including living material which has been deliberately inoculated or contaminated with such cultures, as follows:

(1) Bacillus anthracis;

(2) Brucella abortus;

(3) Brucella melitensis;

(4) Brucella suis;

(5) Chlamydia psittaci;

(6) Clostridium botulinum;

(7) Francisella tularensis;

(8) Pseudomonas mallei (Burkholderia mallei);

(9) Pseudomonas pseudomallei (Burkholderia pseudomallei;

(10) Salmonella typhi;

(11) Shigella dysenteriae;

(12) Vibrio cholerae;

(13) Pasteurella pseudotuberculosis var pestis (Yersinia pestis);

(d) **Toxins,** as follows;

(1) Botulinum toxins;

(2) Clostridium perfringens toxins;

(3) Conotoxin;

(4) Ricin;

(5) Saxitoxin;

(6) Shiga toxin;

(7) Staphylococcus aureus toxins;

(8) Tetrodotoxin;

(9) Verotoxin;

(10) Microcystins (Cyanginosins);

except:

Any **goods** specified in this entry in the form of a vaccine(**19**).

(1C352) Animal Pathogens, as follows(**20**):

(a) Viruses, whether natural, enhanced or modified, either in the form of isolated live cultures or as material including living material which has been deliberately inoculated or contaminated with such cultures, as follows:

(1) African swine fever virus;

(2) Avian influenza virus, which are:

(a) Uncharacterised; or

(b) Those defined in Council Directive 92/40/EEC(**21**), as having high pathogenicity, as follows:

(1) Type A viruses with an IVPI (intravenous pathogenicity index) in 6 week old chickens of greater than 1.2; or

(2) Type A viruses H5 or H7 subtype for which nucletide sequencing has demonstrated multiple basic amino acids at the cleavage site of haemagglutinin;

(3) Bluetongue virus;

(4) Foot and mouth disease virus;

(5) Goat pox virus;

(6) Porcine herpes virus (Aujeszky's disease);

(7) Swine fever virus (Hog cholera virus);

(8) Lyssa virus;

(9) Newcastle disease virus;

(10) Peste des petits ruminants virus;

(11) Swine vesicular disease (porcine enterovirus type 9);

(12) Rinderpest virus;

(13) Sheep pox virus;

(14) Teschen disease virus;

(15) Vesicular stomatitis virus;

(**19**) See also entry 1C992.
(**20**) See also ML7 of Group 1 of Part III of this Schedule.
(**21**) O.J. No. L167, 22.6.92 p.1.

(b) Bacteria, whether natural, enhanced or modified, either in the form of isolated live cultures or as material including living material which has been deliberately inoculated or contaminated with Mycoplasma mycoides;

except:

Any **goods** specified in this entry in the form of a vaccine.

(1C353) Genetically-modified **microorganisms,** as follows(**22**):

(a) Genetically modified **microorganisms** or genetic elements that contain nucleic acid sequences associated with pathogenicity and are derived from organisms specified in heads a. to c. of entry 1C351 or entries 1C352 or 1C354;

(b) Genetically modified **microorganisms** or genetic elements that contain nucleic acid sequences coding for any of the **toxins** specified in head d. of entry 1C351.

(1C354) Plant pathogens, as follows:

(a) Bacteria, whether natural, enhanced or modified, either in the form of **isolated live cultures** or as material which has been deliberately inoculated or contaminated with such cultures, as follows:

(1) Xanthomonas albilineans;

(2) Xanthomonas campestris pv. citri including strains referred to as Xanthomonas campestris pv. citri types A,B,C,D,E or otherwise classified as Xanthomonas citri, Xanthomonas campestris pv. aurantifolia or Xanthomonas campestris pv. citrumelo;

(b) Fungi, whether natural, enhanced or modified, either in the form of **isolated live cultures** or as material which has been deliberately inoculated or contaminated with such cultures, as follows:

(1) Colletotrichum coffeanum var. virulans;

(2) Cochlibolus miyabeanus (Helminthosporium oryzae);

(3) Microcyclus ulei(syn. Dothidella ulei);

(4) Puccinia graminis (syn. Puccinia graminis f. sp. tritici);

(5) Puccinia striiformis (syn. Puccinia glumarum);

(6) Magnaporthe grisea (Pyricularia grisea/Pyricularia oryzae).

(1C991) Other explosives and propellants and related substances as follows(**23**):

(a) Amatol;

(b) Nitrocellulose (containing more than 12.5% nitrogen);

(c) Nitroglycol;

(d) Pentaerythritol tetranitrate (PETN);

(e) Picryl chloride;

(f) Trinitrophenylmethylnitramine (tetryl);

(g) 2,4,6-Trinitrotoluene (TNT).

(1C992) Vaccines for protection against either of the following:

(a) Bacillus anthracis; or

(b) Botulinum toxin.

1D Software

(**22**) See also ML7 of Group 1 of Part III of this Schedule.
(**23**) See also entries 1C115, 1C239 and ML8 of Group 1 of Part III of this Schedule.

(1D001) **Software** specially designed or modified for the **development, production** or **use** of **goods** specified in entries 1B001 to 1B003.

(1D002) **Software** for the **development** of organic **matrix,** metal **matrix** or carbon **matrix** laminates or **composites.**

(1D101) **Software** specially designed for the **use** of **goods** specified in entry 1B101.

(1D103) **Software** specially designed for analysis of reduced observables such as radar reflectivity, ultraviolet/infrared signatures and acoustic signatures.

(1D201) **Software** specially designed for the **use** of **goods** specified in entry 1B201.

1E Technology

(1E001) **Technology required** for the **development** or **production** of **goods** specified in heads b. or c. of entry 1A001, or entries 1A002, 1A003, or sub-categories 1B or 1C.

(1E002) Other **technology:**

(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 characteristics:

(a) Any of the following compositions:

(1) Single or complex oxides of zirconium and complex oxides of silicon or aluminium;

(2) Single nitrides of boron (cubic crystalline forms);

(3) Single or complex carbides of silicon or boron; or

(4) Single or complex nitrides of silicon;

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

(1) 1,000 ppm for single oxides or carbides; or

(2) 5,000 ppm for complex compounds or single nitrides; and

(c) 1. Average particle size equal to or less than 5 micrometre and no more than 10% of the particles larger than 10 micrometre; or

Note: For zirconia, these limits are 1 micrometre and 5 micrometre respectively.

2. 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 micrometre; and

c. Continuous or chopped fibres less than 10 micrometre in diameter;

(2) Non-**composite** ceramic materials (except abrasives) composed of the materials described in sub-head c.1. of this entry;

(d) **Technology** for the **production** of aromatic polyamide fibres;

(e) **Technology** for the installation, maintenance or repair of materials specified in entry 1C001;

(f) **Technology** for the repair of **composite** structures, laminates or materials specified in entry 1A002 and heads c. or d. of entry 1C007.

Note: Head f. of this entry does not specify **technology** for the repair of civil **aircraft** structures using carbon **fibrous or filamentary materials** and epoxy resins, contained in manufacturers' manuals.

(1E101) **Technology required** for the **use** of **goods** specified in entries 1A102, 1B001, 1B101, 1B115, 1B116, 1C001, 1C101, 1C107, 1C115 to 1C117, 1D101 or 1D103.

(1E102) **Technology required** for the **development** of **software** specified in entries 1D001, 1D101 or 1D103.

(1E103) **Technology** for the regulation of temperature, pressure or atmosphere in autoclaves or hydroclaves, when used for the production of composites or partially processed composites.

(1E104) **Technology** relating to the **production** of pyrolitically derived materials formed on a mould, mandrel or other substrate from precursor gases which decompose in the 1,573 K (1,300°C) to 3,173 K (2,900°C) temperature range at pressures of 130 Pa to 20 kPa.*Note:* This entry includes **technology** for the composition of precursor gases, flowrates and process control schedules and parameters.

(1E201) **Technology required** for the **use** of **goods** specified in entries 1A002, 1A202, 1A225 to 1A227, 1B201, 1B225 to 1B231, sub-heads a.2.c. and a.2.d. of entry 1C002, head b. of entry 1C010, or entries 1C202, 1C210, 1C216, 1C225 to 1C239 or 1D201.

(1E202) **Technology required** for the **development** or **production** of **goods** specified in entries 1A202, 1A225 to 1A227.

(1E203) **Technology required** for the **development** of **software** specified in entry 1D201.

Category 2—Materials Processing

Equipment, Assemblies and Components

2A Notes to 2A001 to 2A006:

(1) DN is the product of the bearing bore diameter in mm and the bearing rotational velocity in rpm.

(2) Operating temperatures include those temperatures obtained when a gas turbine engine has stopped after operation.

(2A001) Ball bearings or solid roller bearings (except tapered roller bearings) having tolerances specified by the manufacturer in accordance with ISO Standard Class 4 (Annular Bearing Engineers Committee (ABEC) 7, ABEC 7P, ABEC 7T) or better, and having any of the following characteristics:

(a) Rings, balls or rollers made from monel or beryllium;

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

(c) With lubricating elements or component modifications that, according to the manufacturer’s specifications, are specially designed to enable the bearings to operate at speeds exceeding 2.3 million DN.

(2A002) Other ball bearings or solid roller bearings (except tapered roller bearings) having tolerances specified by the manufacturer in accordance with ISO Standard Class 2 (Annular Bearing Engineers Committee (ABEC) 9, ABEC 9P or better).

(2A003) Solid tapered roller bearings, having tolerances specified by the manufacturer in accordance with American National Standards Institute (ANSI)/Anti-Friction Bearing

Manufacturers Association (AFBMA) Class 00 (inch) or Class A (metric) or better and having either of the following characteristics:

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

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

(2A004) Gas-lubricated foil bearings manufactured for use at operating temperatures of 561 K (288°C) or higher and with a unit load capacity exceeding 1 MPa.

(2A005) Active magnetic bearing systems.

(2A006) Fabric-lined self-aligning or fabric-lined journal sliding bearings manufactured for use at operating temperatures below 219 K (-54°C) or above 423 K (150°C).

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

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

(1) Calcium fluoride (CaF_2);

(2) Calcium zirconate (metazirconate) (Ca_2ZrO_3);

(3) Cerium sulphide (Ce_2S_3);

(4) Erbium oxide (erbia) (Er_20_3);

(5) Hafnium oxide (hafnia) (HfO_2);

(6) Magnesium oxide (MgO);

(7) Nitrided niobium-titanium-tungsten alloy (approximately 50% Nb, 30% Ti, 20%W);

(8) Yttrium oxide (yttria) (Y_2O_3); or

(9) Zirconium oxide (zirconia) (ZrO_2);

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

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

(2A226) Valves 5 mm or greater in diameter, with a bellows seal, wholly made of or lined with aluminium, aluminium alloy, nickel or alloy containing 60% or more nickel, either manually or automatically operated.

(2B) **Test, Inspection and Production Equipment**

Note: Entries 2B001 to 2B009 do not specify measuring interferometer systems, without closed or open loop feedback, containing a **laser** to measure slide movement errors of machine-tools, dimensional inspection machines or similar equipment.

(2B001) **Numerical control** units, **motion control boards** specially designed for **numerical control** applications on machine tools, machine tools, and specially designed components therefor, as follows:

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.

N.B.: Rotary axes need not rotate over 360°. A rotary axis can be driven by a linear device, e.g., a screw or a rack-and-pinion.

(2) Axis nomenclature shall be in accordance with International Standard ISO 841, 'Numerical Control Machines – Axis and Motion Nomenclature'.

(a) **Numerical control** units for machine tools, as follows, and specially designed components therefor:

Note: Head a. of this entry does not specify **numerical control** units:

(a) Modified for and incorporated in machines not specified in this entry; or

(b) Specially designed for machines not specified in this entry.

(1) Having more than four interpolating axes which can be coordinated simultaneously for **contouring control**;

(2) Having two, three or four interpolating axes which can be coordinated simultaneously for **contouring control** and:

(a) Capable of **real time processing** of data to modify, during the machining operation, tool path, feed rate and spindle data by either:

(1) Automatic calculation and modification of part programme data for machining in two or more axes by means of measuring cycles and access to source data; or

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

(b) Capable of receiving directly (on-line) and processing computer aided design (CAD) data for internal preparation of machine instructions; or

(c) Capable, without modification, according to the manufacturer's technical specifications, of accepting additional boards which would permit an increase above the levels specified in this entry, in the number of interpolating axes which can be coordinated simultaneously for **contouring control,** even if they do not contain these additional boards;

(b) **Motion control boards** specially designed for machine tools and having any of the following characteristics:

(1) Interpolation in more than four axes;

(2) Capable of **real time processing** as described in sub-head a.2.a. of this entry; or

(3) Capable of receiving and processing CAD data as described in sub-head a.2.b. of this entry;

(c) Machine tools, as follows, for removing or cutting metals, ceramics or composites, which, according to the manufacturer's technical specifications, can be equipped with electronic devices for simultaneous **contouring control** in two or more axes:

(1) Machine tools for turning, grinding, milling or any combination thereof which:

(a) Have two or more axes which can be coordinated simultaneously for **contouring control**; and

(b) Have any of the following characteristics:

(1) Two or more contouring rotary axes;

Note: The c axis on jig grinders used to maintain grinding wheels normal to the work surface is not considered a contouring rotary axis.

(2) One or more contouring **tilting spindles**;

Note: Sub-head c.1.b.2. of this entry applies to machine tools for grinding or milling only.

(3) **Camming** (axial displacement) in one revolution of the spindle less (better) than 0.0006 mm total indicator reading (TIR);

Note: Sub-head c.1.b.3. of this entry applies to machine tools for turning only.

(4) **Run out** (out-of-true running) in one revolution of the spindle less (better) than 0.0006 mm TIR;

(5) The positioning accuracies, with all compensations available, are less (better) than:

(a) 0.001° on any rotary axis; or

(b)

(1) 0.004 mm along any linear axis (overall positioning) for grinding machines;

(2) 0.006 mm along any linear axis (overall positioning) for turning or milling machines; or

Notes:

(1) Sub-head c.1.b.5. of this entry does not specify milling or turning machine tools with a positioning accuracy along one axis, with all compensations available, equal to or more (worse) than 0.005 mm.

(2) The positioning accuracy of **numerically controlled** machine tools is to be determined and presented in accordance with ISO 230/2 paragraph 2.13, in conjunction with the requirements below:

(a) Test conditions (paragraph 3):

(1) For 12 hours before and during measurements, the machine tool and accuracy measuring equipment will be kept at the same ambient temperature. During the premeasurement time the slides of the machine will be continuously cycled in the same manner that the accuracy measurements will be taken;

(2) The machine shall be equipped with any mechanical, electronic, or software compensation to be exported with the machine;

(3) Accuracy of measuring equipment for the measurements shall be at least four times more accurate than the expected machine tool accuracy;

(4) Power supply for slide drives shall be as follows:

(a) Line voltage variation shall not exceed ± 10% of nominal rated voltage;

(b) Frequency variation shall not exceed ±2 Hz of normal frequency;

(c) Lineouts or interrupted service are not permitted;

(b) Test programme (paragraph 4):

(1) Feed rate (velocity of slides) during measurement shall be the rapid traverse rate, except in the case of machine tools which generate optical quality surfaces, the feed rate shall be equal to or less than 50 mm per minute;

(2) Measurements shall be made in an incremental manner from one limit of the axis travel to the other without returning to the starting position for each move to the target position;

(3) Axes not being measured shall be retained at mid travel during test of an axis;

(c) Presentation of test results (paragraph 2): The results of the measurements must include:

(1) Positioning accuracy (A); and

(2) The mean reversal error (B).

End of Notes

(6)

(a) A positioning accuracy less (better) than 0.007 mm; and

(b) A slide motion from rest for all slides within 20% of a motion command input for inputs of less than 0.5 micrometre;

Notes:

(1) Minimum increment of motion test (slide motion from rest): The test is conducted only if the machine tool is equipped with a control unit the minimum increment of which is less (better) than 0.5 micrometre. Prepare the machine for testing in accordance with ISO 230/2 paragraphs 3.1, 3.2, 3.3.Conduct the test on each axis (slide) of the machine tool as follows:

(a) Move the axis over at least 50% of the maximum travel in plus and minus directions twice at maximum feed rate, rapid traverse rate or jog control;

(b) Wait at least 10 seconds;

(c) With manual data input, input the minimum programmable increment of the control unit;

(d) Measure the axis movement;

(e) Clear the control unit with the servo null, reset or whatever clears any signal (voltage) in the servo loop;

(f) Repeat steps b. to e. above five times, twice in the same direction of the axis travel and three times in the opposite direction of travel for a total of six test points;

(g) If the axis movement is between 80% and 120% of the minimum programmable input for four of the six test points, the machine is controlled.

For rotary axes, the measurement is taken 200 mm from the centre of rotation.

(2) Sub-head c.1. of this entry does not specify cylindrical external, internal and external-internal grinding machines having all of the following characteristics:

(a) Not centreless (shoe-type) grinding machines;

(b) Limited to cylindrical grinding;

(c) A maximum workpiece capacity of 150 mm outside diameter or length;

(d) Only two axes which can be coordinated simultaneously for **contouring control**; and

(e) No contouring c axis.

(3) Sub-head c.1. of this entry does not specify machines designed specifically as jig grinders having both of the following characteristics:

(a) Axes limited to x, y, c and a, where the c axis is used to maintain the grinding wheel normal to the work surface and the a axis is configured to grind barrel cams; and

(b) A spindle **run out** not less (not better) than 0.0006 mm.

(4) Sub-head c.1. of this entry does not specify tool or cutter grinding machines having all of the following characteristics:

(a) Shipped as a complete system with **software** specially designed for the production of tools or cutters;

(b) No more than two rotary axes which can be coordinated simultaneously for **contouring control**;

(c) **Run out** (out-of-true running) in one revolution of the spindle not less (not better) than 0.0006 mm TIR; and

(d) The positioning accuracies, with all compensations available, are not less (not better) than:

(1) 0.004 mm along any linear axis for overall positioning; or

(2) 0.001° on any rotary axis.

End of Notes

(2) Electrical discharge machines (EDM) of the wire feed type which have five or more axes which can be coordinated simultaneously for **contouring control**;

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

(4) Machine tools for removing metals, ceramics or composites:

(a) By means of:

(1) Water or other liquid jets, including those employing abrasive additives;

(2) Electron beam; or

(3) **Laser** beam; and

(b) Having two or more rotary axes which:

(1) Can be coordinated simultaneously for **contouring control**; and

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

Note: Machines capable of being simultaneously coordinated for contouring control, in two or more rotary axes or one or more tilting spindles, are specified in this entry regardless of the number of simultaneously coordinated contouring axes that can be controlled by the **numerical control** unit attached to the machine.

(2B002) Non-**numerically controlled** machine tools for generating optical quality surfaces, as follows:

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

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

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

(3) Spindle **run out** and **camming** less (better) than 0.0004 mm TIR;

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

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

Note: The bidirectional slide positioning repeatability (R) of an axis is the maximum value of the repeatability of positioning at any position along or around the axis determined using the procedure and under the conditions specified in part 2.11 of ISO 230/2: 1988.

(b) Fly cutting machines having both of the following characteristics:

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

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

(2B003) **Numerically controlled** or manual machine tools specially designed for cutting, finishing, grinding or honing either of the following classes of bevel or parallel axis hardened (R_c = 40 or more) gears, and specially designed components, controls and accessories therefor:

(a) Hardened bevel gears finished to a quality of better than ISO 1328 class 4; or

(b) Hardened 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 ISO 1328 class 3 or better.

(2B004) Hot **isostatic presses**, as follows, and specially designed dies, moulds, components, accessories and controls therefor(**24**):

(a) Having a controlled thermal environment within the closed cavity and possessing a chamber cavity with an inside diameter of 406 mm or more; and

(b) Having:

(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.

Note: The inside chamber dimension is that of the chamber in which both the working temperature and the working pressure are achieved and does not include fixtures. That dimension will be the smaller of either the inside diameter of the pressure chamber or the inside diameter of the insulated furnace chamber, depending on which of the two chambers is located inside the other.

(2B005) Equipment specially designed for the deposition, processing and in-process control of inorganic overlays, coatings and surface modifications, as follows, for non-electronic substrates, by processes shown in the Table and associated Notes following head d. of entry 2E003, and specially designed automated handling, positioning, manipulation and control components therefor:

(a) **Stored programme controlled** chemical vapour deposition (CVD) production equipment with both of the following:

(1) Process modified for one of the following:

(a) Pulsating CVD;

(b) Controlled nucleation thermal decomposition (CNTD); or

(c) Plasma enhanced or plasma assisted CVD; and

(2) Either 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;

(**24**) See also Entries 2B104 and 2B204.

(b) **Stored programme controlled** ion implantation production equipment having beam currents of 5 mA or more;

(c) **Stored programme controlled** electron beam physical vapour deposition (EBPVD) production equipment incorporating:

(1) Power systems rated for over 80 kW;

(2) A liquid pool level **laser** control system which regulates precisely the ingots feed rate; and

(3) A computer controlled rate monitor operating on the principle of photoluminescence of the ionised atoms in the evaporant stream to control the deposition rate of a coating containing two or more elements;

(d) **Stored programme controlled** plasma spraying production equipment having either of the following characteristics:

(1) Operating at reduced pressure controlled atmosphere (equal to or less than 10 kPa measured above and within 300 mm of the gun nozzle exit) in a vacuum chamber capable of evacuation down to 0.01 Pa prior to the spraying process; or

(2) Incorporating in situ coating thickness control;

(e) **Stored programme controlled** sputter deposition production equipment capable of current densities of 0.1 mA/mm^2 or higher at a deposition rate of 15 micrometre/hr or more;

(f) **Stored programme controlled** cathodic arc deposition production equipment incorporating a grid of electromagnets for steering control of the arc spot on the cathode;

(g) **Stored programme controlled** ion plating production equipment allowing for the in situ measurement of either:

(1) Coating thickness on the substrate and rate control; or

(2) Optical characteristics.

Note: Head g. of this entry does not specify standard ion plating coating equipment for cutting or machining tools.

(2B006) Dimensional inspection or measuring systems or equipment, as follows:

(a) Computer controlled, **numerically controlled** or **stored programme controlled** dimensional inspection machines, having both of the following characteristics:

(1) Two or more axes; and

(2) A one dimensional length **measurement uncertainty** equal to or less (better) than (1.25 + L/1,000) micrometre tested with a probe with an **accuracy** of less (better) than 0.2 micrometre (L is the measured length in mm);

(b) Linear and angular displacement measuring instruments, as follows:

(1) Linear measuring instruments having any of the following characteristics:

(a) Non-contact type measuring systems with a **resolution** equal to or less (better) than 0.2 micrometre within a measuring range up to 0.2 mm;

(b) Linear voltage differential transformer systems with both of the following characteristics:

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

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

(c) Measuring systems having both of the following characteristics:

(1) Containing a **laser**; and

(2) Maintaining, for at least 12 hours, over a temperature range of ± 1 K around a standard temperature and at a standard pressure:

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

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

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

Note: Sub-head b.2. of this entry does not specify optical instruments, such as autocollimators, using collimated light to detect angular displacement of a mirror.

(c) Systems for simultaneous linear-angular inspection of hemishells, having both of the following characteristics:

(1) **Measurement uncertainty** along any linear axis equal to or less (better) than 3.5 micrometre per 5 mm; and

(2) **Angular position deviation** equal to or less (better) than 0.02°;

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

Notes:

(1) The probe used in determining the **measurement uncertainty** of a dimensional inspection system shall be as described in Verein Deutscher Ingenieure (VDI) / Verband Deutscher Elektrotechniker (VDE) 2617 Parts 2, 3 and 4.

(2) All measurement values in this entry represent permissible positive and negative deviations from the target value, i.e., not total band.

(3) Machine tools which can be used as measuring machines are specified if they meet or exceed the criteria specified for the machine tool function or the measuring machine function.

(4) A machine described in this entry is specified if it exceeds the threshold anywhere within its operating range.

(5) In this entry **measurement uncertainty** means 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: VDI/ VDE 2617).

(2B007) **Robots,** as follows, and specially designed controllers and **end-effectors** therefor(**25**):

(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;

Note: The scene analysis limitation does not include approximation of the third dimension by viewing at a given angle, or limited grey scale interpretation for the perception of depth or texture for the approved tasks (2 1/2 D).

(b) Specially designed to comply with national safety standards applicable to explosive munitions environments; or

(**25**) See also entry 2B207.

(c) Specially designed or rated as radiation-hardened beyond that necessary to withstand normal industrial (i.e., non-nuclear industry) ionizing radiation.

(2B008) Assemblies, units or inserts specially designed for machine tools, or for equipment specified in entries 2B006 or 2B007, as follows:

(a) Spindle assemblies, consisting of spindles and bearings as a minimal assembly, with radial **(run out)** or axial **(camming)** axis motion in one revolution of the spindle less (better) than 0.0006 mm TIR;

(b) 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 × L × 10^{-3})) nm (L equals the effective length in mm);

(c) Rotary position feedback units, e.g., inductive type devices, graduated scales, infrared systems or **laser** systems, having an accuracy less (better) than 0.00025°;

(d) Slide way assemblies consisting of a minimal assembly of ways, bed and slide having all of the following characteristics:

(1) A yaw, pitch or roll of less (better) than 2 seconds of arc TIR over full travel;

(2) A horizontal straightness of less (better) than 2 micrometre per 300 mm length; and

(3) A vertical straightness of less (better) than 2 micrometre per 300 mm length;

(e) Single point diamond cutting tool inserts, having all of the following characteristics:

(1) Flawless and chip-free cutting edge when magnified 400 times in any direction;

(2) Cutting radius from 0.1 to 5 mm inclusive; and

(3) Cutting radius out-of-roundness less (better) than 0.002 mm TIR.

(2B009) Specially designed printed circuit boards with mounted components and **software** therefor, or **compound rotary tables** or **tilting** spindles, capable of upgrading, according to the manufacturer's specifications, **numerical control** units, machine tools or feed-back devices to or above the levels specified in entries 2B001 to 2B008.

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

Note: The only **isostatic presses** and furnaces specified in this entry are as follows:

a. **Isostatic presses**, other than those specified in entry 2B004, having all the following characteristics:

1. Maximum working pressure of 69 MPa or greater;

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

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

b. CVD furnaces designed or modified for the densification of carbon-carbon composites.

(2B115) Flow-forming machines, and specially designed components therefor(**26**), which:

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

(b) With more than two axes which can be coordinated simultaneously for **contouring control**.

Note: Machines combining the function of spin-forming and flow-forming are for the purpose of this entry regarded as flow-forming machines.

(**26**) See also entry 2B215.

(2B116) Vibration test equipment and components therefor, the following:

(a) Vibration test systems employing feedback or closed loop techniques and incorporating a digital controller, capable of vibrating a system at 10 g rms or more over the entire range 20 Hz to 2000 Hz and imparting forces of 50 kN (11,250 lbs), measured bare table, or greater;

(b) Digital controllers, combined with specially designed vibration test software, with a real-time bandwidth greater than 5 kHz and designed for use with vibration test systems in head a. of this entry;

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

(d) Test piece support structures and electronic units designed to combine multiple shaker units in a system capable of providing an effective combined force of 50 kN, measured bare table, or greater, and usable in vibration systems in head a. of this entry.

In this entry, "bare table" means a flat table, or surface, with no fixtures or fittings.

(2B204) **Isostatic presses**, other than those specified in entries 2B004 or 2B104, capable of achieving a maximum working pressure of 69 MPa or greater and having a chamber cavity with an inside diameter in excess of 152 mm and specially designed dies, moulds and controls therefor.

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

(2B215) Spin-forming and flow-forming machines, other than those specified in entry 2B115, and precision rotor-forming mandrels designed to form cylindrical rotors of inside diameter between 75 mm and 400 mm therefor, which:

(a) According to the manufacturer's technical specification, can be equipped with **numerical control** units or a computer control; and

(b) With two or more axes that can be coordinated simultaneously for **contouring control**.

Note: The only spin-forming machines specified in this entry are those combining the function of spin-forming and flow-forming.

(2B225) Remote manipulators that provide mechanical translation of human operator actions by electrical, hydraulic or mechanical means to an operating arm and terminal fixture that can be used to provide remote actions in radiochemical separation operations and hot cells, as follows:

(a) Having a capability of penetrating 0.6 m or more of cell wall; or

(b) Having a capability to bridge over the top of a cell wall with a thickness of 0.6 m or more.

(2B226) Vacuum or controlled environment (inert gas) induction furnaces capable of operating above 1,123 K (850°C) and having induction coils 600 mm or less in diameter and specially designed power supplies therefor with an output rating of 5 kW or more(**27**).

Note: This entry does not specify furnaces designed for the processing of semiconductor wafers.

(2B227) Vacuum and controlled atmosphere metallurgical melting and casting furnaces as follows; and specially configured computer control and monitoring systems therefor:

(a) Arc remelt and casting furnaces with consumable electrode capacities between 1000 cm^3 and 20,000 cm^3, capable of operating with melting temperatures above 1973 K (1700°C);

(b) Electron beam melting and plasma atomization and melting furnaces, with a power of 50 kW or greater, capable of operating with melting temperatures above 1473 K (1200°C).

(**27**) See also sub-category 3B.

(2B228) Rotor fabrication and assembly equipment and bellows-forming mandrels and dies, as follows:

(a) Rotor assembly equipment for assembly of gas centrifuge rotor tube sections, baffles and end caps, including associated precision mandrels, clamps and shrink fit machines;

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

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

(c) Bellows-forming mandrels and dies for producing single-convolution bellows (bellows made of high-strength aluminium alloys, maraging steel or high strength filamentary materials). The bellows have all of the following dimensions:

(1) 75 mm to 400 mm inside diameter;

(2) 12.7 mm or more in length; and

(3) Single convolution depth more than 2 mm.

(2B229) Centrifugal multiplane balancing machines, fixed or portable, horizontal or vertical, as follows:

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

(1) A swing or journal diameter of 75 mm or more;

(2) Mass capability of from 0.9 to 23 kg; and

(3) Capable of balancing speed of revolution more than 5000 rpm;

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

(1) A journal diameter of 75 mm or more;

(2) Mass capability of from 0.9 to 23 kg;

(3) Capable of balancing to a residual imbalance of 0.01 kg mm/kg per plane or better; and

(4) Belt drive type.

(2B230) Instruments capable of measuring pressures up to 13 kPa to an accuracy of better than 1% (full-scale), with corrosion-resistant pressure-sensing elements constructed of nickel, nickel alloys, phosphor bronze, stainless steel, aluminium or aluminium alloys.

(2B231) Vacuum pumps with an input throat size of 380 mm or greater with a pumping speed of 15,000 litres/s or greater and capable of producing an ultimate vacuum better than 13 mPa.

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

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

(2B350) Chemical manufacturing facilities and equipment, as follows:

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

(1) Alloys with more than 25% nickel and 20% chromium by weight;

(2) Fluoropolymers;

(3) Glass (including vitrified or enamelled coating or glass lining);

(4) Nickel or alloys with more than 40% nickel by weight;

(5) Tantalum or tantalum alloys;

(6) Titanium or titanium alloys; or

(7) Zirconium or zirconium alloys;

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

(1) Alloys with more than 25% nickel and 20% chromium by weight;

(2) Fluoropolymers;

(3) Glass (including vitrified or enamelled coating or glass lining);

(4) Nickel or alloys with more than 40% nickel by weight;

(5) Tantalum or tantalum alloys;

(6) Titanium or titanium alloys; or

(7) Zirconium or zirconium alloys;

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

(1) Alloys with more than 25% nickel and 20% chromium by weight;

(2) Fluoropolymers;

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

(4) Nickel or alloys with more than 40% nickel by weight;

(5) Tantalum or tantalum alloys;

(6) Titanium or titanium alloys; or

(7) Zirconium or zirconium alloys;

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

(1) Alloys with more than 25% nickel and 20% chromium by weight;

(2) Fluoropolymers;

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

(4) Graphite;

(5) Nickel or alloys with more than 40% nickel by weight;

(6) Tantalum or tantalum alloys;

(7) Titanium or titanium alloys; or

(8) Zirconium or zirconium alloys;

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

(1) Alloys with more than 25% nickel and 20% chromium by weight;

(2) Fluoropolymers;

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

(4) Graphite;

(5) Nickel or alloys with more than 40% nickel by weight;

(6) Tantalum or tantalum alloys;

(7) Titanium or titanium alloys; or

(8) Zirconium or zirconium alloys;

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

(1) Alloys with more than 25% nickel and 20% chromium by weight; or

(2) Nickel or alloys with more than 40% nickel by weight;

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

(1) Alloys with more than 25% nickel and 20% chromium by weight;

(2) Fluoropolymers;

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

(4) Nickel or alloys with more than 40% nickel by weight;

(5) Tantalum or tantalum alloys;

(6) Titanium or titanium alloys; or

(7) Zirconium or zirconium alloys;

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

(1) Alloys with more than 25% nickel and 20% chromium by weight;

(2) Fluoropolymers;

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

(4) Graphite;

(5) Nickel or alloys with more than 40% nickel by weight;

(6) Tantalum or tantalum alloys;

(7) Titanium or titanium alloys; or

(8) Zirconium or zirconium alloys;

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

(1) Alloys with more than 25% nickel and 20% chromium by weight;

(2) Ceramics;

(3) Ferrosilicon;

(4) Fluoropolymers;

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

(6) Graphite;

(7) Nickel or alloys with more than 40% nickel by weight;

(8) Tantalum or tantalum alloys;

(9) Titanium or titanium alloys; or

(10) Zirconium or zirconium alloys;

(j) Incinerators designed to destroy chemicals specified in entry 1C350, having specially designed waste supply systems, special handling facilities and an average combustion chamber temperature greater than 1273 K (1000°C), in which all surfaces in the waste supply system that come into direct contact with the waste products are made from or lined with any of the following materials:

(1) Alloys with more than 25% nickel and 20% chromium by weight;

(2) Ceramics; or

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

(2B351) Toxic gas monitoring systems, as follows, and dedicated detectors therefor:

(a) Designed for continuous operation and usable for the detection of chemical warfare agents, chemicals specified in entry 1C350 or organic compounds containing phosphorus, sulphur, fluorine or chlorine, at concentrations of less than 0.3 mg/m^3; or

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

(2B352) Equipment capable of use in biological manufacturing, as follows;

(a) Containment facilities at Containment Level (ACDP) 3 or 4, and related equipment, as follows:

(1) Facilities that meet the criteria for Containment Level 3 or 4 as specified in guidance from the Advisory Committee on Dangerous Pathogens approved by the Health and Safety Commission (published by HMSO, Second Edition 1990);

Note: The criteria for Containment Level 3 or 4 in head a. of this entry are equivalent to the criteria for P3 or P4, BL3 or BL4, L3 or L4 containment as specified in the WHO Laboratory Biosafety manual (Geneva, 1983).

(2) Independently ventilated protective full or half suits;

(3) Biological safety cabinets or isolators, which allow manual operations to be performed within, whilst providing an environment equivalent to Class III biological protection;

Note: In this sub-head, "isolators" include flexible isolators, dry boxes, anaerobic chambers and glove boxes.

(b) Fermenters, bioreactors, chemostats and continuous-flow systems, capable of operation without the propagation of aerosols, having all the following characteristics:

(1) Capacity of 300 litres or more;

(2) Double or multiple sealing joints within the steam containment area; and

(3) Capable of in-situ sterilisation in a closed state;

(c) Centrifugal separators or decanters, capable of continuous separation without the propagation of aerosols, having all the following characteristics:

(1) Flow rate exceeding 100 litres per hour;

(2) Components of polished stainless steel or titanium;

(3) Double or multiple sealing joints within the steam containment area; and

(4) Capable of in-situ sterilisation in a closed state;

(d) Cross-flow filtration equipment, designed for continuous separation without the propagation of aerosols, having both of the following characteristics:

(1) Equal to or greater than 5 square metres; and

(2) Capable of in-situ sterilization;

(e) Steam sterilisable freeze drying equipment with a condenser capacity exceeding 50 kg of ice in 24 hours and less than 1,000 kg of ice in 24 hours;

(f) Chambers designed for aerosol challenge testing with pathogenic **microorganisms** or **toxins** and having a capacity of 1 m^3 or greater.

2C Materials

None

2D Software

(2D001) **Software** specially designed or modified for the **development, production** or **use** of **goods** specified in entries 2A001 to 2A006 or 2B001 to 2B009.

(2D002) Specific **software**, as follows:

(a) **Software** to provide **adaptive control** and having both of the following characteristics:

(1) For **flexible manufacturing units** (FMUs) which consist at least of equipment described in sub-heads b.1. and b.2. of the definition of **flexible manufacturing unit**; and

(2) Capable of generating or modifying, in **real time processing, programmes** or data by using the signals obtained simultaneously by means of at least two detection techniques, such as:

(a) Machine vision (optical ranging);

(b) Infrared imaging;

(c) Acoustical imaging (acoustical ranging);

(d) Tactile measurement;

(e) Inertial positioning;

(f) Force measurement;

(g) Torque measurement;

Note: Head a. of this entry does not specify **software** which only provides rescheduling of functionally identical equipment within **flexible manufacturing units** using pre-stored part programmes and a pre-stored strategy for the distribution of the part programmes.

(b) **Software** for electronic devices other than those described in heads a. or b. of entry 2B001, which provides the **numerical control** capability of the **goods** specified in entry 2B001.

Note: Entry 2B001 and this entry specify any combination of electronic devices or systems that collectively contain software enabling such devices or systems to function as a **numerical control** unit capable of coordinating simultaneously more than 4 axes for **contouring control**.

(2D101) **Software** specially designed for the **use** of **goods** specified in entries 2B104, 2B115 or 2B116(**28**).

(2D201) **Software** specially designed for the **use** of **goods** specified in entries 2B204, 2B207, 2B215, 2B227 or 2B229.

Technology

2E.—(2E001) **Technology required** for the **development** of **goods** specified in sub-categories 2A, 2B or 2D.

(2E002) **Technology required** for the **production** of **goods** specified in sub-categories 2A or 2B.

(2E003) Other **technology**, as follows:

(a) **Technology:**

(1) For the **development** of interactive graphics as an integrated part in **numerical control** units for preparation or modification of part programmes;

(2) For the **development** of generators of machine tool instructions (e.g., part programmes) from design data residing inside **numerical control** units;

(3) For the **development** of integration **software** for incorporation of expert systems for advanced decision support of shop floor operations into **numerical control** units;

(b) **Technology** for metal-working manufacturing processes, as follows:

(1) **Technology** for the design of tools, dies or fixtures specially designed for the following processes:

(a) **Superplastic forming**;

(b) **Diffusion bonding**;

(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;

(**28**) See also entry 9D004.a.

(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 application of inorganic overlay coatings or inorganic surface modification coatings, specified in column 3 of the following Table;

To non-elecronic substrates, specified in column 2 of the following Table; By processes specified in column 1 of the following Table and defined in the Note.

TABLE—

DEPOSITION TECHNIQUES

1	*2*	*3*
Coating Process (1)	*Substrate*	*Resultant Coating*
(A) Chemical Vapour Deposition (CVD)	**Superalloys**	Aluminides for internal passages
	Ceramics and low-expansion glasses(14)	Silicides
		Carbides
		Dielectric layers (15)
	Carbon-carbon, ceramic and metal **matrix composites**	Silicides
		Carbides
		Refractory metals
		Mixtures thereof (4)
		Dielectric layers (15)
		Aluminides
		Alloyed aluminides (2)
	Cemented tungsten carbide (16), silicon carbide	Carbides
		Tungsten
		Mixtures thereof (4)
		Dielectric layers (15)
	Molybdenum and molybdenum alloys	Dielectric layers (15)
	Beryllium and beryllium alloys	Dielectric layers (15)
	Sensor window materials (9)	Dielectric layers (15)

a (The numbers in parenthesis refer to the Notes following this Table.)

1	*2*	*3*
Coating Process (1)	*Substrate*	*Resultant Coating*
(B) Thermal-Evaporation Physical Vapour Deposition (TE-PVD)		
(1) (1) Physical Vapour Deposition (PVD): Electron-Beam (EB-PVD)	**Superalloys**	Alloyed silicides
		Alloyed aluminides (2)
		MCrA1X (5)
		Modified zirconia (12)
		Silicides
		Aluminides
		Mixtures thereof (4)
	Ceramics and low-expansion glasses (14)	Dielectric layers (15)
	Corrosion resistant steel (7)	MCrA1X (5)
		Modified zirconia (12)
		Mixtures thereof (4)
	Carbon-carbon, ceramic and metal **matrix composites**	Silicides
		Carbides
		Refractory metals
		Mixtures thereof (4)
		Dielectric layers (15)
	Cemented tungsten carbide (16), silicon carbide	Carbides
		Tungsten
		Mixtures thereof (4)
		Dielectric layers (15)
	Molybdenum and molybdenum alloys	Dielectric layers (15)
	Beryllium and beryllium alloys	Dielectric layers (15)
		Borides
	Sensor window materials (9)	Dielectric layers (15)

a (The numbers in parenthesis refer to the Notes following this Table.)

1	*2*	*3*
Coating Process (1)	*Substrate*	*Resultant Coating*
	Titanium alloys (13)	Borides
		Nitrides
(B.2) (B.2) Ion assisted resistive heating Physical Vapour Deposition (Ion Plating)	Ceramics and low-expansion glasses (14)	Dielectric layers (15)
	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)
(B.3) (B.3) Physical Vapour Deposition: **laser** evaporation	Ceramics and low-expansion glasses (14)	Silicides
		Dielectric layers (15)
	Carbon-carbon, ceramic and metal **matrix composites**	Dielectric layers (15)
	Cemented tungsten carbide (16), silicon carbide	Dielectric layers (15)
	Molybdenum and molybdenum alloys	Dielectric layers (15)
	Beryllium and beryllium alloys	Dielectric layers (15)
	Sensor window materials (9)	Dielectric layers (15)
		Diamond-like carbon
(B.4) (B.4) Physical Vapour Deposition: cathodic arc discharge	**Superalloys**	Alloyed silicides
		Alloyed aluminides (2)
		MCrA1X (5)

a (The numbers in parenthesis refer to the Notes following this Table.)

1	*2*	*3*
Coating Process (1)	*Substrate*	*Resultant Coating*
	Polymers (11) and organic **matrix composites**	Borides
		Carbides
		Nitrides
(C) (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**	MCrA1X (5)
		Modified zirconia (12)
		Mixtures thereof (4)
		Abradable Nickel-Graphite
		Abradable Ni-Cr-Al-Bentonite
		Abradable Al-Si-Polyester
		Alloyed aluminides (2)
	Aluminium alloys (6)	MCrA1X (5)
		Modified zirconia (12)
		Silicides
		Mixtures thereof (4)
	Refractory metals and alloys (8)	Aluminides
		Silicides
		Carbides
	Corrosion resistant steel (7)	Modified zirconia (12)
		Mixtures thereof (4)

a (The numbers in parenthesis refer to the Notes following this Table.)

1	*2*	*3*
Coating Process (1)	*Substrate*	*Resultant Coating*
	Titanium alloys (13)	Carbides
		Aluminides
		Silicides
		Alloyed aluminides (2)
		Abradable Nickel-Graphite
		Abradable Ni-Cr-Al-Bentonite
		Abradable Al-Si-Polyester
E. Slurry Deposition	Refractory metals and alloys (8)	Fused silicides
		Fused aluminides except for resistance heating elements
	Carbon-carbon, ceramic and metal **matrix composites**	Silicides
		Carbides
		Mixtures thereof (4)
F. Sputter Deposition	**Superalloys**	Alloyed silicides
		Alloyed aluminides (2)
		Noble metal modified aluminides (3)
		MCrA1X (5)
		Modified zirconia (12)
		Platinum
		Mixtures thereof (4)
	Ceramics and low-expansion glasses (14)	Silicides
		Platinum
		Mixtures thereof (4)
		Dielectric layers (15)
	Titanium alloys (13)	Borides
		Nitrides
		Oxides
		Silicides
		Aluminides

a (The numbers in parenthesis refer to the Notes following this Table.)

1	*2*	*3*
Coating Process (1)	*Substrate*	*Resultant Coating*
		Alloyed aluminides (2)
		Carbides
	Carbon-carbon, ceramic and metal **matrix composites**	Silicides
		Carbides
		Refractory metals
		Mixtures thereof (4)
		Dielectric layers (15)
	Cemented tungsten carbide (16), silicon carbide	Carbides
		Tungsten
		Mixtures thereof (4)
		Dielectric layers (15)
	Molybdenum and molybdenum alloys	Dielectric layers (15)
Beryllium and beryllium alloys	Borides	
Sensor window materials (9)	Dielectric layers (15)	
		Dielectric layers (15)
	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

a (The numbers in parenthesis refer to the Notes following this Table.)

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. Mixtures consist of 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. MCrA1X refers to a coating alloy where M equals cobalt, iron, nickel or combinations thereof and X equals hafnium, yttrium, silicon, tantalum in any amount or other intentional additions over 0.01 weight percent in various proportions and combinations;

except:

(a) CoCrAlY coatings which contain less than 22 weight percent of chromium, less than 7 weight percent of aluminium and less than 2 weight percent of yttrium;

(b) CoCrAlY coatings which contain 22 to 24 weight percent of chromium, 10 to 12 weight percent of aluminium and 0.5 to 0.7 weight percent of yttrium; or

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

6. The term "aluminium alloys" means alloys having an ultimate tensile strength of 190 MPa or more measured at 293 K (20°C).

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

8. Refractory metals consist of 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 and the following metal halides: potassium iodide, potassium fluoride, or sensor window materials of more than 40 mm diameter for thallium bromide and thallium chlorobromide.

10. Technology for single-step pack cementation of solid airfoils is not specified in 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, etc., to zirconia in order to stabilise certain crystallographic phases and phase compositions. Thermal barrier coatings made of zirconia, modified with calcia or magnesia by mixing or fusion, are not controlled.

13. Titanium alloys refers 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. 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.

Notes:

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

(2) Pack denotes a substrate immersed in a powder mixture.

(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. Resistive heating PVD employs electrically resistive heating sources capable of producing a controlled and uniform flux of evaporated coating species;

3. **Laser** evaporation uses either pulsed or continuous wave **laser** beams to heat the material which forms the coating;

4. Cathodic arc deposition employs a consumable cathode of the material which forms the coating and has an arc discharge established on the surface by a momentary contact of a ground trigger. Controlled motion of arcing erodes the cathode surface creating a highly ionized plasma. The anode can be either a cone attached to the periphery of the cathode, through an insulator, or the chamber. Substrate biasing is used for non line-of-sight deposition.

Note:

Cathodic arc deposition does not include random cathodic arcdeposition with non-biased substrates.

(c) 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 to be deposited 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.

(d) 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.

(e) 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 carried out underwater.

Notes:

(1) Low pressure means less than ambient atmospheric pressure.

(2) High velocity refers to nozzle-exit gas velocity exceeding750 m/s calculated at 293 K (20°C) at 0.1 MPa.

(f) 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.

(g) 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.

Notes:

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

(2) Low-energy ion beams (less than 5 keV) can be used to activatethe deposition.

(h) 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.

(2E101) **Technology required** for the **use** of equipment or **software** specified in entries 2B004, 2B104, 2B115, 2B116 or 2D101.

(2E201) **Technology required** for the **use** of equipment or **software** specified in entries 2A225, 2A226, 2B001,2B006, head b. of entry 2B007, head c. of entry 2B007, or entries 2B008, 2B009, 2B204, 2B207, 2B215, 2B225 to 2B232 or 2D201.

(2E301) **Technology required** for the **use** of **goods** specified in entries 2B350 to 2B352.

Category 3—Electronics

Equipment, Assemblies and Components

3A.—(3A) *Notes:*

(1) The control on export of equipment, devices and components described in entries 3A001 or 3A002, other than those described in sub-heads a.3. to a.10. or sub-head a.12. of entry 3A001, which are specially designed for, or which have the same functional characteristics as other equipment, is determined by the export control requirements applying to that other equipment.

(2) The control on export of integrated circuits described in sub-heads a.3. to a.9. or sub-head a.12. of entry 3A001, which are unalterably programmed or designed for a specific function in a piece of equipment, is determined by the export control requirements applying to that other equipment.

N.B.:

(1) When the export control requirements applying to the equipment cannot be determined, the integrated circuits are evaluated against the parameters in entry 3A001.

(2) For silicon based **microcomputer microcircuits** or micro-controller microcircuits, having an operand (data) word length of 8 bits or less, the export control requirements thereof are determined only in sub-head a.3. of entry 3A001.

Electronic devices and components:

(a) General purpose integrated circuits, as follows:

Notes:

(1) Wafers (finished or unfinished), in which the function has been determined, are evaluated against the parameters of this head.

(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 either of the following:

(a) a total dose of 5×10^5 rads(Si), or higher; or

(b) a dose rate upset of 5×10^8 rads(Si)/s or higher;

Note:

For integrated circuits designed or rated against neutron or transient ionising radiation, see Group 1 of Part III of this Schedule.

(2) **Microprocessor microcircuits, microcomputer microcircuits,** microcontroller microcircuits, electrical erasable programmable read-only memories (EEPROMs), static random-access memories (SRAMs), storage integrated circuits manufactured from a compound semiconductor, analogue-to-digital converters, digital-to-

analogue converters, electro-optical or **optical integrated circuits** for **signal processing,** field programmable gate arrays, field programmable logic arrays, neural network integrated circuits, custom integrated circuits for which either the function is unknown or the control status of the equipment in which the integrated circuit will be used is unknown, or Fast Fourier Transform (FFT) processors, as follows:

(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:

This sub-head does not apply to integrated circuits for civil automobiles or railway train applications.

(3) **Microprocessor microcircuits, microcomputer microcircuits** and microcontroller microcircuits, having any of the following:*Note:* Sub-head a.3. of this entry includes digital signal processors, digital array processors and digital coprocessors.

(a) An arithmetic logic unit with an access width of 32 bit or more and a **composite theoretical performance** (CTP) of 80 million theoretical operations per second (Mtops) or more;

(b) Manufactured from a compound semiconductor and operating at a clock frequency exceeding 40 MHz; or

(c) More than one data or instruction bus or serial communication port for external interconnection in a parallel processor with a transfer rate exceeding 2.5 Mbyte/s;

(4) Electrically erasable programmable read-only memories (EEPROMs) static random-access memories (SRAMs) and storage integrated circuits manufactured from a compound semiconductor, as follows:

(a) EEPROMs with a storage capacity:

(1) Exceeding 16 Mbit per package for flash memory types; or

(2) Exceeding either of the following limits for all other EEPROMtypes:

(a) 4 Mbit per package; or

(b) 1 Mbit per package and having a maximum access time of lessthan 80 ns;

(b) SRAMs with a storage capacity:

(1) Exceeding 4 Mbit per package; or

(2) Exceeding 1 Mbit per package and having a maximum access time of less than 20 ns;

(c) Storage integrated circuits manufactured from a compoundsemiconductor;

(5) Analogue-to-digital and digital-to-analogue converter integrated circuits, as follows:

(a) Analogue-to-digital converters having any of the following:

(1) A resolution of 8 bit or more, but less than 12 bit, with a total conversion time to maximum resolution of less than 10 ns;

(2) A resolution of 12 bit with a total conversion time to maximumresolution of less than 200 ns; or

(3) A resolution of more than 12 bit with a total conversion time to maximum resolution of less than 2 microseconds;

(b) Digital-to-analogue converters with a resolution of 12 bit or more, and a **settling time** of less than 10 ns;

(6) Electro-optical or **optical integrated circuits** for **signal processing** having all of the following:

(a) One or more internal **laser** diodes;

(b) One or more internal light detecting elements; and

(c) Optical waveguides;

(7) Field programmable gate arrays having either of the following:

(a) An equivalent usable gate count of more than 30,000 (2 input gates); or

(b) A typical **basic gate propagation delay time** of less than 0.4 ns;

(8) Field programmable logic arrays having either of the following:

(a) An equivalent usable gate count of more than 30,000 (2 input gates); or

(b) A toggle frequency exceeding 133 MHz;

(9) Neural network integrated circuits;

(10) Custom integrated circuits, for which either the function is unknown, or the control status of the equipment in which the integrated circuit will be used is unknown, having any of the following:

(a) More than 144 terminals;

(b) A typical **basic gate propagation delay time** of less than 0.4 ns; or

(c) An operating frequency exceeding 3 GHz;

(11) Digital integrated circuits based upon any compound semiconductor and having either of the following:

(a) An equivalent gate count of more than 300 (2 input gates); or

(b) A toggle frequency exceeding 1.2 GHz;

Note: This sub-head does not apply to **microprocessor microcircuits, microcomputer microcircuits,** microcontroller microcircuits, electrical erasable programmable read-only memories (EEPROMs), static random-access memories (SRAMs), storage integrated circuits manufactured from a compound semiconductor, analogue-to-digital converters, digital-to-analogue converters, electro-optical or **optical integrated circuits** for **signal processing,** field programmable gate arrays, field programmable logic arrays, neural network integrated circuits, custom integrated circuits for which either the function is unknown or the control status of the equipment in which the integrated circuit will be used is unknown, or Fast Fourier Transform (FFT) processors.

(12) Fast Fourier Transform (FFT) processors having any of the following:

(a) A rated execution time for a 1,024 point complex FFT of less than 1 ms;

(b) A rated execution time for an N-point complex FFT of other than 1,024 points of less than $N \log_2 N/10{,}240$ ms, where N is the number of points; or

(c) A butterfly throughput of more than 5.12 MHz;

(b) Microwave or millimetre wave devices:

(1) Electronic vacuum tubes and cathodes, as follows:

Notes:

1. For frequency agile magnetron tubes, see entry ML11 in Group 1 of Part III of this Schedule.
2. Sub-head b.1. of this entry does not specify tubes designed or rated to operate in the Standard Civil Telecommunications Bands at frequencies not exceeding 31 GHz.

a. Travelling wave tubes, pulsed or continuous wave, as follows:
1. Operating at frequencies higher than 31 GHz;
2. 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 an **instantaneous bandwidth** of more than 7% or a peak power exceeding 2.5 kW;
4. Helix tubes, or derivatives thereof, with any of the following characteristics:
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. **Space qualified;**

b. Crossed-field amplifier tubes with a gain of more than 17 dB;
c. Impregnated cathodes for electronic tubes, with either of the following:
1. Having a turn on time to rated emission of less than 3 seconds; or
2. Producing a continuous emission current density at rated operating conditions exceeding 5 A/cm^2;

(2) Microwave integrated circuits or modules containing **monolithic integrated circuits** operating at frequencies exceeding 3 GHz;

Note: Sub-head b.2. of this entry does not specify circuits or modules for equipment designed or rated to operate in the Standard Civil Telecommunications Bands at frequencies not exceeding 31 GHz.

(3) Microwave transistors rated for operation at frequencies exceeding 31 GHz;

(4) Microwave solid state amplifiers, as follows:
(a) Operating at frequencies exceeding 10.5 GHz and having an **instantaneous bandwidth** of more than half an octave;
(b) Operating at frequencies exceeding 31 GHz;

(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 microseconds with either:
(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) Microwave assemblies capable of operating at frequencies exceeding 31 GHz;

(7) Mixers and converters designed to extend the frequency range of equipment described in heads c., e. or f. of entry 3A002 beyond the limits stated therein;

(c) Acoustic wave devices, as follows, and specially designed components therefor:

(1) Surface acoustic wave and surface skimming (shallow bulk) acoustic wave devices (i.e., **signal processing** devices employing elastic waves in materials), having any of the following:

(a) A carrier frequency exceeding 2.5 GHz;

(b) A carrier frequency of 2.5 GHz or less, and:

(1) A frequency side-lobe rejection exceeding 55 dB;

(2) A product of the maximum delay time and the bandwidth (time in microseconds and bandwidth in MHz) of more than 100; or

(3) A dispersive delay of more than 10 microseconds; or

(c) A carrier frequency exceeding 1 GHz and a bandwidth of 250 MHz or more;

(2) Bulk (volume) acoustic wave devices (i.e., **signal processing** devices employing elastic waves) which permit direct processing of signals at frequencies exceeding 1 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;

(d) Electronic devices or 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, with any of the following:

(1) Electromagnetic amplification:

(a) At frequencies equal to or less than 31 GHz with a noise figure of less than 0.5 dB; or

(b) At frequencies exceeding 31 GHz;

(2) 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

(3) Frequency selection at all frequencies using resonant circuits with Q-values exceeding 10,000;

(e) High energy devices, as follows:

(1) Batteries, as follows:

Note: Sub-head e.1. of this entry does not specify batteries with volumes equal to or less than 27 cm^3 (e.g., standard C-cells or R14 batteries).

(a) Primary cells and batteries having an energy density exceeding 480 Wh/kg and rated for operation in the temperature range from below 243 K (-30°C) to above 343 K (70°C);

(b) Rechargeable cells and batteries having an energy density exceeding 150 Wh/kg after 75 charge/discharge cycles at a discharge current equal to C/5 hours (C being the nominal capacity in ampere hours) when operating in the temperature range from below 253 K (-20°C) to above 333 K (60°C);

Note: Energy density is obtained by multiplying the average power in watts (average voltage in volts times average current in amperes) by the duration of the discharge in hours to 75% of the open circuit voltage divided by the total mass of the cell (or battery) in kg.

(c) **Space qualified** and radiation hardened photovoltaic arrays with a specific power exceeding 160 W/m^2 at an operating temperature of 301 K (28°C) under a tungsten illumination of 1 kW/m^2 at 2,800 K (2,527°C);

(2) High energy storage capacitors, as follows(**29**):

(a) Capacitors with a repetition rate of less than 10 Hz (single shot capacitors) 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) 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 or solenoids specially designed to be fully charged or discharged in less than one second, having all of the following(**30**):

(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;

Note: Sub-head e.3. of this entry does not specify **superconductive** electromagnets or solenoids specially designed for Magnetic Resonance Imaging (MRI) medical equipment.

(4) Circuits or systems for electromagnetic energy storage, containing components manufactured from **superconductive** materials specially designed for operation at temperatures below the **critical temperature** of at least one of their **superconductive** constituents, having all of the following:

(a) Resonant operating frequencies exceeding 1 MHz;

(b) A stored energy density of 1 MJ/m^3 or more; and

(c) A discharge time of less than 1 ms;

(5) Flash discharge type X-ray systems, and tubes therefor, having all of the following(**31**):

(a) A peak power exceeding 500 MW;

(b) An output voltage exceeding 500 kV; and

(c) A pulse width of less than 0.2 microsecond;

(f) Rotary input type shaft absolute position encoders having either of the following:

(1) A resolution of better than 1 part in 265,000 (18 bit resolution) of full scale; or

(2) An accuracy better than ± 2.5 seconds of arc.

(**29**) See also entry 3A201.a.
(**30**) See also entry 3A201.b.
(**31**) See also entry 3A101.b. and 3A201.c.

(3A002) General purpose electronic equipment:

(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 Inter Range Instrumentation Group (IRIG) or Electronic Industries Association (EIA) documents, of less than ± 0.1 microsecond;

(2) Digital video magnetic tape recorders having a maximum digital interface transfer rate exceeding 180 Mbit/s, except: those specially designed for television recording using a signal format standardized or recommended by the International Radio Consultative Committee (CCIR) or the International Technical Commission (IEC) for civil television applications;

(3) Digital instrumentation magnetic tape data recorders employing helical scan techniques or fixed head techniques, having either of the following:

(a) A maximum digital interface transfer rate exceeding 175 Mbit/s; or

(b) **Space qualified;**

Note: Sub-head a.3. of this entry does not specify analogue magnetic tape recorders equipped with HDDR conversion electronics and configured to record only digital data.

(4) Equipment, with a maximum digital interface transfer rate exceeding 175 Mbit/s, designed to convert digital video magnetic tape recorders for use as digital instrumentation data recorders;

(5) Waveform digitisers and transient recorders with both of the following(**32**):

(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 Gbits/s or more;

Note: 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. In this entry, "continuous throughput" means the fastest data rate the instrument can output to mass storage without the loss of any information whilst sustaining the sample rate and analogue-to-digital conversion.

(b) **Frequency synthesiser electronic assemblies** having a **frequency switching time** from one selected frequency to another of less than 1 ms;

(c) **Signal analysers,** as follows:

(1) Capable of analysing frequencies exceeding 31 GHz;

(2) **Dynamic signal analysers** with a **real-time bandwidth** exceeding 25.6 kHz; except:

Those using only constant percentage bandwidth filters (also known as octave or fractional octave filters);

(**32**) See also entry 3A202.

(d) Frequency synthesised 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 frequency, and having any of the following:

(1) A maximum synthesised frequency exceeding 31 GHz;

(2) A **frequency switching time** from one selected frequency to another of less than 1 ms; or

(3) A single sideband (SSB) phase noise better than $-(126 + 20 \log_{10}F - 20 \log_{10}f)$ in dBc/Hz, where F is the off-set from the operating frequency in Hz and f is the operating frequency in MHz;

Note: Head d. of this entry does not specify 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.

(e) Network analysers with a maximum operating frequency exceeding 31 GHz;

Note: Head e. of this entry does not specify **swept frequency network analysers** with a maximum operating frequency not exceeding 40 GHz and which do not contain a data bus for remote control interfacing.

(f) Microwave test receivers with both of the following:

(1) A maximum operating frequency exceeding 31 GHz; and

(2) Capable of measuring amplitude and phase simultaneously;

(g) Atomic frequency standards having either of the following characteristics:

(1) Long term stability (aging) less (better) than 1×10^{-11}/month; or

Note: Sub-head g.1. of this entry does not specify non-**space qualified** rubidium standards.

(2) **Space qualified;**

(h) Emulators for microcircuits specified in sub-heads a.3. or a.9. of entry 3A001.

Note: Head h. of this entry does not specify emulators designed for a **family** which contains at least one device not specified in sub-heads a.3. or a.9. of entry 3A001.

(3A101) Electronic devices and components, other than those specified in entry 3A001, as follows:

(a) Analogue-to-digital converters, usable in **missiles,** designed to meet military specifications for ruggedized equipment;

(b) Accelerators capable of delivering electromagnetic radiation produced by bremsstrahlung from accelerated electrons of 2 MeV or greater, and systems containing those accelerators.

Note: Head b of this entry does not specify goods specially designed for medical purposes.

(3A201) Electronic devices and components, other than those specified in entry 3A001, as follows:

(a) Capacitors with the following characteristics:

(1) Voltage rating greater than 1.4 kV, energy storage greater than 10J, capacitance greater than 500 nF and series inductance less than 50 nH; or

(2) Voltage rating greater than 750 V, capacitance greater than 250 nF and series inductance less than 10 nH;

(b) Superconducting solenoidal electromagnets with all of the following characteristics:

(1) Capable of creating magnetic fields of more than 2 Teslas (20 kilogauss);

(2) With an L/D ratio (length divided by inner diameter) greater than 2;

(3) With an inner diameter of more than 300 mm; and

(4) With a magnetic field uniform to better than 1% over the central 50% of the inner volume.

Note: Head b. of this entry does not specify magnets specially designed for and exported as parts of medical nuclear magnetic resonance (NMR) imaging systems. In this entry, "as part of" does not necessarily mean physical part in the same shipment; separate shipments from different sources are allowed, provided the related export documents clearly specify that the shipments are dispatched "as part of" the same imaging systems.

(c) Flash X-ray generators or pulsed electron accelerators with peak energy of 500 keV or greater, as follows;

except:

Accelerators that are component parts of devices designed for purposes other than electron beam or X-ray radiation (electron microscopy, for example) and those designed for medical purposes:

1. Having an accelerator peak electron energy of 500 keV or greater but less than 25 MeV and with a figure of merit (K) of 0.25 or greater, where K is defined as:

$K = 1.7 \times 10^3 V^{2.65} Q$;

where

V is the peak electron energy in million electron volts and Q is the total accelerated charge in coulombs if the accelerator beam pulse duration is less than or equal to 1 microsecond; if the accelerator beam pulse duration is greater than 1 microsecond, Q is the maximum accelerated charge in 1 microsecond [Q equals the integral of i with respect to t, over the lesser of 1 microsecond or the time duration of the beam pulse (Q = [integral] idt), where i is beam current in amperes and t is time in seconds]; or

2. Having an accelerator peak electron energy of 25 MeV or greater and a peak power greater than 50 MW. [Peak power = (peak potential in volts) × (peak beam current in amperes)].

Notes:

1. Time duration of the beam pulse—In machines, based on microwave accelerating cavities, the time duration of the beam pulse is the lesser of 1 microsecond or the duration of the bunched beam packet resulting from one microwave modulator pulse.

2. Peak beam current—In machines based on microwave accelerating cavities, the peak beam current is the average current in the time duration of a bunched beam packet.

(3A202) Oscilloscopes and transient recorders other than those specified in sub-head a.5. of entry 3A002, as follows; and specially designed components therefor:

(a) Non-modular analogue oscilloscopes having a bandwidth of 1 GHz or greater;

(b) Modular analogue oscilloscope systems having either of the following characteristics:

(1) A mainframe with a bandwidth of 1 GHz or greater; or

(2) Plug-in modules with an individual bandwidth of 4 GHz or greater;

(c) Analogue sampling oscilloscopes for the analysis of recurring phenomena with an effective bandwidth greater than 4 GHz;

(d) Digital oscilloscopes and transient recorders, using analogue-to-digital conversion techniques, capable of storing transients by sequentially sampling single-shot inputs at successive intervals of less than 1 ns (greater than 1 giga-sample per second), digitizing to 8 bits or greater resolution and storing 256 or more samples.

Notes:

(1) Specially designed components specified in this entry are the following, for analogue oscilloscopes:

(a) Plug-in units;

(b) External amplifiers;

(c) Pre-amplifiers;

(d) Sampling devices;

(e) Cathode ray tubes.

(2) In this entry, the term "bandwidth" means the band of frequencies over which the deflection on the cathode ray tube does not fall below 70.7% of that at the maximum point measured with a constant input voltage to the oscilloscope amplifier.

(3A225) Frequency changers (also known as converters or inverters) or generators, other than those specified in entry B10b.2.k. of Group 2 of Part III of this Schedule, having all of the following characteristics:

(a) A multiphase output capable of providing a power of 40 W or more;

(b) Capable of operating in the frequency range between 600 and 2000 Hz;

(c) Total harmonic distortion below 10%; and

(d) Frequency control better than 0.1%.

(3A226) Direct current high-power supplies capable of continuously producing, over a time period of 8 hours, 100 V or greater with current output of 500 A or greater and with current or voltage regulation better than 0.1%.

(3A227) High-voltage direct current power supplies capable of continuously producing, over a time period of 8 hours, 20,000 V or greater with current output of 1 A or greater and with current or voltage regulation better than 0.1%.

(3A228) Switching devices, as follows:

(a) Cold-cathode tubes (including gas krytron tubes and vacuum sprytron tubes), whether gas filled or not, operating similarly to a spark gap, containing three or more electrodes, and having all of the following characteristics:

(1) Anode peak voltage rating of 2,500 V or more;

(2) Anode peak current rating of 100 A or more; and

(3) Anode delay time of 10 microsecond or less;

(b) Triggered spark-gaps having an anode delay time of 15 microsecond or less and rated for a peak current of 500 A or more;

(c) Modules or assemblies with a fast switching function having all of the following characteristics:

(1) Anode peak voltage rating greater than 2,000 V;

(2) Anode peak current rating of 500 A or more; and

(3) Turn-on time of 1 microsecond or less.

(3A229) Firing sets and equivalent high-current pulse generators (for controlled detonators), as follows(**33**):

(a) Explosive detonator firing sets designed to drive multiple controlled detonators specified in entry 3A232;

(b) Modular electrical pulse generators (pulsers) designed for portable, mobile or ruggedized use (including xenon flash-lamp drivers) having all the following characteristics:

(1) Capable of delivering their energy in less than 15 microsecond;

(2) Having an output greater than 100 A;

(3) Having a rise time of less than 10 microsecond into loads of less than 40 ohms (rise time is the time interval from 10% to 90% current amplitude when driving a resistive load);

(4) Enclosed in a dust-tight enclosure;

(5) No dimension greater than 254 mm;

(6) Weight less than 25 kg; and

(7) Specified for use over an extended temperature range (223 K [-50°C] to 373 K [100°C]) or specified as suitable for aerospace use.

(3A230) High-speed pulse generators with output voltages greater than 6 volts into a less than 55 ohm resistive load, and with pulse transition times less than 500 picoseconds.

In this entry, "pulse transition time" means the time interval between 10% and 90% voltage amplitude.

(3A231) Neutron generator systems, including tubes, designed for operation without an external vacuum system and utilizing electrostatic acceleration to induce a tritium-deu-terium nuclear reaction.

(3A232) Detonators and multipoint initiation systems, as follows(**34**):

(a) Electrically driven explosive detonators, the following:

(1) Exploding bridge (EB);

(2) Exploding bridge wire (EBW);

(3) Slapper;

(4) Exploding foil initiators (EFI);

(b) Arrangements using single or multiple detonators designed to nearly simultaneously initiate an explosive surface (over greater than 5000 mm^2) from a single firing signal (with an initiation timing spread over the surface of less than 2.5 microseconds).

Notes:

(1) This entry does not specify detonators using only primary explosives, such as lead azide.

(2) The detonators in this entry all utilise a small electrical conductor (bridge, bridge wire or foil) that explosively vaporizes when a fast, high-current electrical pulse is passed through it. In nonslapper types, the exploding conductor starts a chemical detonation in a contacting high-explosive material such as PETN (Pentaerythritoltetranitrate). In slapper detonators, the explosive vaporization 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

(**33**) See also Group 1 of Part III of this Schedule.
(**34**) See also Group 1 of Part III of this Schedule.

driven by a magnetic force. The term 'exploding foil' detonator may refer to either an EB or a slapper-type detonator.

(3A233) Mass spectrometers, other than those specified in entry B20g. of Group 2 of Part III of this Schedule, capable of measuring ions of 230 atomic mass units or greater and having a resolution of better than 2 parts in 230, as follows; and ion sources therefor:

(a) Inductively coupled plasma mass spectrometers (ICP/MS);

(b) Glow discharge mass spectrometers (GDMS);

(c) Thermal ionization mass spectrometers (TIMS);

(d) Electron bombardment mass spectrometers which have a source chamber constructed from, lined with or plated with materials resistant to UF_6;

(e) Molecular beam mass spectrometers as follows:

(1) Which have a source chamber constructed from, lined with or plated with stainless steel or molybdenum and have a cold trap capable of cooling to 193 K (-80°C) or less; or

(2) Which have a source chamber constructed from, lined with or plated with materials resistant to UF_6; or

(f) Mass spectrometers equipped with a microfluorination ion source designed for use with actinides or actinide fluorides.

(3A990) Apparatus or devices, other than those specified in entry PL5006 of Group 1 of Part III of this Schedule or entries 3A229 to 3A232 of this Group, designed for the handling, control, discharging, decoying, jamming, detonation, disruption or detection of explosive devices or **improvised explosive devices**;

except:

1. Inspection devices not employing electronic management;

2. X-ray apparatus or devices, not specified elsewhere in this Group.

3B Test, Inspection and Production Equipment

(3B) Equipment for the manufacture or testing of semiconductor devices or materials, as follows, and specially designed components and accessories therefor:

(3B001) **Stored programme controlled** equipment for epitaxial growth, as follows:

(a) Capable of producing a layer thickness uniform to less than ± 2.5% across a distance of 75 mm or more;

(b) Metal organic chemical vapour deposition (MOCVD) reactors specially designed for compound semiconductor crystal growth by the chemical reaction between materials specified in entries 3C003 or 3C004;

(c) Molecular beam epitaxial growth equipment using gas sources.

(3B002) **Stored programme controlled** equipment designed for ion implantation, having any of the following:

(a) An accelerating voltage exceeding 200 keV;

(b) Specially designed and optimized to operate at an accelerating voltage of less than 10 keV;

(c) Direct write capability; or

(d) Capable of high energy oxygen implant into a heated semiconductor material **substrate**.

(3B003) **Stored programme controlled** anisotropic plasma dry etching equipment, as follows:

(a) With cassette-to-cassette operation and load-locks, and having either of the following:

(1) Magnetic confinement; or

(2) Electron cyclotron resonance (ECR);

(b) Specially designed for equipment specified in entry 3B005 and having either of the following:

(1) Magnetic confinement; or

(2) Electron cyclotron resonance (ECR).

(3B004) **Stored programme controlled** plasma enhanced CVD equipment, as follows:

(a) With cassette-to-cassette operation and load-locks, and having either of the following:

(1) Magnetic confinement; or

(2) Electron cyclotron resonance (ECR);

(b) Specially designed for equipment specified in entry 3B005 and having either of the following:

(1) Magnetic confinement; or

(2) Electron cyclotron resonance (ECR).

(3B005) **Stored programme controlled** automatic loading multi-chamber central wafer handling systems, having interfaces for wafer input and output, to which more than two pieces of semiconductor processing equipment are to be connected, to form an integrated system in a vacuum environment for sequential multiple wafer processing.

Note: This entry does not specify automatic robotic wafer handling systems not designed to operate in a vacuum environment.

(3B006) **Stored programme controlled** lithography equipment, as follows:

(a) Align and expose step and repeat equipment for wafer processing using photo-optical or X-ray methods, having either of the following:

(1) A light source wavelength shorter than 400 nm; or

(2) Capable of producing a pattern with a minimum resolvable feature size of 0.7 micrometre or less when calculated by the following formula:

$$\text{MRF} = \frac{(\text{wavelength in micrometre}) \times (\text{K factor})}{\text{numerical aperture}}$$

where:

"MRF" means the minimum resolvable feature size;

the "K factor" = 0.7; and

"wavelength" means the exposure light source wavelength;

(b) Equipment specially designed for mask making or semiconductor device processing using deflected focussed electron beam, ion beam or **laser** beam, with any of the following:

(1) A spot size smaller than 0.2 micrometre;

(2) Capable of producing a pattern with a feature size of less than 1 micrometre; or

(3) An overlay accuracy of better than ± 0.20 micrometre (3 sigma).

(3B007) Masks or reticles, as follows:

(a) For integrated circuits specified in entry 3A001;

(b) Multi-layer masks with a phase shift layer.

(3B008) **Stored programme controlled** test equipment, specially designed for testing semiconductor devices and unencapsulated dice, as follows:

(a) For testing S-parameters of transistor devices at frequencies exceeding 31 GHz;

(b) For testing integrated circuits, and capable of performing functional (truth table) testing at a pattern rate of more than 40 MHz;

Note: Head b. of this entry does not specify test equipment specially designed for testing:

(1) **Electronic assemblies** or a class of **electronic assemblies** for home or entertainment applications;

(2) Electronic components, **electronic assemblies** or integrated circuits not specified in this Group.

(c) For testing microwave integrated circuits at frequencies exceeding 3 GHz;

Note: Head c. of this entry does not specify test equipment specially designed for testing microwave integrated circuits for equipment designed or rated to operate in the Standard Civil Telecommunication Bands at frequencies not exceeding 31 GHz.

(d) Electron beam systems designed for operation at or below 3 keV, or **laser** beam systems, for the non-contactive probing of powered-up semiconductor devices, with both of the following:

(1) Stroboscopic capability with either beam-blanking or detector strobing; and

(2) An electron spectrometer for voltage measurement with a resolution of less than 0.5 V.

Note: Head d. of this entry does not specify scanning electron microscopes; except: when specially designed and instrumented for the non-contactive probing of powered-up semiconductor devices.

3C Materials

(3C001) Hetero-epitaxial materials consisting of a **substrate** with stacked epitaxially grown multiple layers of:

(a) Silicon;

(b) Germanium; or

(c) III/V compounds of gallium or indium.

Note: III/V compounds are polycrystalline or binary or complex monocrystalline products consisting of elements of groups IIIA and VA of Mendeleyev's periodic classification table (gallium arsenide, gallium-aluminium arsenide, indium phosphide, etc.).

(3C002) Resist materials, as follows, and **substrates** coated with controlled resists:

(a) Positive resists for semiconductor lithography specially adjusted (optimised) for use at wavelengths below 370 nm;

(b) All resists, for use with electron beams or ion beams, with a sensitivity of 0.01 microcoulomb/mm^2 or better;

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

(d) All resists optimized for surface imaging technologies, including silylated resists.

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

(3C003) 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: This entry only specifies compounds whose metallic, partly metallic or non-metallic element is directly linked to carbon in the organic part of the molecule.

(3C004) Hydrides of phosphorus, arsenic or antimony, having a purity better than 99.999%, even diluted in inert gases or hydrogen.

Note: This entry does not specify hydrides containing 20% molar or more of inert gases or hydrogen.

3D Software

(3D001) Software specially designed for the **development** or **production** of **goods** specified in head b. of entry 3A001 to head h. of entry 3A002 or Sub-category 3B.

(3D002) **Software** specially designed for the **use** of **stored programme controlled** equipment specified in sub-category 3B.

(3D003) Computer-aided-design (CAD) **software** for semiconductor devices or integrated circuits, having any of the following:

(a) Design rules or circuit verification rules;

(b) Simulation of the physically laid out circuits; or

(c) Lithographic processing simulators for design.

Note: A lithographic processing simulator is a **software** package used in the design phase to define the sequence of lithographic, etching and deposition steps for translating masking patterns into specific topographical patterns in conductors, dielectrics or semiconductor material.

Note: This entry does not specify **software** specially designed for schematic entry, logic simulation, placing and routing, layout verification or pattern generation tape.

N.B.: Libraries, design attributes or associated data for the design of semiconductor devices or integrated circuits are considered as **technology.**

(3D101) **Software** specially designed for the **use** of **goods** specified in head b. of entry 3A101.

3E Technology

(3E001) **Technology required** for the **development** or **production** of **goods** specified in sub-categories 3A, 3B or 3C;

Note: This entry does not specify **technology** for the **development** or **production** of:

(a) Microwave transistors operating at frequencies below 31 GHz;

(b) Integrated circuits specified in sub-heads a.3. to a.12. of entry 3A001, having both of the following characteristics:

(1) Using technology of one micrometre or more; and

(2) Not incorporating multi-layer structures.

N.B.: This Note does not preclude the export of multilayer technology for devices incorporating a maximum of two metal layers and two polysilicon layers.

(3E002) Other **technology** for the **development** or **production** of:

(a) Vacuum microelectronic devices;

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

(c) **Superconductive** electronic devices;

(d) Substrates of films of diamond for electronic components.

(3E101) **Technology required** for the **use** of **goods** specified in sub-heads a.1. or a.2. of entry 3A001, entries 3A101 or 3D101.

(3E102) **Technology required** for the **development** of **software** specified in entry 3D101.

(3E201) **Technology required** for the **use** of **goods** specified in sub-head e.2. of entry 3A001, sub-head e.3. of entry 3A001, sub-head e.5. of entry 3A001, or entries 3A201, 3A202, 3A225 to 3A233.

(3E990) **Technology required** for the **use** of **goods** specified in entry 3A990.

Category 4—Computers

Notes:

(1) In order to determine the export control requirements on computers, related equipment or **software** performing telecommunications or **local area network** functions they must also be evaluated against Category 5 (Part 1 – Telecommunications).

N.B.:

(1) 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).

(2) **Software** which provides routing or switching of **datagram** or **fast select** packets (i.e., packet by packet route selection) or of **software** specially designed for packet switching, is specified in Category 5 (Part 1 – Telecommunications).

(2) Computers, related equipment or **software** performing cryptographic, cryptanalytic, certifiable **multilevel 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**).

4A Equipment, Assemblies and Components

(4A001) Electronic computers and related equipment, as follows, and **electronic assemblies** and specially designed components therefor(**35**):

(a) Specially designed to have either of the following characteristics:

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

Note: Sub-head a.1 of this entry does not apply to computers specially designed for civil automobile or railway train applications.

(2) Radiation hardened to exceed any of the following specifications:

(a) Total Dose 5×10^5 Rads (Si);

(b) Dose Rate Upset 5×10^8 Rads (Si)/sec; or

(c) Single Event Upset 1×10^{-7} Error/bit/day;

Note: For equipment designed or rated for transient ionising radiation, see Group 1 of Part III of this Schedule.

(b) Having characteristics or performing functions exceeding the limits in Category 5 (Part 2—**Information Security**).

(**35**) See also entry 4A101.

(4A002) **Hybrid computers**, as follows, and **electronic assemblies** and specially designed components therefor(**36**):

(a) Containing **digital computers** specified in entry 4A003;

(b) Containing analogue-to-digital converters having both of the following characteristics:

(1) 32 channels or more; and

(2) A resolution of 14 bits (plus sign bit) or more with a conversion rate of 200,000 conversions/s or more.

(4A003) **Digital computers**, **electronic assemblies**, and related equipment therefor, as follows, and specially designed components therefor:

Notes:

1. This entry includes vector processors, array processors, digital signal processors, logic processors, and equipment for **image enhancement** or **signal processing**.

2. The control on export of **digital computers** or related equipment described in or of a type described in this entry is determined by the export control requirements applying to the 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.

*N.B.:***Digital computers** or related equipment for telecommunications equipment, are specified in Category 5 (Part 1 – Telecommunications).

Note: The **technology** for the **digital computers** and related equipment is evaluated against sub-category 4E.

(a) Designed or modified for **fault tolerance**;

Note: For the purposes of head a. of this entry, **digital computers** and related equipment are not considered to be designed or modified for **fault tolerance** if they use:

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 use of 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 a **composite theoretical performance** (CTP) exceeding 260 million theoretical operations per second (Mtops);

(c) **Electronic assemblies** specially designed or modified to be capable of enhancing performance by aggregation of **computing elements** so that the **composite theoretical performance** (CTP) of the aggregation exceeds the limit in head b. of this entry;

Notes:

(**36**) See also entry 4A102.

1. Head c. of this entry applies only to **electronic assemblies** and programmable interconnections not exceeding the limit of head b. of this entry, 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 in heads d. to f. of this entry.
2. Head c. of this entry does not specify **electronic assemblies** specially designed for a product or family of products whose maximum configuration does not exceed the limit of head b. of this entry.

(d) Graphics accelerators or graphics coprocessors exceeding a **3-D vector rate** of 1,600,000;

(e) Equipment performing analogue-to-digital conversions exceeding the limits in sub-head a.5. of entry 3A001;

(f) Equipment containing **terminal interface equipment** exceeding the limits in sub-head b.3. of entry 5A001;

Note: For the purposes of head f. of this entry, **terminal interface equipment** includes **local area network** interfaces, modems and other communications interfaces. **Local area network** interfaces are evaluated as **network access controllers.**

(g) Equipment specially designed to provide for the external interconnection of **digital computers** or associated equipment which allows communications at data rates exceeding 80 Mbytes/s.

Note: Head g. of this entry does not control internal interconnection equipment (e.g. backplanes and buses) or passive interconnection equipment.

(4A004) Computers, as follows, and specially designed related equipment, **electronic assemblies** and components therefor:

(a) **Systolic array computers;**

(b) **Neural computers;**

(c) **Optical computers.**

(4A101) Analogue computers, **digital computers** or digital differential analysers, other than those specified in sub-head a.1. of entry 4A001, which are ruggedized and designed or modified for use in systems specified in entries 9A004 or 9A104.

(4A102) **Hybrid Computers** specially designed for modelling, simulation or design integration of systems specified in entries 9A004 or 9A104.

Notes:

1: This entry only applies when the equipment is supplied with software specified in entries 7D103 or 9D103.

2: Software for the goods specified in this entry is determined by the export control requirements of either entry 7D103 or 9D103.

4B Test, Inspection and Production Equipment

None

4C Materials

None

4D Software

*Note:***Software** for the **development, production,** or **use** of equipment described in other Categories is dealt with in the appropriate Category. **Software** for equipment described in this Category is dealt with herein.

(4D001) **Software** specially designed or modified for the **development, production** or **use** of **goods** specified in entries 4A001 to 4A004, or sub-category 4D.

(4D002) **Software** specially designed or modified to support **technology** specified in subcategory 4E.

(4D003) Specific **software,** as follows:

(a) Operating system **software, software** development tools and compilers specially designed for **multi-data-stream processing** equipment, in **source code**;

(b) **Expert systems** or **software** for **expert system** inference engines providing both:

(1) Time dependent rules; and

(2) Primitives to handle the time characteristics of the rules and the facts;

(c) **Software** having characteristics or performing functions exceeding the limits in Category 5 (Part 2-**Information Security**);

(d) Operating systems specially designed for **real time processing** equipment which guarantees a **global interrupt latency time** of less than 20 microseconds.

4E Technology

(4E001) **Technology required** for the **development, production** or **use** of **goods** specified in sub-categories 4A or 4D.

(a) (4E002) (a) **Technology** for the **development** or **production** of **goods** designed for **multi-data-stream processing** where the **composite theoretical performance** (CTP) exceeds 120 Mtops;

(b) **Technology required** for the **development** or **production** of magnetic hard disk drives with a **maximum bit transfer rate** exceeding 47 Mbit/s.

Category 5 —Telecommunications and Information Security

Part 1 —

Telecommunications

Notes:

(1) Components, **lasers,** test and production equipment, materials and **software** therefor, which are specially designed for telecommunications equipment or systems are described in this Category.

(2) **Digital computers,** related equipment or **software,** when essential for the operation and support of telecommunications equipment specified in or of a type 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.

5A1 Equipment, Assemblies and Components

(a) (5A001) (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 arising from a nuclear explosion;

(2) Specially hardened to withstand gamma, neutron or ion radiation;

(3) Specially designed to operate outside the temperature range from 218 K (-55°C) to 397 K (124°C);

Note: Sub-head a.3 of this entry applies only to electronic equipment.

Note: Sub-heads a.2. and a.3. of this entry do not apply to equipment on board satellites.

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

Note: Telecommunication transmission equipment:

a. Categorised as follows, or combinations thereof:

1. Radio equipment (e.g., transmitters, receivers and transceivers);
2. Line terminating equipment;
3. Intermediate amplifier equipment;
4. Repeater equipment;
5. Regenerator equipment;
6. Translation encoders (transcoders);
7. Multiplex equipment (statistical multiplex included);
8. Modulators/demodulators (modems);
9. Transmultiplex equipment (see **CCITT** Recommendation G.701);
10. **Stored programme controlled** digital crossconnection equipment;
11. **Gateways** and bridges;
12. **Media access units**; and

b. Designed for use in single or multi-channel communication via:

1. Wire (line);
2. Coaxial cable;
3. Optical fibre cable;
4. Electromagnetic radiation;
5. Underwater acoustic wave propagation.

(1) Employing digital techniques, including digital processing of analogue signals, and designed to operate at a **digital transfer rate** at the highest multiplex level exceeding 45 Mbit/s or a **total digital transfer rate** exceeding 90 Mbit/s;

Note: Sub-head b.1. of this entry does not specify equipment specially designed to be integrated and operated in any satellite system for civil use.

(2) Being **stored programme controlled** digital cross connect equipment with a **digital transfer rate** exceeding 8.5 Mbit/s per port;

(3) Being equipment containing:

(a) Modems using the **bandwidth of one voice channel** with a **data signalling rate** exceeding 28,800 bit/s;

(b) **Communication channel controllers** with a digital output having a **data signalling rate** exceeding 2.1 Mbit/s per channel; or

(c) **Network access controllers** and their related common medium having a **digital transfer rate** exceeding 156 Mbit/s;

Note: Equipment, not elsewhere specified, containing a **network access controller,** cannot have any type of telecommunications interface;

except:

Those described in, but not specified in, sub-head b.3. of this entry.

(4) Employing a **laser** and having any of the following characteristics:

(a) A transmission wavelength exceeding 1,000 nm;

(b) Employing analogue techniques and having a bandwidth exceeding 45 MHz;

(c) Employing coherent optical transmission or coherent optical detection techniques (also called optical heterodyne or homodyne techniques);

(d) Employing wavelength division multiplexing techniques; or

(e) Performing **optical amplification**;

(5) Being radio equipment operating at input or output frequencies exceeding:

(a) 31 GHz for satellite-earth station applications;

(b) 26.5 GHz for other applications;

Note: Sub-head b.5.b. of this entry does not specify equipment for civil use conforming with an International Telecommmunications Union (**ITU**) allocated band between 26.5 and 31 GHz.

(6) Being radio equipment:

(a) Employing quadrature-amplitude-modulation (QAM) techniques above level 4 if the **total digital transfer rate** exceeds 8.5 Mbit/s;

(b) Employing quadrature-amplitude-modulation (QAM) techniques above level 16 if the **total digital transfer rate** is equal to or less than 8.5 Mbit/s; or

(c) Employing other digital modulation techniques and having a **spectral efficiency** exceeding 3 bit/sec/Hz;

Note:

(1) Sub-head b.6. of this entry does not specify equipment specially designed to be integrated and operated in any satellite system for civil use.

(2) Sub-head b.6. of this entry does not specify radio relay equipment for operation in an International Telecommunications Union

(**ITU**) allocated band:

(a)

(1) Not exceeding 960 MHz; or

(2) With a **total digital transfer rate** not exceeding 8.5 Mbit/s; and

(b) Having a **spectral efficiency** not exceeding 4 bit/sec/Hz.

(7) Being radio equipment operating in the 1.5 to 87.5 MHz band and having either of the following characteristics:

(a)

(1) Automatically predicting and selecting frequencies and **total digital transfer rates** per channel to optimize the transmission; and

(2) 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 1.5 to 30 MHz frequency range or 250 W or more in the 30 to 87.5 MHz frequency range, over an **instantaneous bandwidth** of one octave or more and with an output harmonic and distortion content of better than -80 dB; or

(b) Incorporating adaptive techniques providing more than 15 dB suppression of an interfering signal;

(8) Being radio equipment employing **spread spectrum** or **frequency agility** (frequency hopping) techniques having either of the following characteristics:

(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;

(9) Being digitally controlled radio receivers having more than 1,000 channels, which:

(a) Search or scan automatically a part of the electromagnetic spectrum;

(b) Identify the received signals or the type of transmitter; and

(c) Have a **frequency switching time** of less than 1 ms;

(10) Providing functions of digital **signal processing** as follows:

(a) Voice coding at rates of less than 2,400 bit/s;

(b) Employing circuitry which incorporates **user-accessible programmability** of digital **signal processing** circuits exceeding the limits of head b. of entry 4A003;

(11) Being underwater communications systems having any of the following characteristics:

(a) An acoustic carrier frequency outside the range from 20 to 60 kHz;

(b) Using an electromagnetic carrier frequency below 30 kHz; or

(c) Using electronic beam steering techniques;

(c) **Stored programme controlled** switching equipment and related signalling systems, having any of the following characteristics, functions or features, and specially designed components and accessories therefor;

Note: Statistical multiplexers with digital input and digital output which provide switching are treated as **stored programme controlled** switches.

(1) **Common channel signalling;**

Note: Signalling systems in which the signalling channel is carried in and refers to no more than 32 multiplexed channels forming a trunk line of no more than 2.1 Mbit/s, and in which the signalling information is carried in a fixed, time division multiplexed channel without the use of labelled messages, are not considered to be **common channel signalling** systems.

(2) Containing **Integrated Services Digital Network** (ISDN) functions and having either of the following:

(a) Switch-terminal (e.g., subscriber line) interfaces with a **digital transfer rate** at the highest multiplex level exceeding 192,000 bit/s, including the associated signalling channel (e.g., 2B+D); or

(b) The capability that a signalling message received by a switch on a given channel that is related to a communication on another channel may be passed through to another switch;

Note: Sub-head c.2. of this entry does not include:

(1) The evaluation and appropriate actions taken by the receiving switch;

(2) Unrelated user message traffic on a D channel of **Integrated Services Digital Network** (ISDN).

(3) Multi-level priority and pre-emption for circuit switching;

Note: Sub-head c.3. of this entry does not specify single-level call pre-emption.

(4) **Dynamic adaptive routing;**

(5) Routing or switching of **datagram** packets;

except:

When applied to networks using only **network access controllers** or to **network access controllers** themselves;

(6) Routing or switching of **fast select** packets;

except:

When applied to networks using only **network access controllers** or to **network access controllers** themselves;

(7) Designed for automatic hand-off of cellular radio calls to other cellular switches or for automatic connection to a centralized subscriber data base common to more than one switch;

(8) Being packet switches, circuit switches and routers with ports or lines exceeding either:

(a) A **data signalling rate** of 64,000 bit/s per channel for a **communications channel controller**; or

Note: Sub-head c.8.a. of this entry does not include the multiplexing over a composite link of communications channels not specified in sub-head c.8.a.

(b) A **digital transfer rate** of 33 Mbit/s for a **network access controller** and related common medium;

(9) **Optical switching;**

(10) Employing **Asynchronous Transfer Mode (ATM)** techniques;

(11) Containing **stored programme controlled** digital crossconnect equipment with a **digital transfer rate** exceeding 8.5 Mbit/s per port;

(d) Centralized network control having both of the following characteristics:

(1) Receives data from the nodes; and

(2) Processes these data in order to provide control of traffic not requiring operator decisions, thereby performing **dynamic adaptive routing**;

Note: Head d. of this entry does not include the characteristic of control of traffic as a function of predictable statistical traffic conditions.

(e) Optical fibre communication cables, optical fibres and accessories, as follows:

(1) Optical fibres or cables of more than 50 m in length having either of the following characteristics:

(a) Designed for single mode operation; or

(b) For optical fibres, capable of withstanding a Proof Test tensile stress of 2 × 10^9 N/m^2 or more;

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%.

(2) Optical fibre cables and accessories designed for underwater use(**37**);

(f) Phased array antennae, operating above 10.5 GHz, containing active elements and distributed components, and designed to permit electronic control of beam shaping and pointing.

Note: Head f. of this entry does not specify landing systems with instruments meeting International Civil Aviation Organisation (ICAO) standards (microwave landing systems (MLS)), published by ICAO in Annex 10 of Volume 1.

(5A101) Telemetering and telecontrol equipment usable for **missiles**.

Note: This entry does not specify equipment specially designed to be used for remote control of model planes, boats or vehicles and having an electric field strength of not more than 200 microvolts per metre at a distance of 500 m.

(5A990) **The export of goods specified in this entry is prohibited to any destination in Iran, Iraq or Libya.**

Tropospheric scatter communication equipment using analogue or digital modulation techniques.

5B1 Test, Inspection and Production Equipment

(a) (5B001) (a) Equipment and specially designed components and accessories therefor, specially designed for:

(1) Development of equipment, materials, functions or features specified in entries 5A001, 5B001, 5C001, 5D001 or 5E001, including measuring or test equipment;

(2) Production of equipment, materials, functions or features specified in entries 5A001, 5B001, 5C001, 5D001 or 5E001, including measuring, test or repair equipment;

(3) Use of equipment, materials, functions or features exceeding any of the least stringent export control requirements specified in entries 5A001, 5B001, 5C001, 5D001 or 5E001, including measuring, test or repair equipment;

Note: Head a. of this entry does not specify optical fibres and **optical fibre preform** characterisation equipment not using semiconductor **lasers**.

(b) Other equipment as follows:

(1) Bit error rate (BER) test equipment designed or modified to test the equipment specified in sub-head b.1. of entry 5A001;

(2) Data communication protocol analyzers, testers and simulators specially designed for functions specified in entry 5A001;

(3) Stand alone **stored programme controlled** radio transmission media simulators/ channel estimators specially designed for testing equipment specified in sub-head b.5. of entry 5A001.

(**37**) For fibre-optic hull penetrators or connectors, see head c.of entry 8A002.

5C1 Materials

(5C001) Preforms of glass or of any other material optimized for the manufacture of optical fibres specified in head e. of entry 5A001.

5D1 Software(38)

(a) (5D001) (a) **Software** specially designed or modified for the **development, production** or **use** of **goods** specified in entries 5A001, 5B001 or 5C001;

(b) **Software** specially designed or modified to support **technology** specified in entry 5E001;

(c) Specific **software** as follows:

(1) **Generic software,** other than in machine-executable form, specially designed or modified for the **use** of **stored programme controlled** digital switching equipment or systems;

(2) **Software,** other than in machine-executable form, specially designed or modified for the **use** of digital cellular radio equipment or systems;

(3) **Software** specially designed or modified to provide characteristics, functions or features of equipment specified in entries 5A001 or 5B001;

(4) **Software** which provides the capability of recovering **source code** of telecommunications **software** specified in this Category;

(5) **Software** specially designed for the **development** or **production** of **software** specified in this entry.

5E1 Technology

(a) (5E001) (a) **Technology required** for the **development, production** or **use** (excluding operation) of **goods** specified in entries 5A001, 5B001, 5C001 or 5D001;

(b) Specific technologies, 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 processing and application of coatings to optical fibre specially designed to make it suitable for underwater use;

(4) **Technology** for the **development** or **production** of equipment employing **Synchronous Digital Hierarchy (SDH)** or **Synchronous Optical Network (SONET) techniques;**

(5) **Technology** for the **development** or **production** of **switch fabric** exceeding 64,000 bit/s per information channel other than for digital cross connect integrated in the switch;

(6) **Technology** for the **development** or **production** of centralized network control;

(7) **Technology** for the **development** or **production** of digital cellular radio systems;

(8) **Technology** for the **development** or **production** of **Integrated Services Digital Network** (ISDN);

(9) **Technology** for the **development** of QAM techniques, for radio equipment, above level 4.

(**38**) See also sub-Categories 4D and 6D for software for signal processing.

(5E101) **Technology required** for the **development, production** or **use** of **goods** specified in entry 5A101.

(5E990) **The export of goods specified in this entry is prohibited to any destination in Iran, Iraq or Libya.**

Technology required for the **development, production** or **use** of **goods** specified in entry 5A990.

Part 2 —

Information Security

*Note:***Information security** equipment, **software,** systems, application specific **electronic assemblies,** modules, integrated circuits, components or functions are specified in this Category even if they are components or **electronic assemblies** of other equipment.

5A2 Equipment, Assemblies and Components

(5A002) Systems, equipment, application specific **electronic assemblies,** modules or integrated circuits for **information security,** as follows, and other specially designed components therefor:

(a) Designed or modified to use **cryptography** employing digital techniques to ensure **information security;**

(b) Designed or modified to perform cryptanalytic functions;

(c) Designed or modified to use **cryptography** employing analogue techniques to ensure **information security;**

except:

1. Equipment using **fixed** band scrambling not exceeding 8 bands and in which the transpositions change not more frequently than once every second;
2. Equipment using **fixed** band scrambling exceeding 8 bands and in which the transpositions change not more frequently than once every ten seconds;
3. Equipment using **fixed** frequency inversion and in which the transpositions change not more frequently than once every second;
4. Facsimile equipment;
5. Restricted audience broadcast equipment;
6. Civil television equipment;

(d) Designed or modified to suppress the compromising emanations of information-bearing signals;

Note: Head d. of this entry does not specify equipment specially designed to suppress emanations for health or safety reasons.

(e) Designed or modified to use cryptographic techniques to generate the spreading code for **spread spectrum** or the hopping code for **frequency agility** systems;

(f) Designed or modified to provide certified or certifiable **multilevel security** or user isolation at a level exceeding Class B2 of the Trusted Computer System Evaluation Criteria (TCSEC);

(g) Communications cable systems which are designed or modified to use mechanical, electrical or electronic means to detect surreptitious intrusion.

Note: This entry does not specify:

a. **Personalized smart cards** using **cryptography** restricted for use only in equipment or systems as follows:

1. Excluded from control under sub-heads c.1. to c.6. of entry 5A002;

2. Excluded from control under heads b. to e. of this Note; or

a. Cellular radio equipment or systems specially designed for cryptographic operation, provided any message traffic encryption capability specified in entry 5A002 contained in such equipment or systems is irreversibly disabled;

b. Access control equipment, such as automatic teller machines, self-service statement printers or point of sale terminals, which protects password or personal identification numbers (PIN) or similar data to prevent unauthorised access to facilities but does not allow for encryption of files or text, except as directly related to the password or PIN protection;

c. Data authentication equipment which calculates a Message Authentication Code (MAC) or similar result to ensure no alteration of text has taken place, or to authenticate users, but does not allow for encryption of data, text or other media other than that needed for the authentication;

d. Cryptographic equipment specially designed, developed or modified for use in machines for banking or money transactions, such as automatic teller machines, self-service statement printers, point of sale terminals, or equipment for the encryption of interbanking transactions, and intended for use only in such applications;

b. Equipment containing **fixed** data compression or coding techniques;

c. Receiving equipment for radio broadcast, pay television or similar restricted audience television of the consumer type, without digital encryption and where digital decryption is limited to the video, audio or management functions;

d. Portable (personal) or mobile radiotelephones for civil use, e.g., for use with commercial civil cellular radiocommunications systems, containing encryption, when accompanying their users;

e. Decryption functions specially designed to allow the execution of copy-protected **software,** provided the decryption functions are not user-accessible.

5B2 Test, Inspection and Production Equipment

(a) (5B002) (a) Equipment specially designed for:

(1) The development of equipment or functions specified in entries 5A002, 5B002, 5D002 or 5E002, including measuring or test equipment;

(2) The production of equipment or functions specified in entries 5A002, 5B002, 5D002 or 5E002, including measuring, test, repair or production equipment;

(b) Measuring equipment specially designed to evaluate and validate the **information security** functions specified in entries 5A002 or 5D002.

5C2 Materials

None

5D2 Software

(a) (5D002) (a) **Software** specially designed or modified for the **development, production** or **use** of equipment or **software** specified in entries 5A002, 5B002 or 5D002;

(b) **Software** specially designed or modified to support **technology** specified in entry 5E002;

(c) Specific **software** as follows:

(1) **Software** having the characteristics, or performing or simulating the functions of the equipment specified in entries 5A002 or 5B002;

(2) **Software** to certify **software** specified in sub-head c.1. of this entry;

(3) Software designed or modified to protect against malicious computer damage, e.g., viruses.

Note: This entry does not specify **software required** for the **use** of equipment described in the Note to 5A002 or providing any of the functions of that equipment 5A002.

5E2 Technology

(5E002) **Technology required** for the **development, production** or **use** of **goods** specified in entries 5A002, 5B002 or 5D002.

Category 6 — Sensors and Lasers

6A Equipment, Assemblies and Components

6A

6A1 Acoustics

(a) (6A001) (a) Marine acoustic systems, equipment or specially designed components therefor, as follows:

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

Note: Sub-head a.1. to this entry does not specify:

(a) Depth sounders operating vertically below the apparatus, not including a scanning function exceeding ± 10°, 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; or

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

(a) Wide-swath bathymetric survey systems for sea bed topographic mapping:

(1) Designed:

(a) To take measurements at an angle exceeding 10° from the vertical; and

(b) To measure depths exceeding 600 m below the water surface; and

(2) Designed:

(a) To incorporate multiple beams any of which is less than 2°; or

(b) To provide data accuracies of better than 0.5% of water depth across the swath averaged over the individual measurements within the swath;

(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 micropascal 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 micropascal at 1m) 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 withstand pressure during normal operation at depths exceeding 1,000 m and having transducers:

(a) Dynamically compensated for pressure; or

(b) Incorporating other than lead zirconate titanate as the transduction element; or

(6) Designed to operate with an unambiguous display range exceeding 5,120 m;

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

Notes:

(1) The control on export of acoustic projectors, including transducers, specially designed for other equipment is determined by the export control requirements applying to that equipment.

(2) Sub-head a.1.c. of this entry does not specify 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;

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) Designed to withstand pressure during normal operation at depths exceeding 1,000 m; or

(4) Side-lobe suppression exceeding 22 dB;

(d) Acoustic systems, equipment or specially designed components for determining the position of surface vessels or underwater vehicles designed:

Note: Sub-head a.1.d. of this entry includes equipment using coherent **signal processing** between two or more beacons and the hydrophone unit carried by the surface vessel or underwater vehicle, or capable of automatically correcting speed-of-sound propagation errors for calculation of a point.

(1) To operate at a range exceeding 1,000 m with a positioning accuracy of less than 10 m rms when measured at a range of 1,000 m; or

(2) To withstand pressure at depths exceeding 1,000 m;

(2) Passive (receiving, whether or not related in normal application to separate active equipment) systems, equipment or specially designed components therefor, as follows:

(a) Hydrophones (transducers) with any of the following characteristics:

(1) Incorporating continuous flexible sensors or assemblies of discrete sensor elements with either a diameter or length less than 20 mm and with a separation between elements of less than 20 mm;

(2) Having any of the following sensing elements:

(a) Optical fibres;

(b) Piezoelectric polymers; or

(c) Flexible piezoelectric ceramic materials;

(3) Hydrophone sensitivity better than -180 dB at any depth with no acceleration compensation;

(4) When designed to operate at depths not exceeding 35 m, hydrophone sensitivity better than -186 dB with acceleration compensation;

(5) When designed for normal operation at depths exceeding 35 m, hydrophone sensitivity better than -192 dB with acceleration compensation;

(6) When designed for normal operation at depths exceeding 100 m, hydrophone sensitivity better than -204 dB; or

(7) Designed for operation at depths exceeding 1,000 m;

Note: 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 micropascal. For example, a hydrophone of -160 dB (reference 1 V per micropascal) 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 with any of the following:

(1) Hydrophone group spacing of less than 12.5 m;

(2) Hydrophone group spacing of 12.5 m to less than 25 m and designed or able to be modified to operate at depths exceeding 35 m;

Note: In this sub-head, "Able to be modified" 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) Hydrophone group spacing of 25 m or more and designed to operate at depths exceeding 100 m;

(4) Heading sensors specified in sub-head a.2.d. of this entry;

(5) Non-metallic strength members or longitudinally reinforced array hoses;

(6) An assembled array of less than 40 mm in diameter;

(7) Multiplexed hydrophone group signals; or

(8) Hydrophone characteristics specified in sub-head a.2.a. of this entry;

(c) Processing equipment, specially designed for towed acoustic hydrophone arrays, with either of the following:

(1) A Fast Fourier or other transform of 1,024 or more complex points in less than 20 ms with no **user-accessible programmability**; or

(2) Time or frequency domain processing and correlation, including spectral analysis, digital filtering and beamforming using Fast Fourier or other transforms or processes with **user-accessible programmability**;

(d) Heading sensors having an accuracy of better than ± 0.5°; and

(1) Designed to be incorporated within the array hosing and 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; or

(2) Designed to be mounted external to the array hosing and having a sensor unit capable of operating with 360° roll at depths exceeding 35 m;

(b) Terrestrial geophones capable of conversion for use in marine systems, equipment or specially designed components specified in sub-head a.2.a. of this entry;

(c) Correlation-velocity sonar log equipment designed to measure the horizontal speed of the equipment carrier relative to the sea bed at distances between the carrier and the sea bed exceeding 500 m.

(6A002) Optical sensors

a. Optical detectors, as follows(**39**):

Note: Head a. of this entry does not specify germanium or silicon photodevices.

1. **Space-qualified** solid state detectors having any of the following:

a. 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. 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; or

c. A peak response in the wavelength range exceeding 1,200 nm but not exceeding 30,000 nm;

2. Image intensifier tubes and specially designed components therefor, as follows:

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. A microchannel plate for electron image amplification with a hole pitch (centre-to-centre spacing) of less than 25 micrometres; and

3. a. An S-20, S-25 or multialkali photocathode; or

b. A GaAs or GaInAs photocathode;

b. Specially designed components, as follows:

1. Fibre optic image inverters;

(**39**) See also entry 6A102.

2. Microchannel plates having both of the following characteristics:
    a. 15,000 or more hollow tubes per plate; and
    b. Hole pitch (centre-to-centre spacing) of less than 25 micro-metres;
3. GaAs or GaInAs photocathodes;

3. Non-**space-qualified focal plane arrays,** having any of the following:

Notes:

1. Linear or two-dimensional multi-element detector arrays are referred to as **focal plane arrays.**
2. Sub-head a.3. of this entry includes photoconductive arrays and photovoltaic arrays.
3. Sub-head a.3. of this entry does not specify silicon focal plane arrays, multi-element (not to exceed 16 elements) encapsulated photoconductive cells or pyroelectric detectors using any of the following:
    a. Lead sulphide;
    b. Triglycine sulphate and variants;
    c. Lead-lanthanum-zirconium titanate and variants;
    d. Lithium tantalate;
    e. Polyvinylidene fluoride and variants;
    f. Strontium barium niobate and variants; or
    g. Lead selenide.

a. 1. Individual elements with a peak response within the wavelength range exceeding 900 nm but not exceeding 1,050 nm; and
    2. A response **time constant** of less than 0.5 ns;

b. 1. Individual elements with a peak response in the wavelength range exceeding 1,050 nm but not exceeding 1,200 nm; and
    2. A response **time constant** of 95 ns or less; or

c. Individual elements with a peak response in the wavelength range exceeding 1,200 nm but not exceeding 30,000 nm;

4. Non-**space-qualified** single-element or non-focal-plane multi-element semi-conductor photodiodes or phototransistors having both of the following:
    a. A peak response in the wavelength range exceeding 1,200 nm but not exceeding 30,000 nm; and
    b. A response **time constant** of 0.5 ns or less;

b. **Multispectral imaging sensors** designed for remote sensing applications, having either of the following characteristics:

1. An Instantaneous-Field-Of-View (IFOV) of less than 200 microradians; or
2. Specified for operation in the wavelength range exceeding 400 nm but not exceeding 30,000 nm; and
    a. Providing output imaging data in digital format; and
    b. 1. **Space-qualified**; or
        2. Designed for airborne operation, using other than silicon detectors, and having an IFOV of less than 2.5 milliradians;

c. Direct view imaging equipment operating in the visible or infrared spectrum, incorporating either of the following:

1. Image intensifier tubes having the characteristics listed in sub-head a.2.a. of this entry; or
2. **Focal plane arrays** having the characteristics listed in sub-head a.3. of this entry;

Notes:

a. In this entry "direct view" means imaging equipment, operating in the visible or infrared spectrum, 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.

b. Head c. of this entry does not specify the following equipment 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.

d. Special support components for optical sensors, as follows:

1. **Space-qualified** cryocoolers;
2. Non-**space-qualified** cryocoolers with a cooling source temperature below 218 K (-55°C), as follows:

a. Closed cycle 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 with bore (outside) diameters of less than 8 mm;

3. Optical sensing fibres:

a. Specially fabricated either compositionally or structurally, or modified by coating, to be acoustically, thermally, inertially, electromagnetically or nuclear radiation sensitive; or

b. Modified structurally to have a **beat length** of less than 50 mm (high birefringence).

(6A003) **Cameras**(**40**)

(a) Instrumentation cameras, as follows:

(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 per second;

Note: This sub-head does not specify cinema recording cameras for normal civil purposes.

(2) Mechanical high speed cameras, in which the film does not move, capable of recording at rates exceeding 1,000,000 frames per second 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;

(**40**) See also entry 6A203.

(3) Mechanical or electronic streak cameras with writing speeds exceeding 10 mm per microsecond;

(4) Electronic framing cameras having a speed exceeding 1,000,000 frames per second;

(5) Electronic cameras having:

(a) An electronic shutter speed (gating capability) of less than 1 microsecond per full frame; and

(b) A read out time allowing a framing rate of more than 125 full frames per second;

(b) Imaging cameras(**41**), as follows:

Note: Head b. of this entry does not specify television or video cameras specially designed for television broadcasting.

(1) Video cameras incorporating solid state sensors, having any of the following:

(a) More than 4×10^6 **active pixels** per solid state array for monochrome (black and white) cameras;

(b) More than 4×10^6 **active pixels** per solid state array for colour cameras incorporating three solid state arrays; or

(c) More than 12×10^6 **active pixels** for solid state array colour cameras incorporating one solid state array;

(2) Scanning cameras and scanning camera systems:

(a) Incorporating linear detector arrays with more than 8,192 elements per array; and

(b) Having mechanical scanning in one direction;

(3) Incorporating image intensifiers specified in sub-head a.2.a. of entry 6A002;

(4) Incorporating **focal plane arrays** specified in sub-head a.3. of entry 6A002.

Note: For cameras specially designed or modified for underwater use, see heads d. and e. of entry 8A002.

(6A004) **Optics**

(a) Optical mirrors (reflectors), as follows:

(1) **Deformable mirrors** with 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 with an average **equivalent density** of less than 30 kg/m^2 and a total weight exceeding 10 kg;

(3) Lightweight **composite** or foam mirror structures with an average **equivalent density** of less than 30 kg/m^2 and a total weight 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 (lambda is equal to 633 nm) with a control bandwidth exceeding 100 Hz;

(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 either of the following:

(**41**) See heads d. and e. of entry 8A002 for cameras specially modified for underwater use.

(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);

(c) **Space-qualified** components for optical systems, as follows:

(1) Lightweighted to less than 20% **equivalent density** compared with a solid blank of the same aperture and thickness;

(2) Substrates, substrates with surface coatings (single-layer or multi-layer, metallic or dielectric, conducting, semiconducting or insulating) or with 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 metre in diameter;

(4) Manufactured from **composite** materials having a coefficient of linear thermal expansion equal to or less than $5 \times 10_{-6}$ in any coordinate direction;

(d) Optical filters, as follows:

(1) For wavelengths longer than 250 nm, comprised of multi-layer optical coatings and having either of the following:

(a) Bandwidths equal to or less than 1 nm Full Width Half Intensity (FWHI) and peak transmission of 90% or more; or

(b) Bandwidths equal to or less than 0.1 nm FWHI and peak transmission of 50% or more;

Note: Sub-head d.1. of this entry does not specify optical filters with fixed air gaps or Lyot-type filters.

(2) For wavelengths longer than 250 nm, having all of the following:

(a) Tunable over a spectral range of 500 nm or more;

(b) Instantaneous optical bandpass of 1.25 nm or less;

(c) Wavelength resettable within 0.1 ms to an accuracy of 1 nm or better within the tunable spectral range; and

(d) A single peak transmission of 91% or more;

(3) Optical opacity switches (filters) with a field of view of 30° or wider and a response time equal to or less than 1 ns;

(e) Optical control equipment, as follows:

(1) Specially designed to maintain the surface figure or orientation of the **space-qualified** components specified in sub-heads c.1. or c.3. of this entry;

(2) Having steering, tracking, stabilization or resonator alignment bandwidths equal to or more than 100 Hz and an accuracy of 10 microradians or less;

(3) Gimbals having a maximum slew exceeding 5°, a bandwidth equal to or more than 100 Hz, and either of the following:

(a) 1. Exceeding 0.15 m but not exceeding 1 m in diameter or major axis length;

2. Capable of angular accelerations exceeding 2 radians/s^2; and

3. Having angular pointing errors equal to or less than 200 microradians; or

(b) 1. Exceeding 1 m in diameter or major axis length;

2. Capable of angular accelerations exceeding 0.5 radians/^{2}; and

3. Having angular pointing errors equal to or less than 200 microradians;

(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;

(f) **Fluoride fibre** cable, or optical fibres therefor, having an attenuation of less than 4 dB/km in the wavelength range exceeding 1,000 nm but not exceeding 3,000 nm.

(6A005) **Lasers**, components and optical equipment, as follows(**42**):

Notes:

1. Pulsed **lasers** include those that run in a continuous wave (CW) mode with pulses superimposed.

2. Pulse-excited **lasers** include those that run in a continuously excited mode with pulse excitation superimposed.

3. The status of Raman **lasers** is determined by the parameters of the pumping source **lasers**. The pumping source **lasers** can be any of the **lasers** described below.

(a) Gas **lasers**, as follows:

(1) Excimer **lasers** having any of the following:

(a) An output wavelength not exceeding 150 nm and:

(1) An output energy exceeding 50 mJ per pulse; or

(2) An average or CW output power exceeding 1 W;

(b) An output wavelength exceeding 150 nm but not exceeding 190 nm and:

(1) An output energy exceeding 1.5 J per pulse; or

(2) An average or CW output power exceeding 120 W;

(c) An output wavelength exceeding 190 nm but not exceeding 360 nm and:

(1) An output energy exceeding 10 J per pulse; or

(2) An average or CW output power exceeding 500 W; or

(d) An output wavelength exceeding 360 nm and:

(1) An output energy exceeding 1.5 J per pulse; or

(2) An average or CW output power exceeding 30 W;

(2) Metal vapour **lasers**, as follows:

(a) Copper (Cu) **lasers** with an average or CW output power exceeding 20 W;

(b) Gold (Au) **lasers** with an average or CW output power exceeding 5 W;

(c) Sodium (Na) **lasers** with an output power exceeding 5 W;

(d) Barium (Ba) **lasers** with an average or CW output power exceeding 2 W;

(3) Carbon monoxide (CO) **lasers** having either:

(a) An output energy exceeding 2 J per pulse and a pulsed **peak power** exceeding 5 kW; or

(b) An average or CW output power exceeding 5 kW;

(4) Carbon dioxide (CO_2) **lasers** having any of the following:

(a) A CW output power exceeding 10 kW;

(**42**) See also entry 6A205.

(b) A pulsed output with a **pulse duration** exceeding 10 microseconds and:

(1) An average output power exceeding 10 kW; or

(2) A pulsed **peak power** exceeding 100 kW; or

(c) A pulsed output with a **pulse duration** equal to or less than 10 microseconds and:

(1) A pulse energy exceeding 5 J per pulse and **peak power** exceeding 2.5 kW; or

(2) An average output power exceeding 2.5 kW;

(5) **Chemical lasers**, as follows:

(a) Hydrogen Fluoride (HF) **lasers**;

(b) Deuterium Fluoride (DF) **lasers**;

(c) **Transfer lasers**:

(1) Oxygen Iodine (O_2-I) **lasers**;

(2) Deuterium Fluoride-Carbon dioxide (DF-CO_2) **lasers**;

(6) Gas discharge and ion **lasers**, i.e., krypton ion or argon ion **lasers**, as follows:

(a) An output energy exceeding 1.5 J per pulse and a pulsed **peak power** exceeding 50 W; or

(b) An average or CW output power exceeding 50 W; or

(7) Other gas **lasers**, except nitrogen **lasers**, having any of the following:

(a) An output wavelength not exceeding 150 nm and:

(1) An output energy exceeding 50 mJ per pulse and a pulsed **peak power** exceeding 1 W; or

(2) An average or CW output power exceeding 1 W;

(b) An output wavelength exceeding 150 nm but not exceeding 800 nm and:

(1) An output energy exceeding 1.5 J per pulse and a pulsed **peak power** exceeding 30 W; or

(2) An average or CW output power exceeding 30 W;

(c) An output wavelength exceeding 800 nm but not exceeding 1,400 nm and:

(1) An output energy exceeding 0.25 J per pulse and a pulsed **peak power** exceeding 10 W; or

(2) An average or CW output power exceeding 10 W; or

(d) An output wavelength exceeding 1,400 nm and an average or CW output power exceeding 1 W;

(b) Semiconductor **lasers**, as follows:

Notes:

1. Semiconductor **lasers** are commonly called **laser** diodes.
2. The control on export of semiconductor **lasers** specially designed for other equipment is determined by the export control requirements applying to that other equipment.

(1) Individual, single-transverse mode semiconductor **lasers** having:

(a) An average output power exceeding 100 mW; or

(b) A wavelength exceeding 1,050 nm;

(2) Individual, multiple-transverse mode semiconductor **lasers**, or arrays of individual semiconductor **lasers,** having:

(a) An output energy exceeding 500 microjoules per pulse and a pulsed **peak power** exceeding 10 W;

(b) An average or CW output power exceeding 10 W; or

(c) A wavelength exceeding 1,050 nm;

(c) Solid state **lasers**, as follows:

(1) **Tunable lasers** having any of the following:

Note: Sub-head c.1. of this entry includes titanium-sapphire (Ti: Al^2O^3), thulium-YAG (Tm: YAG), thulium-YSGG (Tm: YSGG), alexandrite (Cr: $BeAl^2O^4$) and colour centre **lasers**.

(a) An output wavelength less than 600 nm and:

(1) An output energy exceeding 50 mJ per pulse and a pulsed **peak power** exceeding 1 W; or

(2) An average or CW output power exceeding 1 W;

(b) An output wavelength of 600 nm or more but not exceeding 1,400 nm and:

(1) An output energy exceeding 1 J per pulse and a pulsed **peak power** exceeding 20 W; or

(2) An average or CW output power exceeding 20 W; or

(c) An output wavelength exceeding 1,400 nm and:

(1) An output energy exceeding 50 mJ per pulse and a pulsed **peak power** exceeding 1 W; or

(2) An average or CW output power exceeding 1 W;

(2) Non-**tunable lasers**, as follows:

Note: Sub-head c.2. of this entry includes atomic transition solid state **lasers**.

(a) Ruby **lasers** having an output energy exceeding 20 J per pulse;

(b) Neodymium glass **lasers**, as follows:

(1) **Q-switched lasers** having:

(a) An output energy exceeding 20 J but not exceeding 50 J per pulse and an average output power exceeding 10 W; or

(b) An output energy exceeding 50 J per pulse;

(2) Non-**Q-switched lasers** having:

(a) An output energy exceeding 50 J but not exceeding 100 J per pulse and an average output power exceeding 20 W; or

(b) An output energy exceeding 100 J per pulse;

(c) Neodymium-doped (other than glass) lasers(**43**), as follows, with an output wavelength exceeding 1,000 nm but not exceeding 1,100 nm:

Note: For Neodymium-doped (other than glass) **lasers** having an output wavelength not exceeding 1,000 nm or exceeding 1,100 nm, see sub-head c.2.d. of this entry.

(**43**) See also sub-head c.2.d. of this entry.

(1) Pulse excited, mode-locked, **Q-switched lasers** with a **pulse duration** of less than 1 ns and:

(a) A **peak power** exceeding 5 GW;

(b) An average output power exceeding 10 W; or

(c) A pulsed energy exceeding 0.1 J;

(2) Pulse-excited, **Q-switched lasers**, with a pulse duration equal to or more than 1 ns, and:

(a) A single-transverse mode output with:

(1) A **peak power** exceeding 100 MW;

(2) An average output power exceeding 20 W; or

(3) A pulsed energy exceeding 2 J; or

(b) A multiple-transverse mode output with:

(1) A **peak power** exceeding 200 MW;

(2) An average output power exceeding 50 W; or

(3) A pulsed energy exceeding 2 J;

(3) Pulse-excited, non-**Q-switched lasers**, having:

(a) A single-transverse mode output with:

(1) A **peak power** exceeding 500 kW; or

(2) An average output power exceeding 150 W; or

(b) A multiple-transverse mode output with:

(1) A **peak power** exceeding 1 MW; or

(2) An average power exceeding 500 W;

(4) Continuously excited **lasers** having:

(a) A single-transverse mode output with:

(1) A **peak power** exceeding 500 kW; or

(2) An average or CW output power exceeding 150 W; or

(b) A multiple-transverse mode output with:

(1) A **peak power** exceeding 1 MW; or

(2) An average or CW output power exceeding 500 W;

(d) Other non-**tunable lasers**, having any of the following:

(1) A wavelength less than 150 nm and:

(a) An output energy exceeding 50 mJ per pulse and a pulsed **peak power** exceeding 1 W; or

(b) An average or CW output power exceeding 1 W;

(2) A wavelength of 150 nm or more but not exceeding 800 nm and:

(a) An output energy exceeding 1.5 J per pulse and a pulsed **peak power** exceeding 30 W; or

(b) An average or CW output power exceeding 30 W;

(3) A wavelength exceeding 800 nm but not exceeding 1,400 nm, as follows:

(a) **Q-switched** lasers with:

(1) An output energy exceeding 0.5 J per pulse and a pulsed **peak power** exceeding 50 W; or

(2) An average output power exceeding:

(a) 10 W for single-mode **lasers**;

(b) 30 W for multimode **lasers**;

(b) Non-**Q-switched lasers** with:

(1) An output energy exceeding 2 J per pulse and a pulsed **peak power** exceeding 50 W; or

(2) An average or CW output power exceeding 50 W; or

(4) A wavelength exceeding 1,400 nm and:

(a) An output energy exceeding 100 mJ per pulse and a pulsed **peak power** exceeding 1 W; or

(b) An average or CW output power exceeding 1 W;

(d) Dye and other liquid **lasers**, having any of the following:

(1) A wavelength less than 150 nm and:

(a) An output energy exceeding 50 mJ per pulse and a pulsed **peak power** exceeding 1 W; or

(b) An average or CW output power exceeding 1 W;

(2) A wavelength of 150 nm or more but not exceeding 800 nm and:

(a) An output energy exceeding 1.5 J per pulse and a pulsed **peak power** exceeding 20 W;

(b) An average or CW output power exceeding 20 W; or

(c) A pulsed single longitudinal mode oscillator with an average output power exceeding 1 W and a repetition rate exceeding 1 kHz if the **pulse duration** is less than 100 ns;

(3) A wavelength exceeding 800 nm but not exceeding 1,400 nm and:

(a) An output energy exceeding 0.5 J per pulse and a pulsed **peak power** exceeding 10 W; or

(b) An average or CW output power exceeding 10 W; or

(4) A wavelength exceeding 1,400 nm and:

(a) An output energy exceeding 100 mJ per pulse and a pulsed **peak power** exceeding 1 W; or

(b) An average or CW output power exceeding 1 W;

(e) Free electron **lasers**;

(f) Components, as follows:

(1) Mirrors cooled either by active cooling or by heat pipe cooling, 1 mm or less below the reflective surface;

Note: Active cooling is a cooling technique for optical components using flowing fluids within the subsurface 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**;

(g) Optical equipment(**44**), as follows:

(1) Dynamic wavefront (phase) measuring equipment capable of mapping at least 50 positions on a beam wavefront with:

(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 **Super-High Power Laser** (SHPL) system angular beam steering errors of equal to or less than 10 microradians;

(3) Optical equipment, assemblies or components specially designed for a phased-array SHPL system for coherent beam combination to an accuracy of Lambda/10 at the designed wavelength, or 0.1 micrometre, whichever is the smaller;

(4) Projection telescopes specially designed for use with SHPL systems.

(6A006) **Magnetometers, magnetic gradiometers, intrinsic magnetic gradiometers** and compensation systems, and specially designed components therefor, as follows:

Note: This entry does not specify instruments specially designed for biomagnetic measurements for medical diagnostics, unless they incorporate unembedded sensors specified in head h. of this entry.

(a) **Magnetometers** using **superconductive**, optically pumped or nuclear precession (proton/ Overhauser) technology having a **noise level** (sensitivity) lower (better) than 0.05 nT rms per square root Hz;

(b) Induction coil **magnetometers** having a **noise level** (sensitivity) lower (better) than:

(1) 0.05 nT rms per square root Hz at frequencies of less than 1 Hz;

(2) 1×10^{-3} nT rms per square root Hz at frequencies of 1 Hz or more but not exceeding 10 Hz; or

(3) 1×10^{-4} nT rms per square root Hz at frequencies exceeding 10 Hz;

(c) Fibre optic **magnetometers** having a **noise level** (sensitivity) lower (better) than 1 nT rms per square root Hz;

(d) **Magnetic gradiometers** using multiple **magnetometers** specified in heads a., b. or c. of this entry;

(e) Fibre optic **intrinsic magnetic gradiometers** having a magnetic gradient field **noise level** (sensitivity) lower (better) than 0.3 nT/m rms per square root Hz;

(f) **Intrinsic magnetic gradiometers**, using technology other than fibre-optic technology, having a magnetic gradient field **noise level** (sensitivity) lower (better) than 0.015 nT/m rms per square root Hz;

(g) Magnetic compensation systems for magnetic sensors designed for operation on mobile platforms;

(h) **Superconductive** electromagnetic sensors, containing components manufactured from **superconductive** materials, as follows:

(1) Designed for operation at temperatures below the **critical temperature** of at least one of their **superconductive** constituents (including Josephson effect devices or **superconductive** quantum interference devices (SQUIDS));

(**44**) See head d. of entry ML23 of Group 1 of Part III of this Schedule for shared aperture optical elements capable of operating in Super-High Power Laser applications.

(2) Designed for sensing electromagnetic field variations at frequencies of 1 kHz or less; and

(3) Having any of the following characteristics:

(a) Incorporating thin-film SQUIDS with a minimum feature size of less than 2 micrometres and with associated input and output coupling circuits;

(b) Designed to operate with a magnetic field slew rate exceeding 1×10^6 magnetic flux quanta per second;

(c) Designed to function without magnetic shielding in the earth's ambient magnetic field; or

(d) Having a temperature coefficient less (smaller) than 0.1 magnetic flux quantum/K.

(6A007) Gravity meters (gravimeters) and gravity gradiometers, as follows(**45**):

(a) Gravity meters for ground use having a static accuracy of less (better) than 10 microgal;

Note: Head a. of this entry does not specify ground gravity meters of the quartz element (Worden) type.

(b) Gravity meters for mobile platforms for ground, marine, submersible, space or airborne use having:

(1) A static accuracy of less (better) than 0.7 milligal; and

(2) An in-service (operational) accuracy of less (better) than 0.7 milligal with a time-to-steady-state registration of less than 2 minutes under any combination of attendant corrective compensations and motional influences;

(c) Gravity gradiometers.

(6A008) Radar systems, equipment and assemblies having any of the following characteristics, and specially designed components therefor(**46**):

Note: This entry does not specify:

a. Secondary surveillance radar (SSR);

b. Car radar designed for collision prevention;

c. Displays or monitors used for air traffic control (ATC) having no more than 12 resolvable elements per mm;

d. Meteorological (weather) radar.

(a) Operating at frequencies from 40 GHz to 230 GHz and having an average output power exceeding 100 mW;

(b) Having a tunable bandwidth exceeding ± 6.25% of the centre operating frequency;

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) or sidelooking airborne (SLAR) radar mode;

(e) Incorporating **electronically steerable phased array antennae**;

(f) Capable of heightfinding non-cooperative targets;

(**45**) See also entry 6A107.
(**46**) See also entry 6A108.

Note: Head f. of this entry does not specify precision approach radar equipment (PAR) conforming with International Civil Aviation Organisation (ICAO) standards published by ICAO in Annex 10 of Volume 1.

(g) Designed specially for airborne (balloon or airframe mounted) operation and having Doppler signal processing for the detection of moving targets;

(h) Employing processing of radar signals using:

(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: Head i. of this entry does not specify;

a. Fishing ground surveillance radar;

b. Ground radar equipment specially designed for enroute air traffic control and **software** specially designed for the **use** thereof, provided:

1. It has a maximum **instrumented** range of 500 km or less;

2. It is configured so that radar target data can be transmitted only one way from the radar site to one or more civil ATC centres;

3. It contains no provisions for remote control of the radar scan rate from the enroute ATC centre; and

4. It is to be permanently installed.

N.B.: The **use software** must be limited to **object code** and the minimum amount of **source code** necessary for installation, operation or maintenance.

(j) **Laser** radar or Light Detection and Ranging (LIDAR) equipment, having either of the following:

(1) **Space-qualified**; or

(2) Employing coherent heterodyne or homodyne detection techniques and having an angular resolution of less (better) than 20 microradians;

Note: Head j. of this entry does not specify LIDAR equipment specially designed for surveying or for meteorological observation.

(k) Having signal processing sub-systems using **pulse compression** with:

(1) A **pulse compression** ratio exceeding 150; or

(2) A pulse width of less than 200 ns; or

(l) Having data processing sub-systems with:

(1) **Automatic target tracking** providing, at any antenna rotation, the predicted target position beyond the time of the next antenna beam passage;

Note: Sub-head l.1. of this entry does not specify conflict alert capability in ATC systems, or marine or harbour radar.

(2) Calculation of target velocity from primary radar having non-periodic (variable) scanning rates;

(3) Processing for automatic pattern recognition (feature extraction) and comparison with target characteristic data bases (waveforms or imagery) to identify or classify targets; or

(4) Superposition and correlation, or fusion, of target data from two or more **geographically dispersed** and **interconnected radar sensors** to enhance and discriminate targets.

Note: Sub-head l.4 of this entry does not specify systems, equipment and assemblies used for marine traffic control.

(6A102) Radiation hardened detectors, other than those specified in entry 6A002, for use in protecting against nuclear effects (e.g. electromagnetic pulse (EMP), X-rays, combined blast and thermal effects), and usable for **missiles**, designed or rated to withstand radiation levels which meet or exceed a total irradiation dose of 5×10^5 rads (Si).

In this entry, "a detector" means a mechanical, electrical, optical or chemical device that automatically identifies and records, or registers a stimulus such as an environmental change in pressure or temperature, an electrical or electromagnetic signal or radiation from a radioactive material.

(6A107) Specially designed components for gravity meters and gravity gradiometers specified in heads b. and c. of entry 6A007.

(6A108) Radar systems and tracking systems, other than those specified in entry 6A008, as follows:

(a) Radar and laser radar systems designed or modified for use in systems specified in entries 9A004 or 9A104;

(b) Precision tracking systems, usable for **missiles**, as follows:

(1) Tracking systems which use a code translator in conjunction with either surface or airborne references or navigation satellite systems to provide real-time measurements of in-flight position and velocity;

(2) Range instrumentation radars including associated optical/infrared trackers with all of the following capabilities:

(a) angular resolution better than 3 milliradians (0.5 mils);

(b) range of 30 km or greater with a range resolution better than 10 m rms;

(c) velocity resolution better than 3 m/s.

(6A202) Photomultiplier tubes with a photocathode area of greater than 20 cm^2 having an anode pulse rise time of less than 1 ns.

(6A203) Cameras and components, other than those specified in entry 6A003, as follows:

(a) Mechanical rotating mirror cameras and specially designed components therefor, as follows:

(1) Mechanical framing cameras with recording rates greater than 225,000 frames per second;

(2) Streak cameras with writing speeds greater than 0.5 mm per microsecond;

Note: Components of such cameras include specially designed synchronizing electronics and specially designed rotor assemblies (consisting of turbines, mirrors and bearings).

(b) Electronic streak and framing cameras and tubes, as follows:

(1) Electronic streak cameras capable of 50 ns or less time resolution and streak tubes therefor;

(2) Electronic (or electronically shuttered) framing cameras capable of 50 ns or less frame exposure time;

(3) Framing tubes and solid-state imaging devices for use with cameras specified in sub-head b.2. of this entry, as follows:

(a) Proximity focused image intensifier tubes having the photocathode deposited on a transparent conductive coating to decrease photocathode sheet resistance;

(b) Gate silicon intensifier target (SIT) videcon tubes, where a fast system allows gating the photoelectrons from the photocathode before they impinge on the SIT plate;

(c) Kerr or pockel cell electro-optical shuttering; or

(d) Other framing tubes and solid-state imaging devices having a fast-image gating time of less than 50 ns specially designed for cameras specified in sub-head b.2. of this entry;

(c) Radiation-hardened TV cameras specially designed or rated as radiation hardened to withstand greater than 5×10^4 grays (Si)(5×10^6 rad (Si)) without operational degradation and specially designed lenses used therein.

(6A205) **Lasers**, other than those specified in entry 6A005, as follows:

(a) Argon ion **lasers** with greater than 40 W average output power operating at wavelengths between 400 nm and 515 nm;

(b) Tunable pulsed single-mode dye oscillators capable of an average power output of greater than 1 W, a repetition rate greater than 1 kHz, a pulse less than 100 ns, and a wavelength between 300 nm and 800 nm;

(c) Tunable pulsed dye **laser** amplifiers and oscillators, with an average power output of greater than 30W, a repetition rate greater than 1 kHz, a pulse width less than 100 ns, and a wavelength between 300 nm and 800 nm;

except:

Single mode oscillators;

(d) Pulsed carbon dioxide **lasers** with a repetition rate greater than 250 Hz, an average power output of greater than 500 W, and a pulse of less than 200 ns operating at wavelengths between 9,000 nm and 11,000 nm;

(e) Para-hydrogen Raman shifters designed to operate at 16 micrometres output wavelength and at a repetition rate greater than 250 Hz.

(6A225) Velocity interferometers for measuring velocities in excess of 1 km/s during time intervals of less than 10 microsecond (VISARs, Doppler laser interferometers (DLIs), etc.).

(6A226) Pressure sensors, as follows:

(a) Manganin gauges for pressures greater than 100 kilobars; or

(b) Quartz pressure transducers for pressures greater than 100 kilobars.

6B Test, Inspection and Production Equipment

(a) (6B004) (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: This entry does not specify microscopes.

(6B005) Specially designed or modified equipment, including tools, dies, fixtures or gauges, as follows, and other specially designed components and accessories therefor:

(a) For the manufacture or inspection of:

(1) Free electron **laser** magnet wigglers;

(2) Free electron **laser** photo injectors;

(b) For the adjustment, to required tolerances, of the longitudinal magnetic field of free electron **lasers**.

(6B007) Equipment to produce, align and calibrate land-based gravity meters with a static accuracy of better than 0.1 milligal.

(6B008) Pulse radar cross-section measurement systems having transmit pulse widths of 100 ns or less and specially designed components therefor.

(6B108) Systems specially designed for radar cross section measurement usable for **missiles** and their subsystems.

6C Materials

(6C002) Optical Sensors:

(a) Elemental tellurium (Te) of purity levels equal to or more than 99.9995%;

(b) Single crystals of cadmium telluride (CdTe), cadmium zinc telluride (CdZnTe) or mercury cadmium telluride (HgCdTe) of any purity level, including epitaxial wafers thereof;

(c) **Optical fibre preforms** specially designed for the manufacture of high birefringence fibres specified in sub-head d.3. of entry 6A002.

(6C004) Optics:

(a) Zinc selenide (ZnSe) and zinc sulphide (ZnS) **substrate blanks** produced by the chemical vapour deposition process:

(1) Larger than 100 cm^3 in volume; or

(2) Larger than 80 mm in diameter with a thickness equal to or more than 20 mm;

(b) Boules of the following electro-optic materials:

(1) Potassium titanyl arsenate (KTA);

(2) Silver gallium selenide ($AgGaSe_2$); or

(3) Thallium arsenic selenide (Tl_3AsSe_3, also known as TAS);

(c) Non-linear optical materials having:

(1) Third order susceptibility (chi 3) equal to or less than 1 W/m^2; 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) Low optical absorption materials, as follows:

(1) Bulk fluoride compounds containing ingredients with a purity of 99.999% or better;

Note: Sub-head e.1. of this entry specifies fluorides of zirconium or aluminium and variants.

(2) Bulk fluoride glass made from compounds specified in sub-head e.1. of this entry;

(f) Glass, including fused silica, phosphate glass, fluorophosphate glass, zirconium fluoride (ZrF_4) and hafnium fluoride (HfF_4) with:

(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};

(g) 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;

(h) **Optical fibre preforms** made from bulk fluoride compounds containing ingredients with a purity of 99.999% or better, specially designed for the manufacture of **fluoride fibres** specified in head f. of entry 6A004.

(6C005) Synthetic crystalline laser host material in unfinished form, as follows:

(a) Titanium doped sapphire;

(b) Alexandrite.

6D Software

(6D001) **Software** specially designed for the **development** or **production** of **goods** specified in entries 6A004, 6A005, 6A008 or 6B008.

(6D002) **Software** specially designed for the **use** of **goods** specified in head b. of entry 6A002, or entries 6A008 or 6B008.

(6D003) Other **software**, as follows:

(a) (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;

(b) (1) **Software** specially designed for magnetic compensation systems for magnetic sensors designed to operate on mobile platforms;

(2) **Software** specially designed for magnetic anomaly detection on mobile platforms;

(c) **Software** specially designed to correct motional influences of gravity meters or gravity gradiometers;

(d) (1) Air Traffic Control **software** application **programmes** hosted on general purpose computers located at Air Traffic Control centres and capable of any of the following:

(a) Processing and displaying more than 150 simultaneous **system tracks**;

(b) Accepting radar target data from more than four primary radars; or

(c) Automatically handing over primary radar target data (if not correlated with secondary surveillance radar (SSR) data) from the host ATC centre to another ATC centre;

(2) **Software** for the design or **production** of radomes which:

(a) Are specially designed to protect the **electronically steerable phased** array antennae specified in head e. of entry 6A008; and

(b) Limit the average side-lobe level increase by less than 13 dB for frequencies equal to or higher than 2 GHz.

(6D102) Software specially designed for the **use** of **goods** specified in entry 6A108.

(6D103) **Software** which processes post-flight, recorded data, obtained from the systems specified in head b. of entry 6A108, enabling determination of vehicle position throughout its flight path.

6E Technology

(6E001) **Technology required** for the **development** of **goods** specified in sub-categories 6A, 6B, 6C or 6D.

(6E002) **Technology required** for the **production** of **goods** specified in sub-categories 6A, 6B or 6C.

(6E003) Other **technology**, as follows:

(a) (1) Optical surface coating and treatment **technology** required to achieve 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}

(2) Optical fabrication technologies, as follows:

(a) For serially producing optical components at a rate exceeding 10 m^2 of surface area per year on any single spindle and with:

(1) An area exceeding 1 m^2; and

(2) A surface figure exceeding lambda/10 rms at the designed wave-length;

(b) Single point diamond turning techniques producing surface finish accuracies of better than 10 nm rms on non-planar surfaces exceeding 0.5m^2(**47**);

(b) (1) **Technology** for optical filters with a bandwidth equal to or less than 10 nm, a field of view (FOV) exceeding 40° and a resolution exceeding 0.75 line pairs per milliradian;

(2) **Technology required** for the **development**, **production** or **use** of specially designed diagnostic instruments or targets in test facilities for **Super High Power Lasers** (SHPL) testing or testing or evaluation of materials irradiated by SHPL beams;

(c) **Technology required** for the **development** or production of fluxgate **magnetometers** or fluxgate **magnetometer** systems having a noise level:

(1) Less than 0.05 nT rms per square root Hz at frequencies of less than 1 Hz; or

(2) 1×10^{-3} nT rms per square root Hz at frequencies of 1 Hz or more.

(6El01) **Technology required** for the **use** of **goods** specified in entry 6A002, heads b. and c. of entry 6A007, entries 6A008, 6A102, 6A107, 6A108, 6B108, 6D102 or 6D103.

Note: This entry only specifies technology for goods specified in entry 6A008 when designed for airborne applications and usable in **missiles**.

(6E201) **Technology required** for the **use** of **goods** specified in entry 6A003, sub-head a.1.c. of entry 6A005, sub-head a.2.a. of entry 6A005, sub-head c.1.b. of entry 6A005, sub-head c.2.c.2. of entry 6A005, sub-head c.2.d.2.b. of entry 6A005, entries 6A202, 6A203, 6A205, 6A225, or 6A226.

Category 7 — Navigation and Avionics

Equipment, Assemblies and Components

7A.—(7A001) Accelerometers designed for use in inertial navigation or guidance systems and having any of the following characteristics, and specially designed components therefor(**48**):

(a) A **bias stability** of less (better) than 130 micro g with respect to a fixed calibration value over a period of one year;

(**47**) See also head d. of entry 2E003.
(**48**) See also entry 7A101

(b) A **scale factor stability** of less (better) than 130 ppm with respect to a fixed calibration value over a period of one year;

(c) Specified to function at linear acceleration levels exceeding 100 g.

(7A002) Gyros having any of the following characteristics, and specially designed components therefor(**49**):

(a) A **drift rate stability**, when measured in a 1 g environment over a period of three months and with respect to a fixed calibration value, of:

(1) Less (better) than 0.1° per hour when specified to function at linear acceleration levels below 10 g; or

(2) Less (better) than 0.5° per hour when specified to function at linear acceleration levels from 10 g to 100 g inclusive;

(b) Specified to function at linear acceleration levels above 100 g.

(7A003) Inertial navigation systems (gimballed and strapdown) and inertial equipment for attitude, guidance or control having any of the following characteristics, and specially designed components therefor(**50**):

(a) For **aircraft**:

(1) Navigation error (free inertial) of 0.8 nautical mile per hour (50% Circular Error Probable (CEP)) or less (better) subsequent to normal alignment;

(2) Not certified for use on civil **aircraft** by civil aviation authorities; or

(3) Specified to function at linear acceleration levels exceeding 10 g;

(b) For land or **spacecraft**:

(1) Navigation error (free inertial) of 0.8 nautical mile per hour (50% CEP) or less (better) subsequent to normal alignment; or

(2) Specified to function at linear acceleration levels exceeding 10 g.

(7A004) 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(**51**).

(7A005) Global Positioning Satellite (GPS) receiving equipment having either of the following characteristics, and specially designed components therefor(**52**):

(a) Employing encryption/decryption; or

(b) A null-steerable antenna.

(7A006) Airborne altimeters(**53**) operating at frequencies other than 4.2 to 4.4 GHz inclusive, having either of the following characteristics(**54**):

(a) **Power management**; or

(b) Using phase shift key modulation.

Note: For automatic pilots for underwater vehicles, see Category 8, for radar, see Category 6.

(7A101) Accelerometers, other than those specified in entry 7A001, with a threshold of 0.05 g or less, or a linearity error within 0.25% of full scale output, or both, which are designed for use in

(**49**) See also entry 7A102.
(**50**) See also entry 7A102.
(**51**) See also entry 7A104.
(**52**) See also entry 7A105.
(**53**) See Category 6 for radar and Category 8 for automatic pilots for underwater vehicles.
(**54**) See also entry 7A106.

inertial navigation systems or in guidance systems of all types and specially designed components therefor.

Note: This entry does not specify accelerometers which are specially designed and developed as Measurement While Drilling (MWD) sensors for use in downhole well service operations.

(7A102) All types of gyros, other than those specified in entry 7A002, usable in **missiles**, with a rated **drift rate stability** of less than 0.5° (1 sigma or rms) per hour in a 1 g environment and specially designed components therefor.

(7A103) Instrumentation, navigation and direction finding equipment and systems, other than those specified in entry 7A003, as follows; and specially designed components therefor:

(a) Inertial or other equipment using accelerometers or gyros specified in entries 7A001, 7A002, 7A101 or 7A102 and systems incorporating such equipment;

(b) Integrated flight instrument systems, which include gyrostabilisers or automatic pilots, designed or modified for use in systems specified in entries 9A004 or 9A104.

(7A104) Gyro-astro compasses and other devices, other than those specified in entry 7A004, which derive position or orientation by means of automatically tracking celestial bodies or satellites and specially designed components therefor.

(7A105) Global Positioning Systems (GPS) or similar satellite receivers, other than those specified in entry 7A005, capable of providing navigation information under the following operational conditions and designed or modified for use in systems specified in entry 9A004 or 9A104;

(a) At speeds in excess of 515 m/s; and

(b) At altitudes in excess of 18 km.

(7A106) Altimeters, other than those specified in entry 7A006, of radar or laser radar type, designed or modified for use in systems specified in entry 9A004 or 9A104.

(7A115) Passive sensors for determining bearing to specific electromagnetic source (direction finding equipment) or terrain characteristics, designed or modified for use in systems specified in entry 9A004 or 9A104.

Note: This entry includes sensors for the following equipment:

a. Terrain contour mapping equipment;

b. Imaging sensor equipment;

c. Interferometer equipment.

(7A116) Flight Control systems, as follows; designed or modified for systems specified in entry 9A004 or 9A104:

(a) Hydraulic, mechanical, electro-optical, electro-mechanical or fly by wire types;

(b) Attitude control equipment.

(7A117) **Guidance sets**, usable in **missiles**, capable of achieving system accuracy of 3.33% or less of the range (e.g., a CEP of 10 km or less at a range of 300 km).

7B Test, Inspection and Production Equipment

(7B001) Test, calibration or alignment equipment specially designed for equipment specified in sub-category 7A except: equipment for Maintenance Level I or Maintenance Level II.

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.

3. *N.B.:* Maintenance Level II does not include the removal of specified accelerometers or gyro sensors from the SRA.

(7B002) Equipment, as follows(**55**), specially designed to characterize mirrors for ring laser gyros:

(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).

(7B003) Equipment specially designed for the production of equipment specified in sub-category 7A, including:

(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 Fixture for Gyro bearing;

(f) Accelerometer axis align stations.

(7B102) Reflectometers specially designed to characterise mirrors, for **laser** gyros, having a measurement accuracy of 50 ppm or less (better).

(7B103) Specially designed **production facilities** for equipment specified in entry 7A117.

7C Materials

None

7D Software

(7D001) **Software** specially designed or modified for the **development** or **production** of **goods** specified in sub-categories 7A or 7B.

(7D002) **Source code** for the **use** of any inertial navigation equipment or Attitude Heading Reference Systems (AHRS) (except: gimballed AHRS) including inertial equipment not specified in entries 7A003 or 7A004.

Note: AHRS generally differ from inertial navigation systems (INS) in that an AHRS provides attitude heading information and normally does not provide the acceleration, velocity and position information associated with an INS.

(7D003) 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 in entries 7A003 or 7A004;

(b) **Source code** for hybrid integrated systems which improves the operational performance or reduces the navigational error of systems to the level specified in entry 7A003 by continuously combining inertial data with any of the following navigation data:

(**55**) See also entry 7B102.

(1) Doppler radar velocity;

(2) Global Positioning Satellite (GPS) references; or

(3) Terrain data base;

(c) **Source code** for integrated avionics or mission systems which combine sensor data and employ knowledge-based expert systems;

(d) **Source code** for the **development** of:

(1) Digital flight management systems for flight path optimization;

(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;

(7) Raster-type head-up displays or three dimensional displays.

(7D101) **Software** specially designed for the **use** of **goods** specified in entries 7A001 to 7A006, 7A101 to 7A106, 7A115, 7B002, 7B003, 7B102 or 7B103.

(7D102) Integration **software** for the **goods** specified in entries 7A003 or 7A103.

(7D103) **Software** specially designed for modelling or simulation of the **guidance sets** specified in entry 7A117 or for their design integration with the systems specified in entries 9A004 or 9A104.

*Note:***Software** specified in this entry remains controlled by this entry when combined with specially designed hardware specified in entry 4A102.

7E Technology

(7E001) **Technology required** for the **development** of **goods** or **software** specified in sub-categories 7A, 7B or 7D.

(7E002) **Technology required** for the **production** of **goods** specified in sub-categories 7A or 7B.

(7E003) **Technology required** for the repair, refurbishing or overhaul of **goods** specified in entries 7A001 to 7A004;

except:

for 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(**56**).

(7E004) Other technology, as follows:

(a) Technology for the development or production of:

(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) Raster-type head-up displays or three dimensional displays for **aircraft**;

(4) Inertial navigation systems or gyro-astro compasses containing accelerometers or gyros specified in entries 7A001 or 7A002;

(b) **Development technology**, as follows, for **active flight control systems** (including fly-by-wire or fly-by-light):

(**56**) See Note to entry 7B001.

(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: Sub-head b.3. of this entry does not specify **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 flight path optimization;

except:

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 multi sensor mission management systems incorporating knowledge-based expert systems (**57**);

(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.

(7E101) **Technology required** for the **use** of **goods** specified in entries 7A001 to 7A006, 7A101 to 7A106, 7A115 to 7A117, 7B002, 7B003, 7B102, 7B103 or 7D101 to 7D103.

(7E102) **Technology** for protection of avionics and electrical subsystems against electromagnetic pulse (EMP) and electromagnetic interference (EMI) hazards, from external sources, as follows:

(a) Design **technology** for shielding systems;

(b) Design **technology** for the configuration of hardened electrical circuits and sub-systems;

(c) Design **technology** for the determination of hardening criteria for heads a. or b. of this entry.

(7E104) *Technology* for the integration of the flight control, guidance, and propulsion data into a flight management system for optimization of rocket system trajectory.

Category 8 — Marine

(**57**) For technology for Full Authority Digital Engine Control (FADEC) see sub-head a.10. of entry 9E003.

Equipment, Assemblies and Components

8A.—(8A001) Submersible vehicles(**58**) or surface vessels, as follows:

(a) Manned, tethered submersible vehicles designed to operate at depths exceeding 1,000 m;

(b) Manned, untethered submersible vehicles:

(1) Designed to **operate autonomously** and having a lifting capacity of:

(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) (a) Designed to carry a crew of 4 or more;

(b) Designed to **operate autonomously** for 10 hours or more;

(c) Having a **range** of 25 nautical miles or more; and

(d) Having a length of 21 m or less;

(c) Unmanned, tethered submersible vehicles designed to operate at depths exceeding 1,000 m:

(1) Designed for self-propelled manoeuvre using propulsion motors or thrusters specified in sub-head a.2. of entry 8A002; or

(2) Having a fibre optic data link;

(d) Unmanned, untethered submersible vehicles:

(1) Designed for deciding a course relative to any geographical reference without real-time human assistance;

(2) Having an acoustic data or command link; or

(3) Having a fibre optic 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 either 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 with positioning accuracies to within 10 m of a predetermined point;

(f) Surface-effect vehicles (fully skirted variety) with a maximum design speed, fully loaded, exceeding 30 knots in a significant wave height of 1.25 m (Sea State 3) or more, a cushion pressure exceeding 3,830 Pa, and a light-ship-to-full-load displacement ratio of less than 0.7;

(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 with:

(1) A 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

(**58**) See also Category 5 for encrypted communication equipment; Category 6 for sensors; Categories 7 and 8 for navigation equipment; entry 8A002 for underwater systems or equipment.

(2) A 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.

Note: A small waterplane area vessel is defined by the following formula: waterplane area at an operational design draft less than 2 × (displaced volume at the operational design draught)^2/3;.

(8A002) Systems or equipment(**59**), as follows:

Note: For underwater communications systems and underwater optical fibre cables, see Category 5 Telecommunications.

a. Systems or equipment, specially designed or modified for submersible vehicles, 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;

b. Systems specially designed or modified for the automated control of the motion of equipment for submersible vehicles specified in entry 8A001 using navigation data and having closed loop servo-controls to:

1. Enable a vehicle to move within 10 m of a predetermined point in the water column;
2. Maintain the position of the vehicle within 10 m of a predetermined point in the water column; or
3. Maintain 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. a. Television systems (comprising camera, lights, monitoring and signal transmission equipment) having a limiting resolution when measured in air of more than 500 lines and specially designed or modified for remote operation with a submersible vehicle; or

b. Underwater television cameras having a limiting resolution when measured in air of more than 700 lines;

Note: Limiting resolution in television 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 Institution of Electrical and Electronic Engineers (IEEE) Standard 208/1960.

2. Systems, specially designed or modified for remote operation with an underwater vehicle, employing techniques to minimise the effects of back scatter, including range-gated illuminators or **laser** systems;
3. Low light level television cameras specially designed or modified for underwater use containing:

a. Image intensifier tubes specified in sub-head a.2.a. of entry 6A002; and

b. More than 150,000 **active pixels** per solid state area array;

(**59**) See Category 5 Telecommunications for underwater communications systems and underwater optical fibre cable.

e. Photographic still cameras specially designed or modified for underwater use, having a film format of 35 mm or larger, and:

1. Annotating the film with data provided by a source external to the camera;
2. Having autofocussing or remote focussing specially designed for underwater use;
3. Having automatic back focal distance correction; or
4. Having automatic compensation control specially designed to permit an underwater camera housing to be usable at depths exceeding 1,000 m;

f. Electronic imaging systems, specially designed or modified for underwater use, capable of storing digitally more than 50 exposed images;

g. Light systems, as follows, specially designed or modified for underwater use:

1. Stroboscopic light systems capable of a light output energy of more than 300 J per flash;
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 stored programme computer:

1. Having 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. Capable of exerting a force of 250 N or more or a torque of 250 Nm or more and using titanium based alloys or **fibrous or filamentary composite** materials in their structural members;

i. Remotely controlled articulated manipulators specially designed or modified for use with submersible vehicles:

1. Having systems which control the manipulator using the information from sensors which measure the torque or force applied to an external object, or tactile sense between the manipulator and an external object; or
2. Controlled by proportional master-slave techniques or by using a dedicated stored programme computer, and having 5 degrees of freedom of movement or more;

Note: Only functions having proportional control using positional feedback or by using a dedicated stored programme computer are counted when determining the number of degrees of freedom of movement.

j. Air independent power systems, as follows, specially designed for underwater use:

1. Brayton, Stirling 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 specially designed:
        1. To pressurise the products of reaction or for fuel reformation;
        2. To store the products of the reaction; and

3. 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 having either 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 specially designed:
      1. To pressurise the products of reaction or for fuel reformation;
      2. To store the products of the reaction; and
      3. To discharge the products of the reaction against a pressure of 100 kPa or more;

k. Skirts, seals and fingers, as follows:
   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 in head f. of entry 8A001;
   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 in head g. of entry 8A001;

l. Lift fans rated at more than 400 kW specially designed for **surface effect vehicles** specified in heads f. or g. of entry 8A001;

m. Fully submerged subcavitating or supercavitating hydrofoils specially designed for vessels specified in head h. of entry 8A001;

n. Active systems specially designed or modified to control automatically the sea-induced motion of vehicles or vessels specified in heads f., g., h. or i. of entry 8A001;

o. 1. Water-screw propeller or power transmission systems, as follows, specially designed for **surface effect vehicles** (fully skirted or rigid sidewall variety), hydrofoils or small waterplane area vessels specified in heads f., g., h. or i. of entry 8A001:
      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, capable of transmitting more than 1 MW;

2. Water-screw propeller, power generation or transmission systems 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, 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 for use on vessels of 1,000 tonnes displacement or more, as follows:

a. Noise reduction systems that attenuate 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, 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, and incorporating 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 with a power output exceeding 2.5 MW using divergent nozzle and flow conditioning vane techniques to improve propulsive efficiency or reduce propulsion-generated underwater-radiated noise.

(8A990) **The export of goods specified in this entry is prohibited to any destination in Iran or Iraq.**

Vessels, other than those specified in entry 8A001, as follows: and specially designed components therefor;

a. Vessels having special structural features for landing personnel and/or vehicles on a beach;

b. Vessels capable of supporting helicopter operations and maintenance;

c. Vessels capable of submerging;

d. Vessels not elsewhere specified in this Part of this Schedule of below 100 tonnes GRT including inflatable craft in an inflated or uninflated state;

except:

Light vessels, fire floats and dredgers.

(8A991) **The export of goods specified in this entry is prohibited to any destination in Libya.**

Vessels with decks and platforms specially strengthened to receive weapons, other than those specified in entry 8A001, and specially designed components therefor.

8B Test, Inspection and Production Equipment

(8B001) Water tunnels, having a background noise of less than 100 dB (reference 1 micro-pascal, 1 Hz) in the frequency range from 0 to 500 Hz, designed for measuring acoustic fields generated by a hydro-flow around propulsion system models.

8C Materials

(8C001) Syntactic foam for underwater use:

(a) Designed for marine depths exceeding 1,000 m; and

(b) With a density less than 561 kg/m^3.

Note: Syntactic foam consists of hollow spheres of plastic or glass embedded in a resin matrix.

8D Software

(8D001) **Software** specially designed or modified for the **development, production** or **use** of **goods** specified in sub-categories 8A, 8B or 8C.

(8D002) Specific **software** specially designed or modified for the **development, production**, repair, overhaul or refurbishing (re-machining) of propellers specially designed for underwater noise reduction.

8E Technology

(8E001) **Technology required** for the **development** or **production** of **goods** specified in entries 8A001 and 8A002, or sub-categories 8B or 8C.

(8E002) Other **technology,** as follows:

(a) **Technology** for the **development, production,** repair, overhaul or refurbishing (re-machining) of propellers specially designed for underwater noise reduction;

Note: For the purpose of head a. of this entry, a licence granted in relation to propellers which are specially designed for underwater noise reduction, does not authorize the export of any related repair technology.

(b) **Technology** for the overhaul or refurbishing of equipment specified in entry 8A001 or heads b., j., o. or p. of entry 8A002.

(8E990) **The export of goods specified in this entry is prohibited to any destination in Iran or Iraq.**

Technology required for the **development, production** or **use of goods** specified in entry 8A990.

(8E991) **The export of goods specified in this entry is prohibited to any destination in Libya.**

Technology required for the **development, production** or **use** of **goods** specified in entry 8A991.

Category 9 — Aircraft, Space Vehicles, Propulsion Systems and Related Equipment

Equipment, Assemblies and Components

9A.—(9A001) Aero gas turbine engines incorporating any of the technologies specified in head a. of entry 9E003., as follows(**60**):

(a) Not certified for the specific civil **aircraft** for which they are intended;

(b) Not certified for civil use by the aviation authorities in a relevant country;

(**60**) See also entry 9A101.

In this head, "relevant country" means an authority in Australia, Belgium, Canada, Denmark, Eire, France, Germany, Greece, Italy, Japan, Luxembourg, Netherlands, Norway, Portugal, Spain, Turkey, United Kingdom or United States of America.

(c) Designed to cruise at speeds exceeding Mach 1.2 for more than thirty minutes.

(9A002) Marine gas turbine engines with an ISO standard continuous power rating of 24,245 kW or more and a specific fuel consumption of less than 0.219 kg/kWh at any point in the power range from 35 to 100%, and specially designed assemblies and components therefor.

Note: Marine gas turbine engines includes those industrial, or aero-derivative, gas turbine engines adapted for marine propulsion or shipboard power generation.

(9A003) Specially designed assemblies and components, incorporating any of the technologies specified in head a. of entry 9E003, for the following gas turbine engine propulsion systems:

(a) Specified in entry 9A001; or

(b) Whose design or production origins are unknown to the manufacturer.

Note: This entry does not specify multiple domed combustors operating at average burner outlet temperatures equal to or less than 1,813 K (1,540°C).

(9A004) Space launch vehicles or **spacecraft** (not including their payloads)(**61**).

(9A005) Liquid rocket propulsion systems containing any of the systems or components specified in entry 9A006(**62**).

(9A006) Systems or components, as follows(**63**), specially designed for liquid rocket propulsion systems:

(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).

(9A007) Solid rocket propulsion systems with any of the following,(**64**):

(a) (1) Total impulse capacity exceeding 1.1 MNs; or

(2) 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;

(b) (1) Stage mass fractions exceeding 88%; and

(2) Propellant solid loadings exceeding 86%;

(c) Any of the components specified in entry 9A008; or

(**61**) See also entry 9A104. See the appropriate categories for products contained in spacecraft payloads.
(**62**) See also entries 9A105 and 9A119.
(**63**) See also entry 9A106.
(**64**) See also entry 9A119.

(d) 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.

Note: For the purposes of head d. of this entry, a strong mechanical bond means bond strength equal to or more than propellant strength.

(9A008) Components, as follows(**65**), specially designed for solid rocket propulsion systems:

(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;

Note: For the purposes of head a. of this entry, a strong mechanical bond means bond strength equal to or more than propellant strength.

(b) Filament-wound **composite** motor cases exceeding 0.61 m in diameter or having structural efficiency ratios (PV/W) exceeding 25 km;

Note: The 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:

(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.

(9A009) Hybrid rocket propulsion systems(**66**) with:

(a) Total impulse capacity exceeding 1.1 MNs; or

(b) Thrust levels exceeding 220 kN in vacuum exit conditions.

(9A010) Specially designed components or structures, for launch vehicles or launch vehicle propulsion systems, manufactured using metal **matrix composite,** organic **composite,** ceramic **matrix** or intermetallic reinforced materials specified in entries 1C007 or 1C010(**67**).

(9A011) Ramjet, scramjet or combined cycle engines and specially designed components therefor(**68**).

(9A101) Lightweight turbojet and turbofan engines (including turbocompound engines) usable in **missiles,** other than those specified in entry 9A001, as follows;

(a) Engines having both of the following characteristics:

(1) Maximum thrust value greater than 1 kN (achieved un-installed) excluding civil certified engines with a maximum thrust value greater than 8.89 kN (achieved un-installed); and

(2) Specific fuel consumption of 0.13 kg/N/hr or less (at sea level static and standard conditions); or

(b) Engines designed or modified for use in **missiles.**

(9A104) Sounding rockets, capable of a range of at least 300 km.

(**65**) See also entry 9A108.
(**66**) See also entries 9A109 and 9A119.
(**67**) See also entries IA002 and 9A110.
(**68**) See also entries 9A111 and 9A118.

(9A105) Liquid propellant rocket engines usable in **missiles,** other than those specified in entry 9A005, having a total impulse capacity of 0.841 MNs or greater(**69**).

(9A106) Systems or components, other than those specified in entry 9A006, usable in **missiles,** as follows, specially designed for liquid rocket propulsion systems:

(a) Rocket nozzles;

(b) Thrust vector control sub-systems;

Note: Examples of methods of achieving thrust vector control specified in head b. of this entry are:

a. Flexible Nozzle;

b. Fluid or secondary gas injection;

c. Movable engine or nozzle;

d. Deflection of exhaust gas stream (jet vanes or probes); or

e. Thrust tabs.

(c) Liquid and slurry propellant (including oxidiser) control systems, and specially designed components therefor, designed or modified to operate in vibration environments of more than 10 g rms between 20 Hz and 2000 Hz.

Note: The only servo valves and pumps specified in head c. of this entry are as follows:

a. Servo valves designed for flow rates of 24 litres per minute or greater, at an absolute pressure of 7 MPa or greater, that have an actuator response time of less than 100 ms;

b. Pumps, for liquid propellants, with shaft speeds equal to or greater than 8,000 rpm or with discharge pressures equal to or greater than 7 MPa.

(9A107) Solid propellant rocket engines, usable in **missiles,** other than those specified in entry 9A007 having a total impulse capacity of 0.841 MNs or greater(**70**).

(9A108) Components, other than those specified in entry 9A008, usable in **missiles,** as follows, specially designed for solid rocket propulsion systems:

(a) Rocket motor cases, interior lining and **insulation** therefor;

(b) Rocket nozzles;

(c) Thrust vector control sub-systems.

Note: Examples of methods of achieving thrust vector control specified in head c. of this entry are:

a. Flexible Nozzle;

b. Fluid or secondary gas injection;

c. Movable engine or nozzle;

d. Deflection of exhaust gas stream (jet vanes or probes); or

e. Thrust tabs.

Note: In this entry, "interior lining" means suited for the bond interface between the solid propellant and the case or insulating liner; usually a liquid polymer based dispersion of refractory or insulating materials, e.g. carbon filled hydroxy-terminated polybutadiene (HTPB) or other polymer with added curing agents sprayed or screeded over a case interior.

(**69**) See also entry 9A119.
(**70**) See also entry 9A119.

(9A109) Hybrid rocket motors, usable in **missiles,** other than those specified in entry 9A009, and specially designed components therefor(**71**).

(9A110) Composite structures, laminates and manufactures thereof, other than those specified in entry 9A010, specially designed for use in the systems specified in entries 9A004 or 9A104 or the subsystems specified in entries 9A005, 9A007, 9A105 to 9A108, 9A116 or 9A119, and resin impregnated fibre prepregs and metal coated fibre preforms therefor, made either with organic matrix or metal matrix utilising fibrous or filamentary reinforcements having a specific tensile strength greater than 7.62×10^4 m and a specific modulus greater than 3.18×10^6 m(**72**).

Note: The only resin impregnated fibre prepregs specified in this entry are those using resins with a glass transition temperature (T_g), after cure, exceeding 418 K (145°C) as determined by ASTM D4065 or equivalent.

(9A111) Pulse jet engines, usable in **missiles,** and specially designed components therefor(**73**).

(9A115) Launch support equipment, designed or modified for systems specified in entries 9A004 or 9A104, as follows:

(a) Apparatus and devices for handling, control, activation or launching;

(b) Vehicles for transport, handling, control, activation or launching.

(9A116) Reentry vehicles, usable in **missiles,** and equipment designed or modified therefor, as follows:

(a) Heat shields and components therefor fabricated of ceramic or ablative materials;

(b) Heat sinks and components therefor fabricated of light-weight, high heat capacity materials;

(c) Electronic equipment specially designed for reentry vehicles.

(9A117) Staging mechanisms, separation mechanisms, and interstages, usable in **missiles.**

(9A118) Devices to regulate combustion usable in engines, which are usable in **missiles,** specified in entries 9A011 or 9A111.

(9A119) Individual rocket stages, usable in **missiles,** other than those specified in entries 9A005, 9A007, 9A009, 9A105, 9A107 or 9A109.

(9A990) **The export of goods specified in this entry is prohibited to any destination in Libya, Iran, Iraq, Syria or South Africa.**

Aircraft having a maximum all up weight of 390 kg or more, and aeroengines, and equipment or components designed therefor, other than those specified eleswhere in this Schedule.

(9A991) **Aircraft** or steerable parachutes other than those specified in entry ML10 of Group 1 of Part III of this Schedule, having a maximum all up weight of not more than 390 kg.

(9A993) **The export of goods specified in this entry is prohibited to any destination in Libya.**

Equipment for simulating or modelling any function of any **aircraft** or any part of any **aircraft,** specially designed components and specially designed accessories therefor.

9B Test, Inspection and Production Equipment

(9B001) Specially designed equipment, tooling or fixtures, as follows, for manufacturing or measuring gas turbine blades, vanes or tip shroud castings:

(a) Automated equipment using non-mechanical methods for measuring airfoil wall thickness;

(**71**) See also entry 9A119.
(**72**) See also entry 1A002.
(**73**) See also entries 9A011 and 9A118.

(b) Tooling, fixtures or measuring equipment for the **laser,** water jet or ECM/EDM hole drilling processes specified in head c. of entry 9E003;

(c) Directional solidification or single crystal casting equipment;

(d) Ceramic cores or shells;

(e) Ceramic core manufacturing equipment or tools;

(f) Ceramic core leaching equipment;

(g) Ceramic shell wax pattern preparation equipment;

(h) Ceramic shell burn out or firing equipment.

(9B002) On-line (real time) control systems, instrumentation (including sensors) or automated data acquisition and processing equipment, specially designed for the development of gas turbine engines, assemblies or components incorporating technologies specified in head a. of entry 9E003.

(9B003) Equipment specially designed for the production or test of gas turbine brush seals designed to operate at tip speeds exceeding 335 m/s, and specially designed parts or accessories therefor.

(9B004) Tools, dies or fixtures for the solid state joining of gas turbine **superalloy** or titanium components.

(9B005) On-line (real time) control systems, instrumentation (including sensors) or automated data acquisition and processing equipment, specially designed for use with the following wind tunnels or devices(**74**):

(a) Wind tunnels designed for speeds of Mach 1.2 or more;

except:

those specially designed for educational purposes and having a test section size (measured laterally) of less than 250 mm;

In this head, "Test section size" means the diameter of the circle, or the side of a square, or the longest side of a 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;

(c) Wind tunnels or devices, other than two-dimensional sections, capable of simulating Reynolds number flows exceeding 25×10^6.

(9B006) Specially designed acoustic vibration test equipment capable of producing sound pressure levels of 160 dB or more (referenced to 20 micropascals) with a rated output of 4 kW or more at a test cell temperature exceeding 1,273 K (1,000°C), and specially designed transducers, strain gauges, accelerometers, thermocouples or quartz heaters therefor.

(9B007) Equipment specially designed for inspecting the integrity of rocket motors using non-destructive test (NDT) techniques other than planar X-ray or basic physical or chemical analysis(**75**).

(9B008) Transducers specially designed for the direct measurement of the wall skin friction of the test flow with a stagnation temperature exceeding 833 K (560°C).

(9B009) 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.

(9B105) Wind tunnels for speeds of Mach 0.9 or more, usable for **missiles** and their subsystems.

(9B106) Environmental chambers and anechoic chambers, as follows:

(**74**) See also 9B105

(**75**) For Radiographic equipment, see sub-head e.5. of entry 3A001.

(a) Environmental chambers capable of simulating the following flight conditions:

(1) Vibration environments of 10 g rms or greater between 20 Hz and 2,000 Hz and imparting forces of 5 kN or greater; and

(2) Altitudes of 15,000 m or greater; or

(3) Temperature of at least 223 K (-50°C) to 398 K (+ 125°C);

(b) Anechoic chambers capable of simulating the following flight conditions:

(1) Acoustic environments at an overall sound pressure level of 140 dB or greater (referenced to 20 micropascals) or with a rated power output of 4 kW or greater; and

(2) Altitudes of 15,000 m or greater; or

(3) Temperature of at least 223 K (-50°C) to 398 K (+ 125°C).

(9B115) Specially designed **production equipment** for the systems, sub-systems and components specified in entries 9A005 to 9A009, 9A011, 9A101, 9A105 to 9A109, 9A111, 9A116 to 9A119.

(9B116) Specially designed **production facilities** for the systems, sub-systems, and components specified in entries 9A004 to 9A009, 9A011, 9A101, 9A104 to 9A109, 9A111, 9A116 to 9A119.

(9B117) Test benches and test stands for solid or liquid propellant rockets or rocket motors, having either of the following characteristics:

(a) The capacity to handle more than 90 kN of thrust; or

(b) Capable of simultaneously measuring the three axial thrust components.

9C Materials

None

9D Software

(9D001) **Software** required for the **development** of **goods** or **technology** specified in sub-categories 9A, 9B or entry 9E003.

(9D002) **Software** required for the **production** of **goods** specified in sub-categories 9A or 9B.

(9D003) **Software** required for the **use** of full authority digital electronic engine controls (FADEC) for propulsion systems specified in sub-category 9A or equipment specified in sub-category 9B, as follows:

(a) **Software** in digital electronic controls for propulsion systems, aerospace test facilities or air breathing aero-engine test facilities;

(b) Fault-tolerant **software** used in FADEC systems for propulsion systems and associated test facilities.

(9D004) Other **software,** as follows:

(a) **Software** specially designed for vibration test equipment, other than that specified in entry 2D101, using real time digital controls with individual exciters (thrusters) with a maximum thrust exceeding 100 kN;

(b) 2D or 3D viscous **software** validated with wind tunnel or flight test data required for detailed engine flow modelling;

(c) **Software** required for the **development** or **production** of real time full authority electronic test facilities for engines or components specified in sub-category 9A;

(d) **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;

(e) **Software** specially designed to control directional solidification or single crystal casting;

(f) **Software** in **source code, object code** or machine code required for the use of active compensating systems for rotor blade tip clearance control.

Note: Head f. of this entry does not specify **software** embedded in non-specified equipment or required for maintenance activities associated with the calibration or repair or updates to the active compensating clearance control system.

(9D101) **Software** specially designed for the use of **goods** specified in entries 9B105, 9B106, 9B116 or 9B117.

(9D103) **Software** specially designed for modelling, simulation or design integration of the systems specified in entries 9A004 or 9A104 or the sub-systems specified in entries 9A005, 9A007, 9A105 to 9A108, 9A116 or 9A119.

*Note:***Software** specified in this entry remains controlled when combined with specially designed hardware specified in entry 4A102.

(9D993) **The export of goods specified in this entry is prohibited to any destination in Libya.**

Software specially designed or modified for the use of **goods** specified in entry 9A993.

9E Technology

(9E001) **Technology required** for the **development** of **goods** specified in head c. of entry 9A001, or entries 9A004 to 9A011, or sub-Categories 9B or 9D.

(9E002) **Technology required** for the **production** of **goods**(**76**) specified in head c. of entry 9A001, or entries 9A004 to 9A011 or sub-Category 9B.

Notes:

1. **Development** or **production technology** specified in sub-category 9E for gas turbine engines remains specified when used as **use technology** for repair, rebuild and overhaul.
2. This entry does not include 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.
3. For **technology** for the repair of specified structures, laminates or materials, see head f. of entry 1E002.

(9E003) Other **technology,** as follows:

(a) **Technology required** for the **development** or **production** of the following gas turbine engine components or systems:

(1) Directionally solidified gas turbine blades, vanes or tip shrouds rated to operate at gas path temperatures exceeding 1,593 K (1,320°C);

(2) Single crystal blades, vanes or tip shrouds;

(3) Multiple domed combustors operating at average burner outlet temperatures exceeding 1,643 K (1,370°C), or combustors incorporating thermally de-coupled combustion liners, non-metallic liners or non-metallic shells;

(4) Components manufactured from organic **composite** materials designed to operate above 588 K (315°C), or from metal **matrix composite,** ceramic **matrix,** intermetallic or intermetallic reinforced materials specified in entries 1A002 or 1C007;

(5) Uncooled turbine blades, vanes, tip-shrouds or other components designed to operate at gas path temperatures of 1,323 K (1,050°C) or more;

(**76**) See head f. of entry 1E002 for technology for the repair of specified structures, laminates or materials.

(6) Cooled turbine blades, vanes or tip-shrouds, other than those described in sub-heads a.1. and a.2. of this entry, exposed to gas path temperatures of 1,643 K (1,370°C) or more;

(7) Airfoil-to-disk blade combinations using solid state joining;

(8) Gas turbine engine components using **diffusion bonding technology** specified in head b. of entry 2E003;

(9) Damage tolerant gas turbine engine rotating components using powder metallurgy materials specified in head b. of entry 1C002;

(10) FADEC for gas turbine and combined cycle engines and their related diagnostic components, sensors and specially designed components;

(11) Adjustable flow path geometry and associated control systems for:

(a) Gas generator turbines;

(b) Fan or power turbines;

(c) Propelling nozzles;

Notes:

(1) Adjustable flow path geometry and associated control systems do not include inlet guide vanes, variable pitch fans, variable stators or bleed valves for compressors.

(2) Sub-head a.11. of this entry does not specify **development** or **production technology** for adjustable flow path geometry for reverse thrust.

(12) Rotor blade tip clearance control systems employing active compensating casing **technology** limited to a design and development data base;

(13) Gas bearings for gas turbine engine rotor assemblies;

(14) Wide chord hollow fan blades without part-span support;

(b) **Technology required** for the **development** or **production** of:

(1) Wind tunnel aero-models equipped with non-intrusive sensors capable of transmitting data from the sensors to the data acquisition system;

(2) **Composite** propeller blades or propfans capable of absorbing more than 2,000 kW at flight speeds exceeding Mach 0.55;

(c) **Technology required** for the **development** or **production** of gas turbine engine components using **laser,** water jet or ECM/EDM hole drilling processes to produce holes with:

(1) (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) (a) Depths more than five times their diameter;

(b) Diameters less than 0.4 mm; and

(c) Incidence angles of more than 25°;

Note: For the purposes of head c. of this entry, incidence angle is measured from a plane tangential to the airfoil surface at the point where the hole axis enters the airfoil surface.

(d) **Technology required** for the **development** or **production** of helicopter power transfer systems or tilt rotor or tilt wing aircraft power transfer systems:

(1) Capable of loss-of-lubrication operation for 30 minutes or more; or

(2) Having an input power-to-weight ratio equal to or more than 8.87 kW/kg;

(e) (1) **Technology** for the **development** or **production** of reciprocating diesel engine ground vehicle propulsion systems having all of the following:

(a) A box volume of 1.2 m^3 or less;

(b) An overall power output of more than 750 kW based on Council Directive 80/1269/EEC(**77**) or ISO 2534; and

(c) A power density of more than 700 kW/m^3 of box volume;

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 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 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.

(2) **Technology required** for the **production** of specially designed components, as follows, for high output diesel engines:

(a) **Technology required** for the **production** of engine systems having all of the following components employing ceramics materials specified in entry 1C007:

(1) Cylinder liners;

(2) Pistons;

(3) Cylinder heads; and

(4) One or more other components (including exhaust ports, turbo-chargers, valve guides, valve assemblies or insulated fuel injectors);

(b) **Technology required** for the **production** of turbocharger systems, with single-stage compressors having all of the following:

(1) Operating at pressure ratios of 4:1 or higher;

(2) A mass flow in the range from 30 to 130 kg per minute; and

(3) Variable flow area capability within the compressor or turbine sections;

(c) **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)), having both of the following:

(1) Injection amount in excess of 230 mm^3 per injection per cylinder; and

(**77**) O.J. No. L.375, Vol 23 31.12.80, p.46 as amended by Commission Directive 88/195/EEC, O.J. No. L.92, 9.4.88, p.50 and Commission Directive 89/491/EEC, O.J. No. L.238, 15.8.89 p.43.

(2) Specially designed electronic control features for switching governor characteristics automatically depending on fuel property to provide the same torque characteristics by using the appropriate sensors;

(3) **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, 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.

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 rpm, provided the rated speed is 2,300 rpm or more.

(9El01) **Technology required** for the **development** or **production** of **goods** specified in entries 9A101, 9A104 to 9A111 or 9A115 to 9A119.

(9E102) **Technology required** for the **use** of **goods** specified in entries 9A004 to 9A011, 9A101, 9A104 to 9A111, 9A115 to 9A119, 9B105, 9B106, 9B115 to 9B117, 9D101 or 9D103.

(9E990) **The export of goods specified in this entry is prohibited to any destination in Libya, Iran, Iraq, Syria or South Africa.**

Technology required for the **development, production** or **use** of **goods** specified in entry 9A990.

(9E991) **Technology required** for the **development, production** or **use** of **goods** specified in entry 9A991.

(9E993) **The export of goods specified in this entry is prohibited to any destination in Libya.**

Technology required for the **development, production** or **use** of **goods** specified in entry 9A993.