(Acts adopted pursuant to Title V of the Treaty on European Union)

COUNCIL DECISION

of 20 March 2000

amending Decision 94/942/CFSP on the Joint Action concerning the control of exports of dual-use goods

(2000/243/CFSP)

THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty on European Union, and in particular Article 13 thereof,

Having regard to the general guidelines given by the European Council held at Lisbon on 26 and 27 June 1992,

Whereas:

(1) The lists of dual-use goods in Annexes I and IV to Decision 94/942/CFSP [1] should be amended to take into account commitments undertaken by Member States in international fora.

(2) For reasons of clarity, all the various versions should be combined in a single text,

HAS DECIDED AS FOLLOWS:

Article 1

Annexes I, II, III, IV and V to Decision 94/942/CFSP, as referred to in Council Regulation (EC) No 3381/94 of 19 December 1994 setting up a Community regime for the control of exports of dual-use goods [2], shall be replaced by Annexes I, II, III, IV and V set out in the Annex hereto.

Article 2

This Decision shall enter into force on the day of its publication.

It shall apply from the 30th day following the date of its publication.

Article 3

This Decision shall be published in the Official Journal.

Done at Brussels, 20 March 2000.

For the Council

The President

J. GAMA

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[1] OJ L 367, 31.12.1994, p. 8. Decision as last amended by Decision 1999/193/CFSP (OJ L 73, 19.3.1999, p. 1).

[2] OJ L 367, 31.12.1994, p. 1. Regulation as amended by Regulation (EC) No 837/95 (OJ L 90, 21.4.1995, p. 1).

ANNEX

"ANNEX I

List referred to in Article 2 of Decision 94/942/CFSP and Article 3(1) of Regulation (EC) No 3381/94

LIST OF DUAL-USE GOODS

This list implements internationally agreed dual-use controls including the Wassenaar Arrangement, the Missile Technology Control Regime (MTCR), the Nuclear Suppliers' Group (NSG), the Australia Group and the Chemical Weapons Convention (CWC). No account has been taken of any items that Member States wish to place on an exclusion list. No account has been taken of any national controls (non-regime origin controls) that may be maintained by Member States.

GENERAL NOTES TO ANNEX I

1. For control of goods which are designed or modified for military use, see the relevant list(s) of controls on military goods maintained by individual Member States. References in this Annex that state "SEE ALSO MILITARY GOODS CONTROLS" refer to the same lists.

2. The object of the controls contained in this Annex should not be defeated by the export of any non-controlled goods (including plant) containing one or more controlled components when the controlled component or components are the principal element of the goods and can feasibly be removed or used for other purposes.

   N.B.: In judging whether the controlled component or components are to be considered the principal element, it is necessary to weigh the factors of quantity, value and technological know-how involved and other special circumstances which might establish the controlled component or components as the principal element of the goods being procured.

3. The control of technology transfer in this Annex is limited to tangible forms.

4. Goods specified in this Annex include both new and used goods.

NUCLEAR TECHNOLOGY NOTE (NTN)

(To be read in conjunction with section E of Category 0.)

The "technology" directly associated with any goods controlled in Category 0 is controlled according to the provisions of Category 0.

"Technology" for the "development", "production" or "use" of goods under control remains under control even when applicable to non-controlled goods.

The approval of goods for export also authorizes the export to the same end-user of the minimum "technology" required for the installation, operation, maintenance and repair of the goods.

Controls on "technology" transfer do not apply to information "in the public domain" or to "basic scientific research".

GENERAL TECHNOLOGY NOTE (GTN)

(To be read in conjunction with section E of Categories 1 to 9.)

The export of "technology" which is "required" for the "development", "production" or "use" of goods controlled in Categories 1 to 9, is controlled according to the provisions of Categories 1 to 9.

"Technology" "required" for the "development", "production" or "use" of goods under control remains under control even when applicable to non-controlled goods.

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

N.B.: This does not release such "technology" specified in 1E002.e., 1E002.f., 8E002.a. and 8E002.b.

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

GENERAL SOFTWARE NOTE (GSN)

(This note overrides any control within section D of Categories 0 to 9.)

Categories 0 to 9 of this list do not control "software" which is either:

a. Generally available to the public by being:
   1. Sold from stock at retail selling points, without restriction, by means of:
      a. Over-the-counter transactions;
      b. Mail order transactions; or
      c. Telephone order transactions; and
   2. Designed for installation by the user without further substantial support by the supplier; or

   N.B. Entry a. of the General Software Note does not release "software" specified in Category 5 - Part 2 ("Information Security").

b. "In the public domain".

DEFINITIONS OF TERMS USED IN THIS ANNEX

Category references are given in brackets after the defined term.

"Accuracy" (2 6), 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" (7) are systems that function to prevent undesirable "aircraft" and missile motions or structural loads by autonomously processing outputs from multiple sensors and then providing necessary preventive commands to effect automatic control.

"Active pixel" (6 8) is a minimum (single) element of the solid state array which has a photoelectric transfer function when exposed to light (electromagnetic) radiation.

"Adapted for use in war" (1) means any modification or selection (such as altering purity, shelf life, virulence, dissemination characteristics, or resistence to UV radiation) designed to increase the effectiveness in producing casualties in humans or animals, degrading equipment or damaging crops or the environment.

"Adaptive control" (2) means a control system that adjusts the response from conditions detected during the operation (ref. ISO 2806-1980).

"Aircraft" (1 7 9) means a fixed wing, swivel wing, rotary wing (helicopter), tilt rotor or tilt-wing airborne vehicle.

N.B.: See also "civil aircraft".

"All compensations available" (2) means after all feasible measures available to the manufacturer to minimise all systematic positioning errors for the particular machine-tool model are considered.

"Angular position deviation" (2) 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 (ref. VDI/VDE 2617, Draft: 'Rotary tables on coordinate measuring machines').

"Asymmetric algorithm " (5) means a cryptographic algorithm using different, mathematically-related keys for encryption and decryption.

N.B.: A common use of "asymmetric algorithms" is key management.

"Asynchronous transfer mode" ("ATM") (5) 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.

"ATM" is equivalent to "Asynchronous transfer mode".

"Automatic target tracking" (6) 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.

"Basic gate propagation delay time" (3) means the propagation delay time value corresponding to the basic gate used in a "monolithic integrated circuit". For a 'family' of "monolithic integrated circuits", this may be specified either as the propagation delay time per typical gate within the given 'family' or as the typical propagation delay time per gate within the given 'family'.

N.B. 1: "Basic gate propagation delay time" is not to be confused with the input/output delay time of a complex "monolithic integrated circuit".

N.B. 2: 'Family' consists of all integrated circuits to which all of the following are applied as their manufacturing methodology and specifications except their respective functions:

a. The common hardware and software architecture;

b. The common design and process technology; and

c. The common basic characteristics.

"Basic scientific research" (GTN NTN) means experimental or theoretical work undertaken principally to acquire new knowledge of the fundamental principles of phenomena or observable facts, not primarily directed towards a specific practical aim or objective.

"Bias" (accelerometer) (7) means an accelerometer output when no acceleration is applied.

"Carbon fibre preforms" (1) means an ordered arrangement of uncoated or coated fibres intended to constitute a framework of a part before the "matrix" is introduced to form a "composite".

"CE" is equivalent to "computing element".

"CEP" (circle of equal probability) (7) is a measure of accuracy; the radius of the circle centred at the target, at a specific range, in which 50% of the payloads impact.

"Chemical Laser" (6) means a "laser" in which the excited species is produced by the output energy from a chemical reaction.

"Circulation-controlled anti-torque or circulation controlled direction control systems" (7) are systems that use air blown over aerodynamic surfaces to increase or control the forces generated by the surfaces.

"Civil aircraft" (1 7 9) means those "aircraft" listed by designation in published airworthiness certification lists by the civil aviation authorities to fly commercial civil internal and external routes or for legitimate civil, private or business use.

N.B.: See also "aircraft".

"Commingled" (1) means filament to filament blending of thermoplastic fibres and reinforcement fibres in order to produce a fibre reinforcement "matrix" mix in total fibre form.

"Comminution" (1) means a process to reduce a material to particles by crushing or grinding.

"Common channel signalling" (5) is 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" (4) 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" (1 2 6 8 9) 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") (3 4) is a measure of computational performance given in millions of theoretical operations per second (Mtops), calculated using the aggregation of "computing elements" ("CE").

N.B.: See Category 4, Technical Note.

"Compound rotary table" (2) 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") (4) means the smallest computational unit that produces an arithmetic or logic result.

"Contouring control" (2) 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 (ref. ISO/DIS 2806 - 1980).

"Critical temperature" (1 3 6) (sometimes referred to as the transition temperature) of a specific "superconductive" material means the temperature at which the material loses all resistance to the flow of direct electrical current.

"Cryptography" (5) 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' (e.g., crypto variables) or associated key management.

N.B.: 'Secret parameter': a constant or key kept from the knowledge of others or shared only within a group.

"CTP" is equivalent to "composite theoretical performance".

"Data signalling rate" (5) means the rate, as defined in ITU Recommendation 53-36, taking into account that, for non-binary modulation, baud and bit per second are not equal. Bits for coding, checking and synchronisation functions are to be included.

N.B. 1: When determining the "data signalling rate", servicing and administrative channels shall be excluded.

N.B. 2: It is the maximum one-way rate, i.e., the maximum rate in either transmission or reception.

"Deformable mirrors" (6) (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 repositioned by the application of torques or forces to compensate for distortions in the optical waveform incident upon the mirror.

"Depleted uranium" (0) means uranium depleted in the isotope 235 below that occurring in nature.

"Development" (GTN NTN All) is related to all phases prior to serial production, such as: design, design research, design analyses, design concepts, assembly and testing of prototypes, pilot production schemes, design data, process of transforming design data into a product, configuration design, integration design, layouts.

"Diffusion bonding" (1 2 9) 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" (4 5) means equipment which can, in the form of one or more discrete variables, perform all of the following:

a. Accept data;

b. Store data or instructions in fixed or alterable (writable) storage devices;

c. Process data by means of a stored sequence of instructions which is modifiable; and

d. Provide output of data.

N.B.: Modifications of a stored sequence of instructions include replacement of fixed storage devices, but not a physical change in wiring or interconnections.

"Digital transfer rate" (5) means the total bit rate of the information that is directly transferred on any type of medium.

N.B.: See also "total digital transfer rate".

"Direct-acting hydraulic pressing" (2) means a deformation process which uses a fluid-filled flexible bladder in direct contact with the workpiece.

"Drift rate" (gyro) (7) 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" (5) means automatic rerouting of traffic based on sensing and analysis of current actual network conditions.

N.B.: This does not include cases of routing decisions taken on predefined information.

"Dynamic signal analysers" (3) 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.

N.B.: See also "signal analysers".

"Effective gramme" (0 1) of "special 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 uranium-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 uranium-235, the element weight in grammes multiplied by 0.0001;

"Electronic assembly" (3 4 5) means a number of electronic components (i.e., 'circuit elements', 'discrete components', integrated circuits, etc.) connected together to perform (a) specific function(s), replaceable as an entity and normally capable of being disassembled.

N.B. 1: 'Circuit element': a single active or passive functional part of an electronic circuit, such as one diode, one transistor, one resistor, one capacitor, etc.

N.B. 2: 'Discrete component': a separately packaged 'circuit element' with its own external connections.

"Electronically steerable phased array antenna" (5 6) means an antenna which forms a beam by means of phase coupling, i.e., the beam direction is controlled by the complex excitation coefficients of the radiating elements and the direction of that beam can be varied in azimuth or in elevation, or both, by application, both in transmission and reception, of an electrical signal.

"End-effectors" (2) means grippers, 'active tooling units' and any other tooling that is attached to the baseplate on the end of a "robot" manipulator arm.

N.B.: 'Active tooling unit' means a device for applying motive power, process energy or sensing to the workpiece.

"Equivalent Density" (6) means the mass of an optic per unit optical area projected onto the optical surface.

"Expert systems" (4 7) mean 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).

"FADEC" is equivalent to "full authority digital engine control".

"Fault tolerance" (4) is the capability of a computer system, after any malfunction of any of its hardware or "software" components, to continue to operate without human intervention, at a given level of service that provides: continuity of operation, data integrity and recovery of service within a given time.

"Fibrous or filamentary materials" (0 1 8) 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" (3) means an array of 'circuit elements' and metallic interconnections formed by deposition of a thick or thin film on an insulating "substrate".

N.B.: 'Circuit element' is a single active or passive functional part of an electronic circuit, such as one diode, one transistor, one resistor, one capacitor, etc.

"Fixed" (5) 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.

"Flight control optical sensor array" (7) is a network of distributed optical sensors, using "laser" beams, to provide real-time flight control data for on-board processing.

"Flight path optimization" (7) is a procedure that minimizes deviations from a four-dimensional (space and time) desired trajectory based on maximizing performance or effectiveness for mission tasks.

"Focal plane array" (6) 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.

N.B.: 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 hopping" (5) means a form of "spread spectrum" in which the transmission frequency of a single communication channel is made to change by a random or pseudo-random sequence of discrete steps.

"Frequency switching time" (3 5) 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" (3) 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.

"Full Authority Digital Engine Control" ("FADEC") (7 9) means an electronic control system for gas turbine or combined cycle engines utilising a digital computer to control the variables required to regulate engine thrust or shaft power output throughout the engine operating range from the beginning of fuel metering to fuel shutoff.

"Gas Atomisation" (1) 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.

"Geographically dispersed" (6) is where each location is distant from any other more than 1,500 m in any direction. Mobile sensors are always considered "geographically dispersed".

"Global interrupt latency time" (4) means the time taken by the computer system to recognize an interrupt due to the event, service the interrupt and perform a context switch to an alternate memory-resident task waiting on the interrupt.

"Guidance set" (7) 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" (2) means the process of pressurising a casting at temperatures exceeding 375 K (102°C) in a closed cavity through various media (gas, liquid, solid particles, etc.) to create equal force in all directions to reduce or eliminate internal voids in the casting.

"Hybrid computer" (4) means equipment which can perform all of the following:

a. Accept data;

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

c. Provide output of data.

"Hybrid integrated circuit" (3) means any combination of integrated circuit(s), or integrated circuit with 'circuit elements' or 'discrete components' connected together to perform (a) specific function(s), and having all of the following characteristics:

a. Containing at least one unencapsulated device;

b. Connected together using typical IC production methods;

c. Replaceable as an entity; and

d. Not normally capable of being disassembled.

N.B. 1: 'Circuit element': a single active or passive functional part of an electronic circuit, such as one diode, one transistor, one resistor, one capacitor, etc.

N.B. 2: 'Discrete component': a separately packaged 'circuit element' with its own external connections.

"Image enhancement" (4) 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.

"Immunotoxin" (1) is a conjugate of one cell specific monoclonal antibody and a "toxin" or "sub-unit of toxin", that selectively affects diseased cells.

"In the public domain" (GTN NTN GSN), as it applies herein, means "technology" or "software" which has been made available without restrictions upon its further dissemination (copyright restrictions do not remove "technology" or "software" from being "in the public domain").

"Information security" (4 5) is 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.

N.B.: 'Cryptanalysis': analysis of a cryptographic system or its inputs and outputs to derive confidential variables or sensitive data, including clear text.

"Instantaneous bandwidth" (3 5 7) means the bandwidth over which output power remains constant within 3 dB without adjustment of other operating parameters.

"Instrumented range" (6) means the specified unambiguous display range of a radar.

"Insulation" (9) is applied to the components of a rocket motor, i.e. the case, nozzle, inlets, case closures, and includes cured or semi-cured compounded rubber sheet stock containing an insulating or refractory material. It may also be incorporated as stress relief boots or flaps.

"Interconnected radar sensors" (6) means two or more radar sensors are interconnected when they mutually exchange data in real time.

"Interior lining" (9) is 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 hydroxyl terminated polybutadiene (HTPB) or other polymer with added curing agents sprayed or screeded over a case interior.

"Intrinsic Magnetic Gradiometer" (6) is a single magnetic field gradient sensing element and associated electronics the output of which is a measure of magnetic field gradient.

N.B.: See also "magnetic gradiometer".

"Isolated live cultures" (1) includes live cultures in dormant form and in dried preparations.

"Isostatic presses" (2) mean equipment capable of pressurising a closed cavity through various media (gas, liquid, solid particles, etc.) to create equal pressure in all directions within the cavity upon a workpiece or material.

"Laser" (0 2 3 5 6 7 8 9) is an assembly of components which produce both spatially and temporally coherent light that is amplified by stimulated emission of radiation.

N.B.: See also: "Chemical laser";
"Q-switched laser";
"Super High Power Laser";
"Transfer laser".

"Linearity" (2) (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" (4) is a data communication system having all of the following characteristics:

a. Allows an arbitrary number of independent 'data devices' to communicate directly with each other; and

b. Is confined to a geographical area of moderate size (e.g., office building, plant, campus, warehouse).

N.B.: 'Data device' means equipment capable of transmitting or receiving sequences of digital information.

"Magnetic Gradiometers" (6) are instruments designed to detect the spatial variation of magnetic fields from sources external to the instrument. They consist of multiple "magnetometers" and associated electronics the output of which is a measure of magnetic field gradient.

N.B.: See also "intrinsic magnetic gradiometer".

"Magnetometers" (6) are instruments designed to detect magnetic fields from sources external to the instrument. They consist of a single magnetic field sensing element and associated electronics the output of which is a measure of the magnetic field.

"Main storage" (4) 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.

"Materials resistant to corrosion by UF_6" (0) may be copper, stainless steel, aluminium, aluminium oxide, aluminium alloys, nickel or alloy containing 60 weight percent or more nickel and UF_6- resistant fluorinated hydrocarbon polymers, as appropriate for the type of separation process.

"Matrix" (1 2 8 9) means a substantially continuous phase that fills the space between particles, whiskers or fibres.

"Measurement uncertainty" (2) is 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 (ref. ISO 10360-2, or VDI/VDE 2617).

"Mechanical Alloying" (1) 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.

"Melt Extraction" (1) 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.

N.B.: 'Solidify rapidly': solidification of molten material at cooling rates exceeding 1,000 K/s.

"Melt Spinning" (1) means a process to 'solidify rapidly' a molten metal stream impinging upon a rotating chilled block, forming a flake, ribbon or rod-like product.

N.B.: 'Solidify rapidly': solidification of molten material at cooling rates exceeding 1,000 K/s.

"Microcomputer microcircuit" (3) 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, on data contained in the internal storage.

N.B.: The internal storage may be augmented by an external storage.

"Microprocessor microcircuit" (3) 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.

N.B. 1: The "microprocessor microcircuit" normally does not contain integral user-accessible storage, although storage present on-the-chip may be used in performing its logic function.

N.B. 2: This includes chip sets which are designed to operate together to provide the function of a "microprocessor microcircuit".

"Microorganisms" (1 2) means bacteria, viruses, mycoplasms, rickettsiae, chlamydiae or fungi, 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.

"Missiles" (1 3 5 6 7 9) means complete rocket systems and unmanned air vehicle systems, capable of delivering at least 500 kg payload to a range of at least 300 km.

"Monofilament" (1) or filament is the smallest increment of fibre, usually several micrometres in diameter.

"Monolithic integrated circuit" (3) 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, a so-called 'chip';

b. Can be considered as indivisibly associated; and

c. Perform the function(s) of a circuit.

N.B.: 'Circuit element' is a single active or passive functional part of an electronic circuit, such as one diode, one transistor, one resistor, one capacitor, etc.

"Monospectral imaging sensors" (6) are capable of acquisition of imaging data from one discrete spectral band.

"Multichip integrated circuit" (3) means two or more "monolithic integrated circuits" bonded to a common "substrate".

"Multi-data-stream processing" (4) 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.

N.B.: 'Microprogramme' means a sequence of elementary instructions, maintained in a special storage, the execution of which is initiated by the introduction of its reference instruction into an instruction register.

"Multilevel security" (5) means a class of system containing information with different sensitivities that simultaneously permits access by users with different security clearances and needs-to-know, but prevents users from obtaining access to information for which they lack authorization.

N.B.: "Multilevel security" is computer security and not computer reliability which deals with equipment fault prevention or human error prevention in general.

"Multispectral imaging sensors" (6) are capable of simultaneous or serial acquisition of imaging data from two or more discrete spectral bands. Sensors having more than twenty discrete spectral bands are sometimes referred to as hyperspectral imaging sensors.

"Natural uranium" (0) means uranium containing the mixtures of isotopes occurring in nature.

"Network access controller" (4) means a physical interface to a distributed switching network. It uses a common medium which operates throughout at the same "digital transfer rate" using arbitration (e.g., token or carrier sense) for transmission. Independently from any other, it selects data packets or data groups (e.g., IEEE 802) addressed to it. It is an assembly that can be integrated into computer or telecommunications equipment to provide communications access.

"Neural computer" (4) 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" (6) means an electrical signal given in terms of power spectral density. The relation between "noise level" expressed in peak-to-peak is given by $S^2_{pp} = 8N_o(f_2-f_1)$, where S_{pp} is the peak-to-peak value of the signal (e.g., nanoteslas), N_o is the power spectral density (e.g., $(\text{nanotesla})^2/\text{Hz}$) and (f_2-f_1) defines the bandwidth of interest.

"Nuclear reactor" (0) 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.

"Numerical control" (2) 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 (ref. ISO 2382).

"Object code" (9) means an equipment executable form of a convenient expression of one or more processes ("source code" (source language)) which has been converted by programming system.

"Optical amplification" (5), 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, i.e., using semiconductor optical amplifiers, optical fibre luminescent amplifiers.

"Optical computer" (4) 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 integrated circuit" (3) 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(s).

"Optical switching" (5) means the routing of or switching of signals in optical form without conversion to electrical signals.

"Overall current density" (3) 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.).

"Participating state" (7 9) is a state participating in the Wassenaar Arrangement.

"Peak power" (6), means energy per pulse in joules divided by the pulse duration in seconds.

"Personalized smart card" (5) means a smart card containing a microcircuit which has been programmed for a specific application and cannot be reprogrammed for any other application by the user.

"Power management" (7) 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.

"Pressure transducers" (2) are devices that convert pressure measurements into an electrical signal.

"Previously separated" (0 1) means the application of any process intended to increase the concentration of the controlled isotope.

"Primary flight control" (7) means an "aircraft" stability or manoeuvering control using force/moment generators, i.e., aerodynamic control surfaces or propulsive thrust vectoring.

"Principal element" (4), as it applies in Category 4, is a "principal element" when its replacement value is more than 35% of the total value of the system of which it is an element. Element value is the price paid for the element by the manufacturer of the system, or by the system integrator. Total value is the normal international selling price to unrelated parties at the point of manufacture or consolidation of shipment.

"Production" (GTN NTN All) means all production phases, such as: construction, production engineering, manufacture, integration, assembly (mounting), inspection, testing, quality assurance.

"Production equipment" (1 9) 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" (9) means equipment and specially designed software therefor integrated into installations for "development" or for one or more phases of "production".

"Programme" (2 6) means a sequence of instructions to carry out a process in, or convertible into, a form executable by an electronic computer.

"Pulse compression" (6) 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" (6) is the duration of a "laser" pulse measured at Full Width Half Intensity (FWHI) levels.

"Q-switched laser" (6) 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" (6) 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" (6) 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.

"Real time bandwidth" (3) for "dynamic signal analysers" is 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" (2 4 6 7) means the processing of data by a computer system providing a required level of service, as a function of available resources, within a guaranteed response time, regardless of the load of the system, when stimulated by an external event.

"Required" (GTN 1-9), as applied to "technology" or "software", refers to only that portion of "technology" or "software" which is peculiarly responsible for achieving or extending the controlled performance levels, characteristics or functions. Such "required" "technology" or "software" may be shared by different goods.

"Resolution" (2) means the least increment of a measuring device; on digital instruments, the least significant bit (ref. ANSI B-89.1.12).

"Robot" (2 8) means a manipulation mechanism, which may be of the continuous path or of the point-to-point variety, may use sensors, and has all the following characteristics:

a. Is multifunctional;

b. Is capable of positioning or orienting material, parts, tools or special devices through variable movements in three dimensional space;

c. Incorporates three or more closed or open loop servo-devices which may include stepping motors; and

d. Has "user-accessible programmability" by means of teach/playback method or by means of an electronic computer which may be a programmable logic controller, i.e., without mechanical intervention.

N.B.: The above definition does not include the following devices:

1. Manipulation mechanisms which are only manually/ teleoperator controllable;

2. Fixed sequence manipulation mechanisms which are automated moving devices, operating according to mechanically fixed programmed motions. The programme is mechanically limited by fixed stops, such as pins or cams. The sequence of motions and the selection of paths or angles are not variable or changeable by mechanical, electronic or electrical means;

3. Mechanically controlled variable sequence manipulation mechanisms which are automated moving devices, operating according to mechanically fixed programmed motions. The programme is mechanically limited by fixed, but adjustable stops, such as pins or cams. The sequence of motions and the selection of paths or angles are variable within the fixed programme pattern. Variations or modifications of the programme pattern (e.g., changes of pins or exchanges of cams) in one or more motion axes are accomplished only through mechanical operations;

4. Non-servo-controlled variable sequence manipulation mechanisms which are automated moving devices, operating according to mechanically fixed programmed motions. The programme is variable but the sequence proceeds only by the binary signal from mechanically fixed electrical binary devices or adjustable stops;

5. Stacker cranes defined as Cartesian coordinate manipulator systems manufactured as an integral part of a vertical array of storage bins and designed to access the contents of those bins for storage or retrieval.

"Rotary atomisation" (1) 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.

"Roving" (1) is a bundle (typically 12-120) of approximately parallel 'strands'.

N.B.: 'Strand' is a bundle of "monofilaments" (typically over 200) arranged approximately parallel.

"Scale factor" (gyro or accelerometer) (7) 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" (3) 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.

"SHPL" is equivalent to "super high power laser".

"Signal analysers" (3) means apparatus capable of measuring and displaying basic properties of the single-frequency components of multi-frequency signals.

"Signal processing" (3 4 5 6) 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).

"Software" (GSN All) means a collection of one or more "programmes" or 'microprogrammes' fixed in any tangible medium of expression.

N.B.: 'Microprogramme' means a sequence of elementary instructions, maintained in a special storage, the execution of which is initiated by the introduction of its reference instruction into an instruction register.

"Source code" (or source language) (4 5 6 7 9) is a convenient expression of one or more processes which may be turned by a programming system into equipment executable form ("object code" (or object language)).

"Spacecraft" (7 9) means active and passive satellites and space probes.

"Space qualified" (3 6) refers to products designed, manufactured and tested to meet the special electrical, mechanical or environmental requirements for use in the launch and deployment of satellites or high altitude flight systems operating at altitudes of 100 km or higher.

"Special fissile material" (0) means plutonium-239, uranium-233, "uranium enriched in the isotopes 235 or 233", and any material containing the foregoing.

"Specific modulus" (0 1) is 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 ($(23 \pm 2)^\circ C$) and a relative humidity of $(50 \pm 5)\%$.

"Specific tensile strength" (0 1) is 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 ($(23 \pm 2)^\circ C$) and a relative humidity of $(50 \pm 5)\%$.

"Splat Quenching" (1) means a process to 'solidify rapidly' a molten metal stream impinging upon a chilled block, forming a flake-like product.

N.B.: 'Solidify rapidly' solidification of molten material at cooling rates exceeding 1,000 K/s.

"Spread spectrum" (5) means the technique whereby energy in a relatively narrow-band communication channel is spread over a much wider energy spectrum.

"Spread spectrum" radar (6) - see "Radar spread spectrum"

"Stability" (7) 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" (2 3 5) means controlled by using instructions stored in an electronic storage which a processor can execute in order to direct the performance of predetermined functions.

N.B.: Equipment may be "stored programme controlled" whether the electronic storage is internal or external to the equipment.

"Substrate" (3) 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.

N.B. 1: 'Discrete component': a separately packaged 'circuit element' with its own external connections.

N.B. 2: 'Circuit element': a single active or passive functional part of an electronic circuit, such as one diode, one transistor, one resistor, one capacitor, etc.

"Substrate blanks" (6) means monolithic compounds with dimensions suitable for the production of optical elements such as mirrors or optical windows.

"Sub-unit of toxin" (1) is a structurally and functionally discrete component of a whole "toxin".

"Superalloys" (2 9) means nickel-, cobalt- or iron-base alloys having strengths superior to any alloys in the AISI 300 series at temperatures over 922 K (649°C) under severe environmental and operating conditions.

"Superconductive" (1 3 6 8) means 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.

N.B.: The "superconductive" state of a material is individually characterised by a "critical temperature", a critical magnetic field, which is a function of temperature, and a critical current density which is, however, a function of both magnetic field and temperature.

"Super High Power Laser" ("SHPL") (6) means a "laser" capable of delivering (the total or any portion of) the output energy exceeding 1 kJ within 50 ms or having an average or CW power exceeding 20 kW.

"Superplastic forming" (1 2) 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.

" Symmetric algorithm " (5) means a cryptographic algorithm using an identical key for both encryption and decryption.

N.B. A common use of "symmetric algorithms" is confidentiality of data.

"System tracks" (6) means processed, correlated (fusion of radar target data to flight plan position) and updated aircraft flight position report available to the Air Traffic Control centre controllers.

"Systolic array computer" (4) means a computer where the flow and modification of the data is dynamically controllable at the logic gate level by the user.

"Tape" (1) is a material constructed of interlaced or unidirectional "monofilaments", 'strands', "rovings", "tows", or "yarns", etc., usually preimpregnated with resin.

N.B.: 'Strand' is a bundle of "monofilaments" (typically over 200) arranged approximately parallel.

"Technology" (GTN NTN All) means specific information necessary for the "development", "production" or "use" of goods. This information takes the form of 'technical data' or 'technical assistance'.

N.B.: 1: 'Technical assistance' may take forms such as instructions, skills, training, working knowledge and consulting services and may involve the transfer of "technical data".

N.B. 2: 'Technical data' may take forms such as blueprints, plans, diagrams, models, formulae, tables, engineering designs and specifications, manuals and instructions written or recorded on other media or devices such as disk, tape, read-only memories.

"Three dimensional Vector Rate" (4) 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).

"Tilting spindle" (2) 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" (6) is 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 control of flight" (7) means an automated control of "aircraft" state variables and flight path to meet mission objectives responding to real time changes in data regarding objectives, hazards or other "aircraft".

"Total digital transfer rate" (5) means the number of bits, including line coding, overhead and so forth per unit time passing between corresponding equipment in a digital transmission system.

N.B.: See also "digital transfer rate".

"Tow" (1) is a bundle of "monofilaments", usually approximately parallel.

"Toxins" (1 2) means toxins in the form of deliberately isolated preparations or mixtures, no matter how produced, other than toxins present as contaminants of other materials such as pathological specimens, crops, foodstuffs or seed stocks of "microorganisms".

"Transfer laser" (6) 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" (6) 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".

"Uranium enriched in the isotopes 235 or 233" (0) 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 per cent).

"Use" (GTN NTN All) means operation, installation (including on-site installation), maintenance (checking), repair, overhaul and refurbishing.

"User-accessible programmability" (4 5 6) 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.

"Vaccine" (1) is a medicinal product which is intended to stimulate a protective immunological response in humans or animals in order to prevent disease.

"Vacuum Atomisation" (1) 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" (7) 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.

"Yarn" (1) is a bundle of twisted 'strands'.

N.B.: 'Strand' is a bundle of "monofilaments" (typically over 200) arranged approximately parallel.

ACRONYMS AND ABBREVIATIONS USED IN THIS ANNEX

An acronym or abbreviation, when used as a defined term, will be found in 'Definitions of Terms used in this Annex'.

ACRONYM OR ABBREVIATION	MEANING
ABEC	Annular Bearing Engineers Committee
AGMA	American Gear Manufacturers' Association
AHRS	attitude and heading reference systems
AISI	American Iron and Steel Institute
ALU	arithmetic logic unit
ANSI	American National Standards Institute
ASTM	the American Society for Testing and Materials
ATC	air traffic control
AVLIS	atomic vapour laser isotope separation
CAD	computer-aided-design
CAS	Chemical Abstracts Service
CCITT	International Telegraph and Telephone Consultative Committee
CDU	control and display unit
CEP	circular error probable
CNTD	controlled nucleation thermal deposition
CRISLA	chemical reaction by isotope selective laser activation.
CVD	chemical vapour deposition
CW	chemical warfare
CW (for lasers)	continuous wave
DME	distance measuring equipment
DS	directionally solidified
EB-PVD	electron beam physical vapour deposition
EBU	European Broadcasting Union
ECM	electro-chemical machining
ECR	electron cyclotron resonance
EDM	electrical discharge machines
EEPROMS	electrically erasable programmable read only memory
EIA	Electronic Industries Association
EMC	electromagnetic compatibility
FFT	Fast Fourier Transform
GLONASS	global navigation satellite system
GPS	global positioning system
HBT	hetero-bipolar transistors
HDDR	high density digital recording
HEMT	high electron mobility transistors
ICAO	International Civil Aviation Organisation
IEC	International Electro-technical Commission
IEEE	Institute of Electrical and Electronic Engineers
IFOV	instantaneous-field-of-view
ILS	instrument landing system
IRIG	inter-range instrumentation group
ISAR	inverse synthetic aperture radar

ACRONYM OR ABBREVIATION	MEANING
ISO	International Organization for Standardization
ITU	International Telecommunication Union
JIS	Japanese Industrial Standard
JT	Joule-Thomson
LIDAR	light detection and ranging
LRU	line replaceable unit
MAC	message authentication code
Mach	ratio of speed of an object to speed of sound (after Ernst Mach)
MLIS	molecular laser isotopic separation
MLS	microwave landing systems
MOCVD	metal organic chemical vapour deposition
MRI	magnetic resonance imaging
MTBF	mean-time-between-failures
Mtops	million theoretical operations per second
MTTF	mean-time-to-failure
NBC	Nuclear, Biological and Chemical
NDT	non-destructive test
PAR	precision approach radar
PIN	personal identification number
ppm	parts per million
PSD	power spectral density
QAM	quadrature-amplitude-modulation
RF	radio frequency
SACMA	Suppliers of Advanced Composite Materials Association
SAR	synthetic aperture radar
SC	single crystal
SLAR	sidelooking airborne radar
SMPTE	Society of Motion Picture and Television Engineers
SRA	shop replaceable assembly
SRAM	static random access memory
SRM	SACMA Recommended Methods
SSB	single sideband
SSR	secondary surveillance radar
TCSEC	trusted computer system evaluation criteria
TIR	total indicated reading
UV	ultraviolet
UTS	ultimate tensile strength
VOR	very high frequency omni-directional range
YAG	yttrium/aluminum garnet

CATEGORY 0 - NUCLEAR MATERIALS, FACILITIES, AND EQUIPMENT

0A Systems, Equipment and Components

0A001 "Nuclear reactors" and specially designed or prepared equipment and components therefor, as follows:

a. "Nuclear reactors" capable of operation so as to maintain a controlled self-sustaining fission chain reaction;

b. Metal vessels, or major shop-fabricated parts therefor, specially designed or prepared to contain the core of a "nuclear reactor", including the reactor vessel head for a reactor pressure vessel;

c. Manipulative equipment specially designed or prepared for inserting or removing fuel in a "nuclear reactor";

d. Control rods specially designed or prepared for the control of the fission process in a "nuclear reactor", support or suspension structures therefor, rod drive mechanisms and rod guide tubes;

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. Zirconium metal and alloys in the form of tubes or assemblies of tubes 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. 'Nuclear reactor internals' specially designed or prepared for use in a "nuclear reactor", including support columns for the core, fuel channels, thermal shields, baffles, core grid plates, and diffuser plates;

Note: *In 0A001.h. 'nuclear reactor internals' means any major structure within a reactor vessel which has one or more functions such as supporting the core, maintaining fuel alignment, directing primary coolant flow, providing radiation shields for the reactor vessel, and guiding in-core instrumentation.*

i. Heat exchangers (steam generators) specially designed or prepared for use in the primary coolant circuit of a "nuclear reactor";

j. Neutron detection and measuring instruments specially designed or prepared for determining neutron flux levels within the core of a "nuclear reactor".

0B Test, Inspection and Production Equipment

0B001 Plant for the separation of isotopes of "natural uranium", "depleted uranium" and "special 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", and "special fissile materials", as follows:

1. Gas centrifuge separation plant;
2. Gaseous diffusion separation plant;
3. Aerodynamic separation plant;
4. Chemical exchange separation plant;
5. Ion-exchange separation plant;
6. Atomic vapour "laser" isotope separation (AVLIS) plant;
7. Molecular "laser" isotope separation (MLIS) plant;
8. Plasma separation plant;
9. Electro magnetic separation plant;

b. Gas centrifuges and assemblies and components, specially designed or prepared for gas centrifuge separation process, as follows:

Note: *In 0B001.b. 'high strength-to-density ratio material' means any of the following:*

a. Maraging steel capable of an ultimate tensile strength of 2,050 MPa or more;

b. Aluminium alloys capable of an ultimate tensile strength of 460 MPa or more; or

c. "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;

1. Gas centrifuges;

2. Complete rotor assemblies;

3. Rotor tube cylinders with a wall thickness of 12 mm or less, a diameter of between 75 mm and 400 mm, made from 'high strength-to-density ratio materials';

4. 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 'high strength-to-density ratio materials';

5. Baffles of between 75 mm and 400 mm diameter for mounting inside a rotor tube, made from 'high strength-to-density ratio materials'.

6. Top or bottom caps of between 75 mm and 400 mm diameter to fit the ends of a rotor tube, made from 'high strength-to-density ratio materials';

7. Magnetic suspension bearings consisting of an annular magnet suspended within a housing made of or protected by "materials resistant to corrosion by UF_6" containing a damping medium and having the magnet coupling with a pole piece or second magnet fitted to the top cap of the rotor;

0B001 b. continued

8. Specially prepared bearings comprising a pivot-cup assembly mounted on a damper;

9. Molecular pumps comprised of cylinders having internally machined or extruded helical grooves and internally machined bores;

10. 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;

11. Centrifuge housing/recipients to contain the rotor tube assembly of a gas centrifuge, consisting of a rigid cylinder of wall thickness up to 30 mm with precision machined ends and made of or protected by "materials resistant to corrosion by UF_6";

12. Scoops consisting of tubes of up to 12 mm internal diameter for the extraction of UF_6 gas from within a centrifuge rotor tube by a Pitot tube action, made of or protected by "materials resistant to corrosion by UF_6";

13. 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:
    a. Multiphase output of 600 to 2,000 Hz;
    b. Frequency control better than 0.1%;
    c. Harmonic distortion of less than 2%; and
    d. An efficiency greater than 80%;

c. Equipment and components, specially designed or prepared for gaseous diffusion separation process, as follows:

1. Gaseous diffusion barriers made of porous metallic, polymer or ceramic "materials resistant to corrosion by UF_6" with a pore size of 10 to 100 nm, a thickness of 5 mm or less, and, for tubular forms, a diameter of 25 mm or less;

2. Gaseous diffuser housings made of or protected by "materials resistant to corrosion by UF_6";

3. Compressors (positive displacement, centrifugal and axial flow types) or gas blowers with a suction volume capacity of 1 m^3/min or more of UF_6, and discharge pressure up to 666.7 kPa, made of or protected by "materials resistant to corrosion by UF_6";

4. Rotary shaft seals for compressors or blowers specified in 0B001.c.3. and designed for a buffer gas in-leakage rate of less than 1,000 cm^3/min.;

5. Heat exchangers made of aluminium, copper, nickel, or alloys containing more than 60 per cent 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;

6. Bellow valves made of or protected by "materials resistant to corrosion by UF_6", with a diameter of 40 mm to 1,500 mm;

0B001 continued

d. Equipment and components, specially designed or prepared for aerodynamic separation process, as follows:

1. Separation nozzles consisting of slit-shaped, curved channels having a radius of curvature less than 1 mm, resistant to corrosion by UF_6 , and having a knife-edge contained within the nozzle which separates the gas flowing through the nozzle into two streams;

2. Tangential inlet flow-driven cylindrical or conical tubes, (vortex tubes), made of or protected by "materials resistant to corrosion by UF_6" with a diameter of between 0.5 cm and 4 cm and a length to diameter ratio of 20:1 or less and with one or more tangential inlets;

3. Compressors (positive displacement, centrifugal and axial flow types) or gas blowers with a suction volume capacity of 2 m^3/min or more, made of or protected by "materials resistant to corrosion by UF_6", and rotary shaft seals therefor;

4. Heat exchangers made of or protected by "materials resistant to corrosion by UF_6";

5. Aerodynamic separation element housings, made of or protected by "materials resistant to corrosion by UF_6" to contain vortex tubes or separation nozzles;

6. Bellows valves made of or protected by "materials resistant to corrosion by UF_6", with a diameter of 40 to 1,500 mm;

7. Process systems for separating UF_6 from carrier gas (hydrogen or helium) to 1 ppm UF_6 content or less, including:
   a. Cryogenic heat exchangers and cryoseparators capable of temperatures of 153K (-120°C) or less;
   b. Cryogenic refrigeration units capable of temperatures of 153 K (-120°C) or less;
   c. Separation nozzle or vortex tube units for the separation of UF_6 from carrier gas;
   d. UF_6 cold traps capable of temperatures of 253 K (-20°C) or less;

e. Equipment and components, specially designed or prepared for chemical exchange separation process, as follows:

1. Fast-exchange liquid-liquid pulse columns with stage residence time of 30 seconds or less and resistant to concentrated hydrochloric acid (e.g. made of or protected by suitable plastic materials such as fluorocarbon polymers or glass);

2. Fast-exchange liquid-liquid centrifugal contactors with stage residence time of 30 seconds or less and resistant to concentrated hydrochloric acid (e.g. made of or protected by suitable plastic materials such as fluorocarbon polymers or glass);

3. Electrochemical reduction cells resistant to concentrated hydrochloric acid solutions, for reduction of uranium from one valence state to another;

0B001 e. continued

4. Electrochemical reduction cells feed equipment to take U^{+4} from the organic stream and, for those parts in contact with the process stream, made of or protected by suitable materials (e.g. glass, fluorocarbon polymers, polyphenyl sulphate, polyether sulfone and resin-impregnated graphite);

5. Feed preparation systems for producing high purity uranium chloride solution consisting of dissolution, solvent extraction and/or ion exchange equipment for purification and electrolytic cells for reducing the uranium U^{+6} or U^{+4} to U^{+3};

6. Uranium oxidation systems for oxidation of U^{+3} to U^{+4};

f. Equipment and components, specially designed or prepared for ion-exchange separation process, as follows:

1. Fast reacting ion-exchange resins, pellicular or porous macro-reticulated resins in which the active chemical exchange groups are limited to a coating on the surface of an inactive porous support structure, and other composite structures in any suitable form, including particles or fibres, with diameters of 0.2 mm or less, resistant to concentrated hydrochloric acid and designed to have an exchange rate half-time of less than 10 seconds and capable of operating at temperatures in the range of 373 K (100°C) to 473 K (200°C);

2. Ion exchange columns (cylindrical) with a diameter greater than 1,000 mm, made of or protected by materials resistant to concentrated hydrochloric acid (e.g. titanium or fluorocarbon plastics) and capable of operating at temperatures in the range of 373 K (100°C) to 473 K (200°C) and pressures above 0.7 MPa;

3. Ion exchange reflux systems (chemical or electrochemical oxidation or reduction systems) for regeneration of the chemical reducing or oxidizing agents used in ion exchange enrichment cascades;

g. Equipment and components, specially designed or prepared for atomic vapour "laser" isotope separation process (AVLIS), as follows:

1. High power strip or scanning electron beam guns with a delivered power of more than 2.5 kW/cm for use in uranium vaporization systems;

2. Liquid uranium metal handling systems for molten uranium or uranium alloys, consisting of crucibles, made of or protected by suitable corrosion and heat resistant materials (e.g. tantalum, yttria-coated graphite, graphite coated with other rare earth oxides or mixtures thereof), and cooling equipment for the crucibles;
N.B.: SEE ALSO 2A225.

3. Product and tails collector systems made of or lined with materials resistant to the heat and corrosion of uranium metal vapour or liquid, such as yttria-coated graphite or tantalum;

4. Separator module housings (cylindrical or rectangular vessels) for containing the uranium metal vapour source, the electron beam gun and the product and tails collectors;

0B001 g. cont.

5. "Lasers" or "laser" systems for the separation of uranium isotopes with a spectrum frequency stabiliser for operation over extended periods of time;
N.B.: SEE ALSO 6A005 AND 6A205.

h. Equipment and components, specially designed or prepared for molecular "laser" isotope separation process (MLIS) or chemical reaction by isotope selective laser activation (CRISLA), as follows:

1. Supersonic expansion nozzles for cooling mixtures of UF_6 and carrier gas to 150 K (-123°C) or less and made from "materials resistant to corrosion by UF_6";

2. Uranium pentafluoride (UF_5) product collectors consisting of filter, impact, or cyclone-type collectors or combinations thereof, and made of "materials resistant to corrosion by UF_5/UF_6";

3. Compressors made of or protected by "materials resistant to corrosion by UF_6", and rotary shaft seals therefor;

4. Equipment for fluorinating UF_5 (solid) to UF_6 (gas);

5. Process systems for separating UF_6 from carrier gas (e.g. nitrogen or argon) including:
   a. Cryogenic heat exchangers and cryoseparators capable of temperatures of 153 K (-120°C) or less;
   b. Cryogenic refrigeration units capable of temperatures of 153 K (-120°C) or less;
   c. UF_6 cold traps capable of temperatures of 253 K (-20°C) or less;

6. "Lasers" or "laser" systems for the separation of uranium isotopes with a spectrum frequency stabiliser for operation over extended periods of time;
N.B.: SEE ALSO 6A005 AND 6A205.

i. Equipment and components, specially designed or prepared for plasma separation process, as follows:

1. Microwave power sources and antennae for producing or accelerating ions, with an output frequency greater than 30 GHz and mean power output greater than 50 kW;

2. Radio frequency ion excitation coils for frequencies of more than 100 kHz and capable of handling more than 40 kW mean power;

3. Uranium plasma generation systems;

4. Liquid metal handling systems for molten uranium or uranium alloys, consisting of crucibles, made of or protected by suitable corrosion and heat resistant materials (e.g. tantalum, yttria-coated graphite, graphite coated with other rare earth oxides or mixtures thereof), and cooling equipment for the crucibles;
N.B.: SEE ALSO 2A225.

0B001 i. continued

5. Product and tails collectors made of or protected by materials resistant to the heat and corrosion of uranium vapour such as yttria-coated graphite or tantalum;

6. Separator module housings (cylindrical) for containing the uranium plasma source, radio-frequency drive coil and the product and tails collectors and made of a suitable non-magnetic material (e.g. stainless steel);

j. Equipment and components, specially designed or prepared for electromagnetic separation process, as follows:

1. Ion sources, single or multiple, consisting of a vapour source, ioniser, and beam accelerator made of suitable non-magnetic materials (e.g. graphite, stainless steel, or copper) and capable of providing a total ion beam current of 50 mA or greater;

2. Ion collector plates for collection of enriched or depleted uranium ion beams, consisting of two or more slits and pockets and made of suitable non-magnetic materials (e.g. graphite or stainless steel);

3. Vacuum housings for uranium electromagnetic separators made of non-magnetic materials (e.g. stainless steel) and designed to operate at pressures of 0.1 Pa or lower;

4. Magnet pole pieces with a diameter greater than 2 m;

5. High voltage power supplies for ion sources, having all of the following characteristics:
   a. Capable of continuous operation;
   b. Output voltage of 20,000 V or greater;
   c. Output current of 1 A or greater; and
   d. Voltage regulation of better than 0.01% over a period of 8 hours;
   N.B.: SEE ALSO 3A227.

6. Magnet power supplies (high power, direct current) having all of the following characteristics:
   a. Capable of continuous operation with a current output of 500 A or greater at a voltage of 100 V or greater; and
   b. Current or voltage regulation better than 0.01% over a period of 8 hours.
   N.B.: SEE ALSO 3A226.

0B002 Specially designed or prepared auxiliary systems, equipment and components, as follows, for isotope separation plant specified in 0B001, made of or protected by "materials resistant to corrosion by UF_6":

a. Feed autoclaves, ovens or systems used for passing UF_6 to the enrichment process;

b. Desublimers or cold traps, used to remove UF_6 from the enrichment process for subsequent transfer upon heating;

0B002 continued

c. Product and tails stations for transferring UF_6 into containers;

d. Liquefaction or solidification stations used to remove UF_6 from the enrichment process by compressing, cooling and converting UF_6 to a liquid or solid form;

e. Piping systems and header systems specially designed for handling UF_6 within gaseous diffusion, centrifuge or aerodynamic cascades;

f. 1. Vacuum manifolds or vacuum headers having a suction capacity of 5 m^3/minute or more; or
2. Vacuum pumps specially designed for use in UF_6 bearing atmospheres;

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;
3. Electron bombardment ionisation sources; and
4. Collector system suitable for isotopic analysis.

0B003 Plant for the conversion of uranium and equipment specially designed or prepared therefor, as follows:

a. Systems for the conversion of uranium ore concentrates to UO_3;
b. Systems for the conversion of UO_3 to UF_6;
c. Systems for the conversion of UO_3 to UO_2;
d. Systems for the conversion of UO_2 to UF_4;
e. Systems for the conversion of UF_4 to UF_6;
f. Systems for the conversion of UF_4 to uranium metal;
g. Systems for the conversion of UF_6 to UO_2;
h. Systems for the conversion of UF_6 to UF_4;
i. Systems for the conversion of UO_2 to UCl_4.

0B004 Plant for the production or concentration of heavy water, deuterium and 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. Water-hydrogen sulphide exchange plants;
2. Ammonia-hydrogen exchange plants;

0B004 continued

b. Equipment and components, as follows:

1. Water-hydrogen sulphide exchange towers fabricated from fine carbon steel (e.g. ASTM A516) with diameters of 6 m to 9 m, capable of operating at pressures greater than or equal to 2 MPa and with a corrosion allowance of 6 mm or greater;

2. Single stage, low head (i.e. 0.2 MPa) centrifugal blowers or compressors for hydrogen sulphide gas circulation (i.e. gas containing more than 70% H_2S) with a throughput capacity greater than or equal to 56 m^3/second when operating at pressures greater than or equal to 1.8 MPa suction and having seals designed for wet H_2S service;

3. Ammonia-hydrogen exchange towers greater than or equal to 35 m in height with diameters of 1.5 m to 2.5 m capable of operating at pressures greater than 15 MPa;

4. Tower internals, including stage contactors, and stage pumps, including those which are submersible, for heavy water production utilizing the ammonia-hydrogen exchange process;

5. Ammonia crackers with operating pressures greater than or equal to 3 MPa for heavy water production utilizing the ammonia-hydrogen exchange process;

6. Infrared absorption analysers capable of on-line hydrogen/deuterium ratio analysis where deuterium concentrations are equal to or greater than 90%;

7. Catalytic burners for the conversion of enriched deuterium gas into heavy water utilizing the ammonia-hydrogen exchange process;

8. Complete heavy water upgrade systems, or columns therefor, for the upgrade of heavy water to reactor-grade deuterium concentration.

0B005 Plant specially designed for the fabrication of "nuclear reactor" fuel elements and specially designed or prepared equipment therefor.

Note: *A plant for the fabrication of "nuclear reactor" fuel elements includes equipment which:*

a. Normally comes into direct contact with or directly processes or controls the production flow of nuclear materials;
b. Seals the nuclear materials within the cladding;
c. Checks the integrity of the cladding or the seal; or
d. Checks the finish treatment of the sealed fuel.

0B006 Plant for the reprocessing of irradiated "nuclear reactor" fuel elements, and specially designed or prepared equipment and components therefor.

Note: *0B006 includes:*

a. Plant for the reprocessing of irradiated "nuclear reactor" fuel elements including equipment and components which normally come into direct contact with and directly control the irradiated fuel and the major nuclear material and fission product processing streams;

b. 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;

c. 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;

d. 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" or "special fissile materials";

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

Note: *Holding or storage vessels may have the following features:*

1. Walls or internal structures with a boron equivalent (calculated for all constituent elements as defined in the note to 0C004) of at least two per cent;

2. A maximum diameter of 175 mm for cylindrical vessels;

or

3. A maximum width of 75 mm for either a slab or annular vessel.

f. Process control instrumentation specially designed or prepared for monitoring or controlling the reprocessing of irradiated "natural uranium", "depleted uranium" or "special fissile materials".

0B007 Plant for the conversion of plutonium and equipment specially designed or prepared therefor, as follows:

a. Systems for the conversion of plutonium nitrate to oxide;
b. Systems for plutonium metal production.

0C **Materials**

0C001 "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;

Note: *0C001 does not control the following:*

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 having a mass not greater than 100 kg;

4. Counter-weights having a mass not greater than 100 kg;

c. Alloys containing less than 5% thorium;

d. Ceramic products containing thorium, which have been manufactured for non-nuclear use.

0C002 "Special fissile materials"

Note: *0C002 does not control four "effective grammes" or less when contained in a sensing component in instruments.*

0C003 Deuterium, heavy water (deuterium oxide) and other compounds of deuterium, and mixtures and solutions containing deuterium, in which the isotopic ratio of deuterium to hydrogen exceeds 1:5,000.

0C004 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.

N.B.: **SEE ALSO 1C107**

Note 1: *0C004 does not control the following:*

a. Manufactures of graphite having a mass less than 1 kg, other than those specially designed or prepared for use in a nuclear reactor;

b. Graphite powder.

Note 2: *In 0C004, 'boron equivalent' (BE) is defined as the sum of BE_z for impurities (excluding BE_{carbon} since carbon is not considered an impurity) including boron, where:*

0C004 Note 2 continued

BE_Z (ppm) = CF x concentration of element Z in ppm;

where CF is the conversion factor $= \dfrac{\sigma_Z A_B}{\sigma_B A_Z}$

and σ_B and σ_Z are the thermal neutron capture cross sections (in barns) for naturally occurring boron and element Z respectively; and A_B and A_Z are the atomic masses of naturally occurring boron and element Z respectively.

0C005 Specially prepared compounds or powders for the manufacture of gaseous diffusion barriers, resistant to corrosion by UF_6 (e.g. nickel or alloy containing 60 weight per cent or more nickel, aluminium oxide and fully fluorinated hydrocarbon polymers), having a purity of 99.9 weight per cent 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.

0D Software

0D001 "Software" specially designed or modified for the "development", "production" or "use" of goods specified in this Category.

0E Technology

0E001 "Technology" according to the Nuclear Technology Note for the "development", "production" or "use" of goods specified in this Category.

CATEGORY 1 - MATERIALS, CHEMICALS, "MICROORGANISMS" & "TOXINS"

1A Systems, Equipment and Components

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 % by weight of any of the materials specified in 1C009.b. or 1C009.c.;

b. Piezoelectric polymers and copolymers made from vinylidene fluoride materials specified in 1C009.a.:
   1. In sheet or film form; and
   2. With a thickness exceeding 200 µm;

c. Seals, gaskets, valve seats, bladders or diaphragms made from fluoroelastomers containing at least one vinylether group as a constitutional unit, specially designed for "aircraft", aerospace or 'missile' use.
   Note: *In 1A001.c., 'missile' means complete rocket systems and unmanned air vehicle systems.*

1A002 "Composite" structures or laminates, having any of the following:
N.B: SEE ALSO 1A202, 9A010 and 9A110

a. An organic "matrix" and made from materials specified in 1C010.c., 1C010.d. or 1C010.e.; or
b. A metal or carbon "matrix" and made from:
   1. Carbon "fibrous or filamentary materials" with:
      a. A "specific modulus" exceeding 10.15×10^6 m; and
      b. A "specific tensile" strength exceeding 17.7×10^4 m; or
   2. Materials specified in 1C010.c.

Note 1: *1A002 does not control composite structures or laminates made from epoxy resin impregnated carbon "fibrous or filamentary materials" for the repair of aircraft structures or laminates, provided the size does not exceed 1 m^2.*

Note 2: *1A002 does not control finished or semi-finished items specially designed for purely civilian applications as follows:*
a. Sporting goods;
b. Automotive industry;
c. Machine tool industry;
d. Medical applications.

1A003 Manufactures of non-fluorinated polymeric substances specified in 1C008.a.3. in film, sheet, tape or ribbon form with either of the following characteristics :

a. With a thickness exceeding 0.254 mm; or
b. Coated or laminated with carbon, graphite, metals or magnetic substances.

Note: *1A003 does not control manufactures when coated or laminated with copper and designed for the production of electronic printed circuit boards.*

1A004 Protective and detection equipment and components, other than those specified in military goods controls, as follows:
N.B.: SEE ALSO 2B351 AND 2B352.

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

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

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

Note: *1A004 does not control:*
a. Personal radiation monitoring dosimeters;
b. Equipment limited by design or function to protect against hazards specific to civil industries, such as mining, quarrying, agriculture, pharmaceuticals, medical, veterinary, environmental, waste management, or to the food industry.

1A005 Body armour, and specially designed components therefor, other than those manufactured to military standards or specifications or to their equivalents in performance.
N.B.: SEE ALSO MILITARY GOODS CONTROLS.

Note 1: *1A005 does not control individual suits of body armour and accessories therefor, when accompanying their users for his/her own personal protection.*
Note 2: *1A005 does not control body armour designed to provide frontal protection only from both fragment and blast from non-military explosive devices.*

1A102 Resaturated pyrolized carbon-carbon components designed for space launch vehicles specified in 9A004 or sounding rockets specified in 9A104.

1A202 Composite structures, other than those specified in 1A002, in the form of tubes and having both of the following characteristics:
N.B.: SEE ALSO 9A010 AND 9A110.

a. An inside diameter of between 75 mm and 400 mm; and
b. Made with any of the "fibrous or filamentary materials" specified in 1C010.a. or b. or 1C210.a. or with carbon prepreg materials specified in 1C210.c.

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 which may be used in separating heavy water from ordinary water, having both of the following characteristics:

a. Made of phosphor bronze mesh chemically treated to improve wettability; and
b. Designed to be used in vacuum distillation towers.

1A227 High-density (lead glass or other) radiation shielding windows, having all of the following characteristics, and specially designed frames therefor:

a. A 'cold area' greater than 0.09 m^2;
b. A density greater than 3 g/cm^3; and
c. A thickness of 100 mm or greater.

Technical Note:
In 1A227 the term 'cold area' means the viewing area of the window exposed to the lowest level of radiation in the design application.

1B Test, Inspection and Production Equipment

1B001 Equipment for the production of fibres, prepregs, preforms or "composites" specified in 1A002 or 1C010, as follows, and specially designed components and accessories therefor:
N.B.: SEE ALSO 1B101 AND 1B201.

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;
Note: *In 1B001.b., 'missile' means complete rocket systems and unmanned air vehicle systems.*

c. Multidirectional, multidimensional weaving machines or interlacing machines, including adapters and modification kits, for weaving, interlacing or braiding fibres to manufacture "composite" structures;
Note: *1B001.c. does not control textile machinery not modified for the above end-uses.*

1B001 continued

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 1C010.e. by the hot melt method;

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

1B002 Systems and components therefor, specially designed to avoid contamination and specially designed for producing metal alloys, metal alloy powder or alloyed materials specified in 1C002.a.2., 1C002.b. or 1C002.c.
N.B.: SEE ALSO 1B102.

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;
b. "Aircraft" or aerospace engines; or
c. Specially designed components for those structures or engines.

1B101 Equipment, other than that specified in 1B001, for the "production" of structural composites as follows; and specially designed components and accessories therefor:
N.B.: SEE ALSO 1B201.

Note: *Components and accessories specified in 1B101 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;

1B101 continued

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. 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;

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

d. Equipment designed or modified for special fibre surface treatment or for producing prepregs and preforms specified in entry 9C110.
Note: *1B101.d. includes rollers, tension stretchers, coating equipment, cutting equipment and clicker dies.*

1B102 Metal powder "production equipment", other than that specified in 1B002, usable for the "production", in a controlled environment, of spherical or atomised materials specified in 1C011.a., 1C011.b., 1C111.a.1., 1C111.a.2. or in the Military Goods Controls.
N.B.: SEE ALSO 1B115.b.

Note: *1B102 includes:*
a. Plasma generators (high frequency arc-jet) usable for obtaining sputtered or spherical metallic powders with organization of the process in an argon-water environment;
b. Electroburst equipment usable for obtaining sputtered or spherical metallic powders with organization of the process in an argon-water environment;
c. Equipment usable for the "production" of spherical aluminium powders by powdering a melt in an inert medium (e.g. nitrogen).

1B115 Equipment, other than that specified in 1B002 or 1B102, for the production of propellant and propellant constituents, as follows, and specially designed components therefor:

a. "Production equipment" for the "production", handling or acceptance testing of liquid propellants or propellant constituents specified in 1C011.a., 1C011.b., 1C111 or in the Military Goods Controls;

b. "Production equipment" for the "production", handling, mixing, curing, casting, pressing, machining, extruding or acceptance

1B115 b. continued

testing of solid propellants or propellant constituents specified in 1C011.a., 1C011.b., 1C111 or in the Military Goods Controls.

Note: *1B115.b. does not control batch mixers, continuous mixers or fluid energy mills. For the control of batch mixers, continuous mixers and fluid energy mills see 1B117, 1B118 and 1B119.*

Note 1: *For equipment specially designed for the production of military goods, see the Military Goods Controls.*

Note 2: *1B115 does not control equipment for the "production", handling and acceptance testing of boron carbide.*

1B116 Specially designed nozzles for producing 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.

1B117 Batch mixers with provision for mixing under vacuum in the range of zero to 13.326 kPa and with temperature control capability of the mixing chamber and having all of the following:

a. A total volumetric capacity of 110 litres or more; and
b. At least one mixing/kneading shaft mounted off centre.

1B118 Continuous mixers with provision for mixing under vacuum in the range of zero to 13.326 kPa and with temperature control capability of the mixing chamber and having all of the following:

a. Two or more mixing/kneading shafts; and
b. Capability to open the mixing chamber.

1B119 Fluid energy mills usable for grinding or milling substances specified in 1C011.a., 1C011.b., 1C111 or in the Military Goods Controls.

1B201 Filament winding machines, other than those specified in 1B001 or 1B101, and related equipment, as follows:

a. Filament winding machines having all of the following characteristics:
   1. Having motions for positioning, wrapping, and winding fibres coordinated and programmed in two or more axes;
   2. Specially designed to fabricate composite structures or laminates from "fibrous or filamentary materials"; and
   3. Capable of winding cylindrical rotors of diameter between 75 and 400 mm and lengths of 600 mm or greater;

b. Coordinating and programming controls for the filament winding machines specified in 1B201.a.;

c. Precision mandrels for the filament winding machines specified in 1B201.a.

1B225 Electrolytic cells for fluorine production with an output capacity greater than 250 g 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: *1B226 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 or 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 said column.

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

a. Designed for operation with internal temperatures of 35 K (-238°C) or less;
b. Designed for operation at an internal pressure of 0.5 to 5 MPa;
c. Constructed of either:
   1. Stainless steel of the 300 series with low sulphur content and with an austenitic ASTM (or equivalent standard) grain size number of 5 or greater; or
   2. Equivalent materials which are both cryogenic and H_2-compatible; 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 and 'internal contactors', as follows:

N.B.: *For columns which are specially designed or prepared for the production of heavy water see 0B004.*

a. Water-hydrogen sulphide exchange tray columns, having all of the following characteristics:
   1. Can operate at pressures of 2 MPa or greater;
   2. Constructed of carbon steel having an austenitic ASTM (or equivalent standard) grain size number of 5 or greater; and
   3. With a diameter of 1.8 m or greater;

b. 'Internal contactors' for the water-hydrogen sulphide exchange tray columns specified in 1B229.a.
Technical Note:
'Internal contactors' of the columns are segmented trays which have an effective assembled diameter of 1.8 m or greater, are designed to facilitate countercurrent contacting and are constructed of stainless steels with a carbon content of 0.03% or less. These may be sieve trays, valve trays, bubble cap trays, or turbogrid trays.

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

a. Airtight (i.e., hermetically sealed);
b. A capacity greater than 8.5 m^3/h; and
c. Either of the following characteristics:
   1. For concentrated potassium amide solutions (1% or greater), an operating pressure of 1.5 to 60 MPa; or
   2. For dilute potassium amide solutions (less than 1%), an operating pressure of 20 to 60 MPa.

1B231 Tritium facilities or plants, and equipment therefor, as follows:

a. Facilities or plants for the production, recovery, extraction, concentration, or handling of tritium;

b. Equipment for tritium facilities or plants, as follows:
   1. Hydrogen or helium refrigeration units capable of cooling to 23 K (-250°C) or less, with heat removal capacity greater than 150 W;
   2. Hydrogen isotope storage or purification systems using metal hydrides as the storage or purification medium.

1B232 Turboexpanders or turboexpander-compressor sets having both of the following characteristics:

a. Designed for operation with an outlet temperature of 35 K (-238°C) or less; and
b. Designed for a throughput of hydrogen gas of 1000 kg/h or greater.

1B233 Lithium isotope separation facilities or plants, and equipment therefor, as follows:

a. Facilities or plants for the separation of lithium isotopes;

b. Equipment for the separation of lithium isotopes, as follows:
   1. Packed liquid-liquid exchange columns specially designed for lithium amalgams;
   2. Mercury or lithium amalgam pumps;
   3. Lithium amalgam electrolysis cells;
   4. Evaporators for concentrated lithium hydroxide solution.

1C Materials

Technical Note:

Metals and alloys:
Unless provision to the contrary is made, the words 'metals' and 'alloys' in 1C001 to 1C012 cover crude and semi-fabricated forms, as follows:

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

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

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

1C001 Materials specially designed for use as absorbers of electromagnetic waves, or intrinsically conductive polymers, as follows:
N.B.: SEE ALSO 1C101.

a. Materials for absorbing frequencies exceeding 2×10^{8} Hz but less than 3×10^{12} Hz;
Note 1: 1C001.a. does not control:
a. Hair type absorbers, constructed of natural or synthetic fibres, with non-magnetic loading to provide absorption;
b. Absorbers having no magnetic loss and whose incident surface is non-planar in shape, including pyramids, cones, wedges and convoluted surfaces;
c. Planar absorbers, having all of the following characteristics:
1. Made from any of the following:
a. Plastic foam materials (flexible or non-flexible) with carbon-loading, or organic materials, including binders, providing more than 5% echo compared with metal over a bandwidth exceeding ±15% of the centre frequency of the incident energy, and not capable of withstanding temperatures exceeding 450 K (177°C); or

1C001 a. Note 1 c. 1. continued

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

Technical Note:

Absorption test samples for 1C001.a. Note: 1.c.1. should be a square at least 5 wavelengths of the centre frequency on a side and positioned in the far field of the radiating element.

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

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

d. Planar absorbers made of sintered ferrite, having:

1. A specific gravity exceeding 4.4; and

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

Note 2: Nothing in Note 1 to 1C001.a. releases magnetic materials to provide absorption when contained in paint.

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.

Technical Note:

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

1C002 Metal alloys, metal alloy powder and alloyed materials, as follows:

N.B.: SEE ALSO 1C202.

Note: 1C002 does not control metal alloys, metal alloy powder and 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 a minimum of 15 weight percent aluminium, a maximum of 38 weight percent aluminium and at least one additional alloying element ;

b. Titanium aluminides containing 10 weight percent or more aluminium and at least one additional alloying element ;

1C002 a. continued

2. Metal alloys, as follows, made from metal alloy powder or particulate material specified in 1C002.b.:

a. Nickel alloys with:
1. A stress-rupture life of 10,000 hours or longer at 923 K (650°C) at a stress of 676 MPa; or
2. A low cycle fatigue life of 10,000 cycles or more at 823 K (550° C) at a maximum stress of 1,095 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 or national equivalents;

Technical Notes:

1. *The metal alloys in 1C002.a. are those containing a higher percentage by weight of the stated metal than of any other element.*

2. *Stress-rupture life should be measured in accordance with ASTM standard E-139 or national equivalents.*

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

1C002 continued

b. Metal alloy powder or particulate material for materials specified in 1C002.a., as follows:

1. Made from any of the following composition systems:

Technical Note:
X in the following equals one or more alloying elements.

a. Nickel alloys (Ni-Al-X, Ni-X-Al) qualified for turbine engine parts or components, i.e. with less than 3 non-metallic particles (introduced during the manufacturing process) larger than 100 µm in 10^9 alloy particles;

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

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

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

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

2. Made in a controlled environment by any of the following processes:
a. "Vacuum atomisation";
b. "Gas atomisation";
c. "Rotary atomisation";
d. "Splat quenching";
e. "Melt spinning" and "comminution";
f. "Melt extraction" and "comminution"; or
g. "Mechanical alloying";

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 1C002.b.

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

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

1C003 continued

c. Amorphous or 'nanocrystalline' alloy strips, having all of the following characteristics:
   1. A composition having a minimum of 75 weight percent of iron, cobalt or nickel;
   2. A saturation magnetic induction (B_S) of 1.6 T or more; and
   3. Any of the following:
      a. A strip thickness of 0.02 mm or less; or
      b. An electrical resistivity of 2×10^{-4} ohm cm or more.

   Technical Note:
   'Nanocrystalline' materials in 1C003.c. are those materials having a crystal grain size of 50 nm or less, as determined by X-ray diffraction.

1C004 Uranium titanium alloys or tungsten alloys with a "matrix" based on iron, nickel or copper, having all of the following:

a. A density exceeding 17.5 g/cm^3;
b. An elastic limit exceeding 880 MPa;
c. An ultimate tensile strength exceeding 1,270 MPa; and
d. An elongation exceeding 8%.

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

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

1C006 Fluids and lubricating materials, as follows:

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

1. Synthetic silahydrocarbon oils, having all of the following:
Technical Note:
For the purpose of 1C006.a.1., silahydrocarbon oils contain exclusively silicon, hydrogen and carbon.
a. A flash point exceeding 477 K (204°C);
b. A pour point at 239 K (-34°C) or less;
c. A viscosity index of 75 or more; and
d. A thermal stability at 616 K (343°C); or

2. Chlorofluorocarbons, having all of the following:
Technical Note:
For the purpose of 1C006.a.2., chlorofluorocarbons contain exclusively carbon, fluorine and chlorine.
a. No flash point;
b. An autogenous ignition temperature exceeding 977 K (704°C);
c. A pour point at 219 K (-54°C) or less;
d. A viscosity index of 80 or more; and
e. A boiling point at 473 K (200°C) or higher;

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

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

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

c. Damping or flotation fluids with a purity exceeding 99.8%, containing less than 25 particles of 200 µm or larger in size per 100 ml and made from at least 85% of any of the following compounds or materials:
1. Dibromotetrafluoroethane;
2. Polychlorotrifluoroethylene (oily and waxy modifications only); or
3. Polybromotrifluoroethylene;

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

1C006 continued

Technical Note:
For the purpose of 1C006:

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

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

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

d. Thermal stability is determined by the following test procedure or national equivalents:
Twenty ml of the fluid under test is placed in a 46 ml type 317 stainless steel chamber containing one each of 12.5 mm (nominal) diameter balls of M-10 tool steel, 52100 steel and naval bronze (60% Cu, 39% Zn, 0.75% Sn);
The chamber is purged with nitrogen, sealed at atmospheric pressure and the temperature raised to and maintained at 644 ± 6 K (371 ± 6°C) for six hours;
The specimen will be considered thermally stable if, on completion of the above procedure, all of the following conditions are met:

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

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

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

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

1C007 Ceramic base materials, non-"composite" ceramic materials, ceramic-"matrix" "composite" materials and precursor materials, as follows:
N.B.: SEE ALSO 1C107.

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

b. Non-"composite" ceramic materials in crude or semi-fabricated form, composed of borides of titanium with a density of 98% or more of the theoretical density;
Note: 1C007.b. does not control abrasives.

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

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

1C007 continued

e. Precursor materials (i.e., special purpose polymeric or metallo-organic materials) for producing any phase or phases of the materials specified in 1C007.c., as follows:
1. Polydiorganosilanes (for producing silicon carbide);
2. Polysilazanes (for producing silicon nitride);
3. Polycarbosilazanes (for producing ceramics with silicon, carbon and nitrogen components);

f. Ceramic-ceramic "composite" materials with an oxide or glass "matrix" reinforced with continuous fibres from any of the following systems:
1. Al_2O_3; or
2. Si-C-N.

Note: *1C007.f. does not control "composites" containing fibres from these systems with a fibre tensile strength of less than 700 MPa at 1,273 K (1,000°C) or fibre tensile creep resistance of more than 1% creep strain at 100 MPa load and 1,273 K (1,000°C) for 100 hours.*

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 513 K (240°C) determined using the dry method described in ASTM D 3418;

Note: *1C008.a. does not control non-fusible compression moulding powders or moulded forms.*

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

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

d. Polyarylene ketones;

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

1C008 continued

f. Polybiphenylenethersulphone.

Technical Note:
The glass transition temperature (T_g) for 1C008 materials is determined using the method described in ASTM D 3418 using the dry method.

1C009 Unprocessed fluorinated compounds, as follows:

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

b. Fluorinated polyimides containing 10% by weight or more of combined fluorine;

c. Fluorinated phosphazene elastomers containing 30% by weight or more of combined fluorine.

1C010 "Fibrous or filamentary materials" which may be used in organic "matrix", metallic "matrix" or carbon "matrix" "composite" structures or laminates, as follows:
N.B.: SEE ALSO 1C210.

a. Organic "fibrous or filamentary materials", having all of the following:
1. A "specific modulus" exceeding 12.7×10^6 m; and
2. A "specific tensile strength" exceeding 23.5×10^4 m;
Note: 1C010.a. does not control polyethylene.

b. Carbon "fibrous or filamentary materials", having all of the following:
1. A "specific modulus" exceeding 12.7×10^6 m; and
2. A "specific tensile strength" exceeding 23.5×10^4 m;
Note: 1C010.b. does not control fabric made from "fibrous or filamentary materials" for the repair of aircraft structures or laminates, in which the size of individual sheets does not exceed 50 cm x 90 cm.
Technical Note:
Properties for materials described in 1C010.b. should be determined using SACMA recommended methods SRM 12 to 17, or national equivalent tow tests, such as Japanese Industrial Standard JIS-R-7601, Paragraph 6.6.2., and based on lot average.

1C010 continued

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

   Note: *1C010.c. does not control:*
   - *1. Discontinuous, multiphase, polycrystalline alumina fibres in chopped fibre or random mat form, containing 3 weight percent or more silica, with a specific modulus of less than 10 x 10^6 m;*
   - *2. Molybdenum and molybdenum alloy fibres;*
   - *3. Boron fibres;*
   - *4. Discontinuous ceramic fibres with a melting, softening, decomposition or sublimation point lower than 2,043 K (1,770°C) in an inert environment.*

d. "Fibrous or filamentary materials":
   1. Composed of any of the following:
      a. Polyetherimides specified in 1C008.a.; or
      b. Materials specified in 1C008.b. to 1C008.f.; or
   2. Composed of materials specified in 1C010.d.1.a. or 1C010.d.1.b. and "commingled" with other fibres specified in 1C010.a., 1C010.b. or 1C010.c.;

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

   1. Made from "fibrous or filamentary materials" specified in 1C010.a., 1C010.b. or 1C010.c.;

   2. Made from organic or carbon "fibrous or filamentary materials":
      a. With a "specific tensile strength" exceeding 17.7 x 10^4 m;
      b. With a "specific modulus" exceeding 10.15 x 10^6 m;
      c. Not controlled by 1C010.a. or 1C010.b.; and
      d. When impregnated with materials specified in 1C008 or 1C009.b., having a glass transition temperature (T_g) exceeding 383 K (110°C) or with phenolic or epoxy resins, having a glass transition temperature (T_g) equal to or exceeding 418 K (145°C).

   Notes: *1C010.e. does not control:*
   - *a. Epoxy resin "matrix" impregnated carbon "fibrous or filamentary materials" (prepregs) for the repair of aircraft structures or laminates, in which the size of individual sheets of prepreg does not exceed 50 cm x 90 cm;*
   - *b. Prepregs when impregnated with phenolic or epoxy resins having a glass transition temperature (T_g) less than 433 K (160°C) and a cure temperature lower than the glass transition temperature.*

   Technical Note:
   The glass transition temperature (T_g) for 1C010.e. materials is determined using the method described in ASTM D 3418 using the dry method. The glass transition temperature for phenolic and epoxy resins is determined using the method described in ASTM D 4065 at a frequency of 1Hz and a heating rate of 2 K (°C) per minute using the dry method.

1C011 Metals and compounds, as follows:
N.B.: SEE ALSO MILITARY GOODS CONTROLS and 1C111.

a. Metals in particle sizes of less than 60 μm whether spherical, atomised, spheroidal, flaked or ground, manufactured from material consisting of 99% or more of zirconium, magnesium and alloys of these;
Technical Note:
The natural content of hafnium in the zirconium (typically 2% to 7%) is counted with the zirconium.
Note: The metals or alloys listed in 1C011.a. are controlled whether or not the metals or alloys are encapsulated in aluminium, magnesium, zirconium or beryllium.

b. Boron or boron carbide of 85% purity or higher and a particle size of 60 μm or less;
Note: The metals or alloys listed in 1C011.b. are controlled whether or not the metals or alloys are encapsulated in aluminium, magnesium, zirconium or beryllium.

c. Guanidine nitrate;

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

1C012 Materials as follows:
Technical Note:
These materials are typically used for nuclear heat sources.

a. Plutonium in any form with a plutonium isotopic assay of plutonium-238 of more than 50% by weight;
Note: 1C012.a. does not control:
a. Shipments with a plutonium content of 1 g or less;
b. Shipments of 3 "effective grammes" or less when contained in a sensing component in instruments.

b. "Previously separated" neptunium-237 in any form.
Note: 1C012.b. does not control shipments with a neptunium-237 content of 1 g or less.

1C101 Materials and devices for reduced observables such as radar reflectivity, ultraviolet/infrared signatures and acoustic signatures, other than those specified in 1C001, usable in "missiles" and their subsystems.
Note 1: 1C101 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.
Note 2: 1C101 does not include coatings when specially used for the thermal control of satellites.

1C102 Resaturated pyrolized carbon-carbon materials designed for space launch vehicles specified in 9A004 or sounding rockets specified in 9A104.

1C107 Graphite and ceramic materials, other than those specified in 1C007, 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, usable for "missile" nozzles and reentry vehicle nose tips;
N.B.: See also 0C004

b. Pyrolytic or fibrous reinforced graphites, usable for "missile" nozzles and reentry vehicle nose tips;
N.B.: See also 0C004

c. Ceramic composite materials (dielectric constant less than 6 at frequencies from 100 Hz to 10,000 MHz) usable for "missile" radomes;

d. Bulk machinable silicon-carbide reinforced unfired ceramic, usable for "missile" nose tips.

1C111 Propellants and constituent chemicals for propellants, other than those specified in 1C011, as follows:

a. Propulsive substances:

1. Spherical aluminium powder, other than that specified in the Military Goods Controls, with particles of uniform diameter of less than 200 µm and an aluminium content of 97% by weight or more, if at least 10% of the total weight is made up of particles of less than 63 µm, according to ISO 2591:1988 or national equivalents;
Technical Note:
A particle size of 63 µm (ISO R-565) corresponds to 250 mesh (Tyler) or 230 mesh (ASTM standard E-11).

2. Metal fuels, other than that specified in the Military Goods Controls, in particle sizes of less than 60 µm, whether spherical, atomized, spheroidal, flaked or ground, consisting 97% by weight or more of any of the following:
a. Zirconium;
b. Beryllium;
c. Magnesium; or
d. Alloys of the metals specified by a. to c. above;
Technical Note:
The natural content of hafnium in the zirconium (typically 2% to 7%) is counted with the zirconium.

3. Liquid oxidisers, the following:
a. Dinitrogen trioxide;
b. Nitrogen dioxide/dinitrogen tetroxide;
c. Dinitrogen pentoxide;

1C111 continued

b. Polymeric substances:
   1. Carboxy-terminated polybutadiene (CTPB);
   2. Hydroxy-terminated polybutadiene (HTPB), other than that specified in the Military Goods Controls;
   3. Polybutadiene-acrylic acid (PBAA);
   4. Polybutadiene-acrylic acid-acrylonitrile (PBAN);

c. Other propellant additives and agents:
   1. SEE MILITARY GOODS CONTROLS FOR Butacene;
   2. Triethylene glycol dinitrate (TEGDN);
   3. 2-Nitrodiphenylamine;
   4. Trimethylolethane trinitrate (TMETN);
   5. Diethylene glycol dinitrate (DEGDN);
   6. Ferrocene derivatives other than those specified in the Military Goods Controls.

Note: *For propellants and constituent chemicals for propellants not specified in 1C111, see the Military Goods Controls.*

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 1,500 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.
N.B.: SEE ALSO 1C216.

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 "missile" motor components, i.e., heat shields, nozzle substrates, nozzle throats and thrust vector control surfaces.

1C118 Titanium-stabilised duplex stainless steel (Ti-DSS) having all of the following:

a. Having all of the following characteristics:
   1. Containing 17.0 - 23.0 weight percent chromium and 4.5 - 7.0 weight percent nickel;
   2. Having a titanium content of greater than 0.10 weight percent; and
   3. A ferritic-austenitic microstructure (also referred to as a two-phase microstructure) of which at least 10 percent is austenite by volume (according to ASTM E-1181-87 or national equivalents); and

b. Having any of the following forms:
   1. Ingots or bars having a size of 100 mm or more in each dimension;
   2. Sheets having a width of 600 mm or more and a thickness of 3 mm or less; or
   3. Tubes having an outer diameter of 600 mm or more and a wall thickness of 3 mm or less.

1C202 Alloys, other than those specified in 1C002.a.2.c. or d., as follows:

a. Aluminium alloys having both of the following characteristics:
   1. 'Capable of' an ultimate tensile strength of 460 MPa or more at 293 K (20°C); and
   2. In the form of tubes or cylindrical solid forms (including forgings) with an outside diameter of more than 75 mm;

b. Titanium alloys having both of the following characteristics:
   1. 'Capable of' an ultimate tensile strength of 900 MPa or more at 293 K (20°C); and
   2. In the form of tubes or cylindrical solid forms (including forgings) with an outside diameter of more than 75 mm.

Technical Note:
The phrase alloys 'capable of' encompasses alloys before or after heat treatment.

1C210 'Fibrous or filamentary materials' or prepregs, other than those specified in 1C010.a., b. or e., as follows:

a. Carbon or aramid 'fibrous or filamentary materials' having either of the following characteristics:
   1. A "specific modulus" of 12.7×10^6 m or greater; or
   2. A "specific tensile strength" of 235×10^3 m or greater;

   Note: 1C210.a. does not control aramid 'fibrous or filamentary materials' having 0.25 percent or more by weight of an ester based fibre surface modifier;

b. Glass 'fibrous or filamentary materials' having both of the following characteristics:
   1. A "specific modulus" of 3.18×10^6 m or greater; and
   2. A "specific tensile strength" of 76.2×10^3 m or greater;

c. Thermoset resin impregnated continuous "yarns", "rovings", "tows" or "tapes" with a width of 15 mm or less (prepregs), made from carbon or glass 'fibrous or filamentary materials' specified in 1C210.a. or b.
   Technical Note:
   The resin forms the matrix of the composite.

Note: In 1C210, 'fibrous or filamentary materials' is restricted to continuous "monofilaments", "yarns", "rovings", "tows" or "tapes".

1C216 Maraging steel, other than that specified in 1C116, 'capable of' an ultimate tensile strength of 2,050 MPa or more, at 293 K (20°C).

Note: *1C216 does not control forms in which all linear dimensions are 75 mm or less.*

Technical Note:

The phrase maraging steel 'capable of' encompasses maraging steel before or after heat treatment.

1C225 Boron enriched in the boron-10 (^{10}B) isotope to greater than its natural isotopic abundance, as follows: elemental boron, compounds, mixtures containing boron, manufactures thereof, waste or scrap of any of the foregoing.

Note: *In 1C225 mixtures containing boron include boron loaded materials.*

Technical Note:

The natural isotopic abundance of boron-10 is approximately 18.5 weight per cent (20 atom per cent).

1C226 Tungsten, tungsten carbide, and alloys containing more than 90% tungsten by weight, having both of the following characteristics:

a. In forms with a hollow cylindrical symmetry (including cylinder segments) with an inside diameter between 100 mm and 300 mm; and
b. A mass greater than 20 kg.

Note: *1C226 does not control manufactures specially designed as weights or gamma-ray collimators.*

1C227 Calcium having both of the following characteristics:

a. Containing less than 1,000 parts per million by weight of metallic impurities other than magnesium; and
b. Containing less than 10 parts per million by weight of boron.

1C228 Magnesium having both of the following characteristics:

a. Containing less than 200 parts per million by weight of metallic impurities other than calcium; and
b. Containing less than 10 parts per million by weight of boron.

1C229 Bismuth having both of the following characteristics:

a. A purity of 99.99% or greater by weight; and
b. Containing less than 10 parts per million by weight of silver.

1C230 Beryllium metal, alloys containing more than 50% beryllium by weight, beryllium compounds, manufactures thereof, and waste or scrap of any of the foregoing.

Note: *1C230 does not control the following:*

a. Metal windows for X-ray machines, or for bore-hole logging devices;

b. Oxide shapes in fabricated or semi-fabricated forms specially designed for electronic component parts or as substrates for electronic circuits;

c. Beryl (silicate of beryllium and aluminium) in the form of emeralds or aquamarines.

1C231 Hafnium metal, alloys containing more than 60% hafnium by weight, hafnium compounds containing more than 60% hafnium by weight, manufactures thereof, and waste or scrap of any of the foregoing.

1C232 Helium-3 (^{3}He), mixtures containing helium-3, and products or devices containing any of the foregoing.

Note: *1C232 does not control a product or device containing less than 1 g of helium-3.*

1C233 Lithium enriched in the lithium-6 (^{6}Li) isotope to greater than its natural isotopic abundance, and products or devices containing enriched lithium, as follows: elemental lithium, alloys, compounds, mixtures containing lithium, manufactures thereof, waste or scrap of any of the foregoing.

Note: *1C233 does not control thermoluminescent dosimeters.*

Technical Note:

The natural isotopic abundance of lithium-6 is approximately 6.5 weight per cent (7.5 atom per cent).

1C234 Zirconium with a hafnium content of less than 1 part hafnium to 500 parts zirconium by weight, as follows: metal, alloys containing more than 50% zirconium by weight, compounds, manufactures thereof, waste or scrap of any of the foregoing.

Note: *1C234 does not control zirconium in the form of foil having a thickness of 0.10 mm or less.*

1C235 Tritium, tritium compounds, mixtures containing tritium in which the ratio of tritium to hydrogen atoms exceeds 1 part in 1000, and products or devices containing any of the foregoing.

Note: *1C235 does not control a product or device containing less than 1.48×10^3 GBq (40 Ci) of tritium.*

1C236 Alpha-emitting radionuclides having an alpha half-life of 10 days or greater but less than 200 years, in the following forms:

a. Elemental;
b. Compounds having a total alpha activity of 37 GBq/kg (1 Ci/kg) or greater;
c. Mixtures having a total alpha activity of 37 GBq/kg (1 Ci/kg) or greater;
d. Products or devices containing any of the foregoing.

Note: *1C236 does not control a product or device containing less than 3.7 GBq (100 millicuries) of alpha activity.*

1C237 Radium-226 (^{226}Ra), radium-226 alloys, radium-226 compounds, mixtures containing radium-226, manufactures therof, and products or devices containing any of the foregoing.

Note: *1C237 does not control the following:*
a. Medical applicators;
b. A product or device containing less than 0.37 GBq (10 millicuries) of radium-226.

1C238 Chlorine trifluoride (ClF_3).

1C239 High explosives, other than those specified in the Military Goods Controls, or substances or mixtures containing more than 2% by weight thereof, with a crystal density greater than 1.8 g/cm^3 and having a detonation velocity greater than 8,000 m/s.

1C240 Nickel powder and porous nickel metal, other than those specified in 0C005, as follows:

a. Nickel powder having both of the following characteristics:
1. A nickel purity content of 99.0% or greater by weight; and
2. A mean particle size of less than 10 micrometres measured by American Society for Testing and Materials (ASTM) B330 standard;

b. Porous nickel metal produced from materials specified in 1C240.a.

Note: *1C240 does not control the following:*
a. Filamentary nickel powders;
b. Single porous nickel sheets with an area of 1,000 cm^2 per sheet or less.

Technical Note:
1C240.b. refers to porous metal formed by compacting and sintering the materials in 1C240.a. to form a metal material with fine pores interconnected throughout the structure.

1C350 Chemicals, which may be used as precursors for toxic chemical agents, as follows:
N.B.: SEE ALSO MILITARY GOODS CONTROLS AND 1C450.

1. Thiodiglycol (111-48-8);
2. Phosphorus oxychloride (10025-87-3);
3. Dimethyl methylphosphonate (756-79-6);
4. **SEE MILITARY GOODS CONTROLS FOR Methyl phosphonyl difluoride (676-99-3);**
5. Methyl phosphonyl dichloride (676-97-1);
6. Dimethyl phosphite (868-85-9);
7. Phosphorus trichloride (7719-12-2);
8. Trimethyl phosphite (121-45-9);
9. Thionyl chloride (7719-09-7);
10. 3-Hydroxy-1-methylpiperidine (3554-74-3);
11. N,N-Diisopropyl-(beta)-aminoethyl chloride (96-79-7);
12. N,N-Diisopropyl-(beta)-aminoethane thiol (5842-07-9);
13. 3-Quinuclidinol (1619-34-7);
14. Potassium fluoride (7789-23-3);
15. 2-Chloroethanol (107-07-3);
16. Dimethylamine (124-40-3);
17. Diethyl ethylphosphonate (78-38-6);
18. Diethyl-N,N-dimethylphosphoramidate (2404-03-7);
19. Diethyl phosphite (762-04-9);
20. Dimethylamine hydrochloride (506-59-2);
21. Ethyl phosphinyl dichloride (1498-40-4);
22. Ethyl phosphonyl dichloride (1066-50-8);
23. **SEE MILITARY GOODS CONTROLS FOR Ethyl phosphonyl difluoride (753-98-0);**
24. Hydrogen fluoride (7664-39-3);
25. Methyl benzilate (76-89-1);
26. Methyl phosphinyl dichloride (676-83-5);
27. N,N-Diisopropyl-(beta)-amino ethanol (96-80-0);
28. Pinacolyl alcohol (464-07-3);
29. **SEE MILITARY GOODS CONTROLS FOR o-Ethyl-2-diisopropylaminoethyl methyl phosphonite (57856-11-8);**
30. Triethyl phosphite (122-52-1);
31. Arsenic trichloride (7784-34-1);
32. Benzilic acid (76-93-7);
33. Diethyl methylphosphonite (15715-41-0);
34. Dimethyl ethylphosphonate (6163-75-3);
35. Ethyl phosphinyl difluoride (430-78-4);
36. Methyl phosphinyl difluoride (753-59-3);
37. 3-Quinuclidone (3731-38-2);
38. Phosphorus pentachloride (10026-13-8);
39. Pinacolone (75-97-8);
40. Potassium cyanide (151-50-8);
41. Potassium bifluoride (7789-29-9);
42. Ammonium hydrogen fluoride (1341-49-7);
43. Sodium fluoride (7681-49-4);
44. Sodium bifluoride (1333-83-1);
45. Sodium cyanide (143-33-9);
46. Triethanolamine (102-71-6);
47. Phosphorus pentasulphide (1314-80-3);

1C350 continued

48. Di-isopropylamine (108-18-9);
49. Diethylaminoethanol (100-37-8);
50. Sodium sulphide (1313-82-2);
51. Sulphur monochloride (10025-67-9);
52. Sulphur dichloride (10545-99-0);
53. Triethanolamine hydrochloride (637-39-8);
54. N,N-Diisopropyl-(Beta)-aminoethyl chloride hydrochloride (4261-68-1).

1C351 Human pathogens, zoonoses and "toxins", as follows:

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;
   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. Tick-borne encephalitis virus (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. Bartonella quintana (Rochalimaea quintana, 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;

1C351 c. continued

7. Francisella tularensis;
8. Burkholderia mallei (Pseudomonas mallei);
9. Burkholderia pseudomallei (Pseudomonas pseudomallei);
10. Salmonella typhi;
11. Shigella dysenteriae;
12. Vibrio cholerae;
13. Yersinia pestis;

d. "Toxins", as follows, and "sub-unit of toxins" thereof:
1. Botulinum toxins;
Note: *1C351.d.1. does not control botulinum toxins in product form meeting all of the following criteria:*
1. Are pharmaceutical formulations designed for human administration in the treatment of medical conditions;
2. Are pre-packaged for distribution as medical products;
3. Are authorised by a state authority to be marketed as medical products.
2. Clostridium perfringens toxins;
3. Conotoxin;
4. Ricin;
5. Saxitoxin;
6. Shiga toxin;
7. Staphylococcus aureus toxins;
8. Tetrodotoxin;
9. Verotoxin;
10. Microcystin (Cyanginosin);
11. Aflatoxins

Note: *1C351 does not control "vaccines" or "immunotoxins".*

1C352 Animal pathogens, as follows:

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. Defined in EC Directive 92/40/EC (O.J. L.16 23.1.92 p.19) 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 nucleotide 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;

1C352 a. continued

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. Porcine enterovirus type 9 (swine vesicular disease virus);
12. Rinderpest virus;
13. Sheep pox virus;
14. Teschen disease virus;
15. Vesicular stomatitis virus;

b. Mycoplasma mycoides, 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 Mycoplasma mycoides.

Note: *1C352 does not control "vaccines".*

1C353 Genetically-modified "microorganisms", as follows:

a. Genetically modified "microorganisms" or genetic elements that contain nucleic acid sequences associated with pathogenicity of organisms specified in 1C351.a. to c. or 1C352 or 1C354;

b. Genetically modified "microorganisms" or genetic elements that contain nucleic acid sequences coding for any of the "toxins" specified in 1C351.d. or "sub-units of toxins" thereof.

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 (Colletotrichum kahawae);
2. Cochliobolus 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).

1C450 Toxic chemicals and toxic chemical precursors, as follows:

N.B.: SEE ALSO ENTRY 1C350, 1C351.d. AND MILITARY GOODS CONTROLS.

a. Toxic chemicals, as follows:

1. Amiton: O,O-Diethyl S-[2-(diethylamino)ethyl] phosphorothiolate (78-53-5) and corresponding alkylated or protonated salts;
2. PFIB: 1,1,3,3,3-Pentafluoro-2-(trifluoromethyl)-1-propene (382-21-8);
3. **SEE MILITARY GOODS CONTROLS FOR BZ: 3-Quinuclidinyl benzilate (6581-06-2);**
4. Phosgene: Carbonyl dichloride (75-44-5);
5. Cyanogen chloride (506-77-4);
6. Hydrogen cyanide (74-90-8);
7. Chloropicrin: Trichloronitromethane (76-06-2);

b. Toxic chemical precursors, as follows:

1. Chemicals, other than those specified in the Military Goods Controls or in 1C350, containing a phosphorus atom to which is bonded one methyl, ethyl or propyl (normal or iso) group but not further carbon atoms;
   Note: *1C450.b.1 does not control Fonofos: O-Ethyl S-phenyl ethylphosphonothiolothionate (944-22-9);*
2. N,N-Dialkyl [methyl, ethyl or propyl (normal or iso)] phosphoramidic dihalides;
3. Dialkyl [methyl, ethyl or propyl (normal or iso)] N,N-dialkyl [methyl, ethyl or propyl (normal or iso)]-phosphoramidates, other than Diethyl-N,N-dimethylphosphoramidate which is specified in 1C350;
4. N,N-Dialkyl [methyl, ethyl or propyl (normal or iso)] aminoethyl-2-chlorides and corresponding protonated salts, other than N,N-Diisopropyl-(beta)-aminoethyl chloride or N,N-Diisopropyl-(beta)-aminoethyl chloride hydrochloride which are specified in 1C350;
5. N,N-Dialkyl [methyl, ethyl or propyl (normal or iso)] aminoethane-2-ols and corresponding protonated salts, other than N,N-Diisopropyl-(beta)-aminoethanol (96-80-0) and N,N-Diethylaminoethanol (100-37-8) which are specified in 1C350;
   Note: *1C450.b.5. does not control the following:*
   a. *N,N-Dimethylaminoethanol (108-01-0) and corresponding protonated salts;*
   b. *Protonated salts of N,N-Diethylaminoethanol (100-37-8);*
6. N,N-Dialkyl [methyl, ethyl or propyl (normal or iso)] aminoethane-2-thiols and corresponding protonated salts, other than N,N-Diisopropyl-(beta)-aminoethane thiol which is specified in 1C350;
7. Ethyldiethanolamine (139-87-7);
8. Methyldiethanolamine (105-59-9).

1D **Software**

1D001 "Software" specially designed or modified for the "development", "production" or "use" of equipment specified in 1B001 to 1B003.

1D002 "Software" for the "development" of organic "matrix", metal "matrix" or carbon "matrix" laminates or "composites".

1D101 "Software" specially designed or modified for the "use" of goods specified in 1B101, 1B102, 1B115, 1B117, 1B118 or 1B119.

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 1B201.

1E **Technology**

1E001 "Technology" according to the General Technology Note for the "development" or "production" of equipment or materials specified in 1A001.b., 1A001.c., 1A002 to 1A005, 1B or 1C.

1E002 Other "technology", as follows:

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

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

1E002 continued

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

1. Base materials having all of the following characteristics:
   a. Any of the following compositions:
      1. Single or complex oxides of zirconium and complex oxides of silicon or aluminium;
      2. Single nitrides of boron (cubic crystalline forms);
      3. Single or complex carbides of silicon or boron; or
      4. Single or complex nitrides of silicon;
   b. Total metallic impurities, excluding intentional additions, of less than:
      1. 1,000 ppm for single oxides or carbides; or
      2. 5,000 ppm for complex compounds or single nitrides; and
   c. Being any of the following:
      1. Zirconia with an average particle size equal to or less than 1 μm and no more than 10% of the particles larger than 5 μm;
      2. Other base materials with an average particle size equal to or less than 5 μm and no more than 10% of the particles larger than 10 μm; or
      3. Having all of the following:
         a. Platelets with a length to thickness ratio exceeding 5;
         b. Whiskers with a length to diameter ratio exceeding 10 for diameters less than 2 μm; and
         c. Continuous or chopped fibres less than 10 μm in diameter;

2. Non-"composite" ceramic materials composed of the materials described in 1E002.c.1;
   Note: *1E002.c.2. does not control "technology" for the design or production of abrasives.*

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

e. "Technology" for the installation, maintenance or repair of materials specified in 1C001;

f. "Technology" for the repair of "composite" structures, laminates or materials specified in 1A002, 1C007.c. or 1C007.d.
   Note: *1E002.f. does not control "technology" for the repair of "civil aircraft" structures using carbon "fibrous or filamentary materials" and epoxy resins, contained in aircraft manufacturers' manuals.*

1E101 "Technology" according to the General Technology Note for the "use" of goods specified in 1A102, 1B001, 1B101, 1B115, 1B116, 1C001, 1C101, 1C107, 1C111 to 1C117, 1D101 or 1D103.

1E102 "Technology" according to the General Technology Note for the"development" of "software" specified in 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 pyrolytically 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: *1E104 includes "technology" for the composition of precursor gases, flow-rates and process control schedules and parameters.*

1E201 "Technology" according to the General Technology Note for the "use" of goods specified in 1A002, 1A202, 1A225 to 1A227, 1B201, 1B225 to 1B233, 1C002.a.2.c. or d., 1C010.b., 1C202, 1C210, 1C216, 1C225 to 1C240 or 1D201.

1E202 "Technology" according to the General Technology Note for the"development" or "production" of goods specified in 1A202 or 1A225 to 1A227.

1E203 "Technology" according to the General Technology Note for the"development" of "software" specified in 1D201.

CATEGORY 2 - MATERIALS PROCESSING

2A Systems, Equipment and Components

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

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

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

a. Ball bearings and solid roller bearings having tolerances specified by the manufacturer in accordance with ABEC 7, ABEC 7P, ABEC 7T or ISO Standard Class 4 or better (or national equivalents), and having rings, balls or rollers made from monel or beryllium;
Note: 2A001.a. does not control tapered roller bearings.

b. Other ball bearings and solid roller bearings having tolerances specified by the manufacturer in accordance with ABEC 9, ABEC 9P or ISO Standard Class 2 or better (or national equivalents);
Note: 2A001.b. does not control tapered roller bearings.

c. Active magnetic bearing systems using any of the following:
1. Materials with flux densities of 2.0 T or greater and yield strengths greater than 414 MPa;
2. All-electromagnetic 3D homopolar bias designs for actuators; or
3. High temperature (450 K (177°C) and above) position sensors.

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

a. Crucibles having both of the following characteristics:
1. A volume of between 150 cm^3 and 8,000 cm^3; and
2. Made of or coated with any of the following materials, having a purity of 98% or greater by weight:
a. Calcium fluoride (CaF_2);
b. Calcium zirconate (metazirconate) ($CaZrO_3$);
c. Cerium sulphide (Ce_2S_3);
d. Erbium oxide (erbia) (Er_2O_3);
e. Hafnium oxide (hafnia) (HfO_2);
f. Magnesium oxide (MgO);
g. Nitrided niobium-titanium-tungsten alloy (approximately 50% Nb, 30% Ti, 20% W);
h. Yttrium oxide (yttria) (Y_2O_3); or
i. Zirconium oxide (zirconia) (ZrO_2);

b. Crucibles having both of the following characteristics:
1. A volume of between 50 cm^3 and 2,000 cm^3; and
2. Made of or lined with tantalum, having a purity of 99.9% or greater by weight;

2A225 continued

c. Crucibles having all of the following characteristics:
   1. A volume of between 50 cm^3 and 2,000 cm^3;
   2. Made of or lined with tantalum, having a purity of 98% or greater by weight; and
   3. Coated with tantalum carbide, nitride, boride, or any combination thereof.

2A226 Valves having all of the following characteristics:

a. A 'nominal size' of 5 mm or greater;
b. Having a bellows seal; and
c. Wholly made of or lined with aluminium, aluminium alloy, nickel, or nickel alloy containing more than 60% nickel by weight.

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

2B Test, Inspection and Production Equipment

Technical Notes:

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

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

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

4. *Stated positioning accuracy levels derived from measurements made according to ISO 230/2 (1988)[1] or national equivalents may be used for each machine tool model instead of individual machine tests. Stated positioning accuracy means the accuracy value provided to the competent authorities of the Member State in which the exporter is established as representative of the accuracy of a machine model.*

   Determination of Stated Values

   a. *Select five machines of a model to be evaluated;*
   b. *Measure the linear axis accuracies according to ISO 230/2 (1988)[1] ;*

[1] Manufacturers calculating positioning accuracy in accordance with ISO 230/2 (1997) should consult the competent authorities of the Member State in which they are established.

2B Determination of Stated Values continued

c. Determine the A-values for each axis of each machine. The method of calculating the A-value is described in the ISO standard;

d. Determine the mean value of the A-value of each axis. This mean value Â becomes the stated value of each axis for the model (Âx Ây...);

e. Since the Category 2 list refers to each linear axis there will be as many stated values as there are linear axes;

f. If any axis of a machine model not controlled by 2B001.a. to 2B001.c. or 2B201 has a stated accuracy Â of 6 microns for grinding machines and 8 microns for milling and turning machines or better, the manufacturer should be required to reaffirm the accuracy level once every eighteen months.

2B001 Machine tools, as follows, and any combination thereof, for removing (or cutting) metals, ceramics or "composites", which, according to the manufacturer's technical specification, can be equipped with electronic devices for "numerical control":
N.B.: SEE ALSO 2B201.

a. Machine tools for turning, having all of the following characteristics:
   1. Positioning accuracy with "all compensations available" equal to or less (better) than 6 μm according to ISO 230/2 (1988)[2] or national equivalents along any linear axis ; and
   2. Two or more axes which can be coordinated simultaneously for "contouring control";

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

b. Machine tools for milling, having any of the following characteristics:
   1. a. Positioning accuracy with "all compensations available" equal to or less (better) than 6 μm according to ISO 230/2 (1988)[2] or national equivalents along any linear axis; and
      b. Three linear axes plus one rotary axis which can be coordinated simultaneously for "contouring control";
   2. Five or more axes which can be coordinated simultaneously for "contouring control"; or
   3. A positioning accuracy for jig boring machines, with "all compensations available", equal to or less (better) than 4 μm according to ISO 230/2 (1988)[2] or national equivalents along any linear axis;

[2] Manufacturers calculating positioning accuracy in accordance with ISO 230/2 (1997) should consult the competent authorities of the Member State in which they are established.

2B001 continued

c. Machine tools for grinding, having any of the following characteristics:
   1. a. Positioning accuracy with "all compensations available" equal to or less (better) than 4 µm according to ISO 230/2 (1988)[3] or national equivalents along any linear axis; and
      b. Three or more axes which can be coordinated simultaneously for "contouring control"; or
   2. Five or more axes which can be coordinated simultaneously for "contouring control";

   Note: 2B001.c. does not control grinding machines, as follows:
   1. Cylindrical external, internal, and external-internal grinding machines having all the following characteristics:
      a. Limited to cylindrical grinding; and
      b. Limited to a maximum workpiece capacity of 150 mm outside diameter or length.
   2. Machines designed specifically as jig grinders having any of the following characteristics:
      a. The c-axis is used to maintain the grinding wheel normal to the work surface; or
      b. The a-axis is configured to grind barrel cams.
   3. Tool or cutter grinding machines limited to the production of tools or cutters.
   4. Crank shaft or cam shaft grinding machines.
   5. Surface grinders.

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

e. Machine tools for removing metals, ceramics or "composites":
   1. By means of:
      a. Water or other liquid jets, including those employing abrasive additives;
      b. Electron beam; or
      c. "Laser" beam; and
   2. Having two or more rotary axes which:
      a. Can be coordinated simultaneously for "contouring control"; and
      b. Have a positioning accuracy of less (better) than 0.003°;

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

2B003 "Numerically controlled" or manual machine tools, and specially designed components, controls and accessories therefor, specially designed for the shaving, finishing, grinding or honing of hardened (R_C = 40 or more) spur, helical and double-helical gears with a pitch diameter exceeding 1,250 mm and a face width of 15% of pitch diameter or larger finished to a quality of AGMA 14 or better (equivalent to ISO 1328 class 3).

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[3] Manufacturers calculating positioning accuracy in accordance with ISO 230/2 (1997) should consult the competent authorities of the Member State in which they are established.

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

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

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

b. Any of the following:

1. A maximum working pressure exceeding 207 MPa;
2. A controlled thermal environment exceeding 1,773 K (1,500°C); or
3. A facility for hydrocarbon impregnation and removal of resultant gaseous degradation products.

Technical Note:

The inside chamber dimension is that of the chamber in which both the working temperature and the working pressure are achieved and does not include fixtures. That dimension will be the smaller of either the inside diameter of the pressure chamber or the inside diameter of the insulated furnace chamber, depending on which of the two chambers is located inside the other.

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

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

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

N.B.: SEE ALSO 2B105.

1. Process modified for one of the following:
   a. Pulsating CVD;
   b. Controlled nucleation thermal deposition (CNTD); or
   c. Plasma enhanced or plasma assisted CVD; and
2. Any of the following:
   a. Incorporating high vacuum (equal to or less than 0.01 Pa) rotating seals; or
   b. Incorporating *in situ* coating thickness control;

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

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

1. A liquid pool level "laser" control system which regulates precisely the ingots feed rate; or
2. A computer controlled rate monitor operating on the principle of photo-luminescence of the ionised atoms in the evaporant stream to control the deposition rate of a coating containing two or more elements;

2B005 continued

d. "Stored programme controlled" plasma spraying production equipment having any of the following characteristics:
   1. Operating at reduced pressure controlled atmosphere (equal to or less than 10 kPa measured above and within 300 mm of the gun nozzle exit) in a vacuum chamber capable of evacuation down to 0.01 Pa prior to the spraying process; or
   2. Incorporating *in situ* coating thickness control;

e. "Stored programme controlled" sputter deposition production equipment capable of current densities of 0.1 mA/mm^2 or higher at a deposition rate of 15 µm/h or more;

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

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

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

2B006 Dimensional inspection or measuring systems and equipment, as follows:

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

N.B.: SEE ALSO 2B206.

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

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

      c. Measuring systems having all of the following:
         1. Containing a "laser"; and

2B006 b. 1. c. continued

2. Maintaining, for at least 12 hours, over a temperature range of ±1 K around a standard temperature and at a standard pressure, all of the following:
   a. A "resolution" over their full scale of 0.1 µm or less (better); and
   b. A "measurement uncertainty" equal to or less (better) than (0.2 + L/2,000) µm (L is the measured length in mm);

Note: *2B006.b.1. does not control measuring interferometer systems, without closed or open loop feedback, containing a "laser" to measure slide movement errors of machine-tools, dimensional inspection machines or similar equipment.*

2. Angular measuring instruments having an "angular position deviation" equal to or less (better) than 0.00025°;
   Note: *2B006.b.2. does not control optical instruments, such as autocollimators, using collimated light to detect angular displacement of a mirror.*

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

Note 1: *Machine tools which can be used as measuring machines are controlled if they meet or exceed the criteria specified for the machine tool function or the measuring machine function.*

Note 2: *A machine described in 2B006 is controlled if it exceeds the control threshold anywhere within its operating range.*

2B007 "Robots" having any of the following characteristics and specially designed controllers and "end-effectors" therefor:
N.B.: **SEE ALSO 2B207.**

a. Capable in real time of full three-dimensional image processing or full three-dimensional 'scene analysis' to generate or modify "programmes" or to generate or modify numerical programme data;
Technical Note:
The 'scene analysis' limitation does not include approximation of the third dimension by viewing at a given angle, or limited grey scale interpretation for the perception of depth or texture for the approved tasks (2 1/2 D).

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

c. Specially designed or rated as radiation-hardened to withstand a total radiation dose greater than 5×10^3 Gy (silicon) without operational degradation; or
Technical Note:
The term Gy(silicon) refers to the energy in Joules per kilogram absorbed by an unshielded silicon sample when exposed to ionising radiation.

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

2B008 Assemblies, units or inserts specially designed for machine tools or for equipment specified in 2B006 or 2B007, as follows:

a. Linear position feedback units (e.g., inductive type devices, graduated scales, infrared systems or "laser" systems) having an overall "accuracy" less (better) than $(800 + (600 \times L \times 10^{-3}))$ nm (L equals the effective length in mm);
N.B.: For "laser" systems see also Note to 2B006.b.1.

b. Rotary position feedback units (e.g., inductive type devices, graduated scales, infrared systems or "laser" systems) having an "accuracy" less (better) than 0.00025°;
N.B.: For "laser" systems see also Note to 2B006.b.1.

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

2B009 Spin-forming machines and flow-forming machines, which, according to the manufacturer's technical specification, can be equipped with "numerical control" units or a computer control and having all of the following:
N.B.: SEE ALSO 2B109 AND 2B209.

a. Two or more controlled axes of which at least two can be coordinated simultaneously for "contouring control"; and
b. A roller force more than 60 kN.

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

2B104 "Isostatic presses", other than those specified in 2B004, having all of the following:
N.B.: SEE ALSO 2B204.

a. Maximum working pressure of 69 MPa or greater;
b. Designed to achieve and maintain a controlled thermal environment of 873 K (600°C) or greater; and
c. Possessing a chamber cavity with an inside diameter of 254 mm or greater.

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

2B109 Flow-forming machines, other than those specified in 2B009, and specially designed components as follows:

N.B.: SEE ALSO 2B209.

a. Flow-forming machines having all of the following:
   1. 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
   2. With more than two axes which can be coordinated simultaneously for "contouring control".

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

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

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

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

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

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

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

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

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

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

2B119 Balancing machines and related equipment, as follows:
N.B.: SEE ALSO 2B219.

a. Balancing machines having all the following characteristics:
1. Not capable of balancing rotors/assemblies having a mass greater than 3 kg;
2. Capable of balancing rotors/assemblies at speeds greater than 12,500 rpm;
3. Capable of correcting unbalance in two planes or more; and
4. Capable of balancing to a residual specific unbalance of 0.2 g mm per kg of rotor mass;

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

b. Indicator heads designed or modified for use with machines specified in 2B119.a.
Technical Note:
Indicator heads are sometimes known as balancing instrumentation.

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

a. Two axes or more;

b. Slip rings capable of transmitting electrical power and/or signal information; and

c. Having any of the following characteristics:
1. For any single axis having all of the following:
a. Capable of rates of 400 degrees/s or more, or 30 degrees/s or less; and
b. A rate resolution equal to or less than 6 degrees/s and an accuracy equal to or less than 0.6 degrees/s;
2. Having a worst-case rate stability equal to or better (less) than plus or minus 0.05 % averaged over 10 degrees or more; or
3. A positioning accuracy equal to or better than 5 arc second.

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

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

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

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

2B122 Centrifuges capable of imparting accelerations above 100 g and having slip rings capable of transmitting electrical power and signal information.

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

a. Machine tools for milling, having any of the following characteristics:
   1. Positioning accuracies with "all compensations available" equal to or less (better) than 6 µm according to ISO 230/2 (1988)[4] or national equivalents along any linear axis; or
   2. Two or more contouring rotary axes;

   Note: *2B201.a. does not control milling machines having the following characteristics:*
   - *a. X-axis travel greater than 2 m; and*
   - *b. Overall positioning accuracy on the x-axis more (worse) than 30 µm.*

b. Machine tools for grinding, having any of the following characteristics:
   1. Positioning accuracies with "all compensations available" equal to or less (better) than 4 µm according to ISO 230/2 (1988)[4] or national equivalents along any linear axis; or
   2. Two or more contouring rotary axes.

   Note: *2B201.b. does not control the following grinding machines:*
   - *a. Cylindrical external, internal, and external-internal grinding machines having all of the following characteristics:*
     - *1. Limited to cylindrical grinding;*
     - *2. A maximum workpiece outside diameter or length of 150 mm;*
     - *3. Not more than two axes that can be coordinated simultaneously for "contouring control"; and*
     - *4. No contouring c axis;*
   - *b. Jig grinders with axes limited to x, y, c and a where c axis is used to maintain the grinding wheel normal to the work surface, and the a axis is configured to grind barrel cams;*
   - *c. Tool or cutter grinding machines with "software" specially designed for the production of tools or cutters; or*
   - *d. Crankshaft or camshaft grinding machines.*

[4] Manufacturers calculating positioning accuracy in accordance with ISO 230/2 (1997) should consult the competent authorities of the Member State in which they are established.

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

a. "Isostatic presses" having both of the following characteristics:
   1. Capable of achieving a maximum working pressure of 69 MPa or greater; and
   2. A chamber cavity with an inside diameter in excess of 152 mm;

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

Technical Note:
In 2B204 the inside chamber dimension is that of the chamber in which both the working temperature and the working pressure are achieved and does not include fixtures. That dimension will be the smaller of either the inside diameter of the pressure chamber or the inside diameter of the insulated furnace chamber, depending on which of the two chambers is located inside the other.

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

a. Computer controlled or numericaly 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/1000) µm tested with a probe of an "accuracy" of less (better) than 0.2 µm (L is the measured length in millimeters) (Ref.:VDI/VDE 2617 Parts 1 and 2);

b. Systems for simultaneously linear-angular inspection of hemishells, having both of the following characteristics:
   1. "Measurement uncertainty" along any linear axis equal to or less (better) than 3.5 µm per 5 mm; and
   2. "Angular position deviation" equal to or less than 0.02°.

Note 1: *Machine tools that can be used as measuring machines are controlled if they meet or exceed the criteria specified for the machine tool function or the measuring machine function.*
Note 2: *A machine specified in 2B206 is controlled if it exceeds the control threshold anywhere within its operating range.*
Technical Notes:
1. *The probe used in determining the measurement uncertainty of a dimensional inspection system shall be described in VDI/VDE 2617 parts 2, 3 and 4.*
2. *All parameters of measurement values in 2B206 represent plus/minus i.e., not total band.*

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

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

2B207 continued

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

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

a. Machines having both of the following characteristics:
   1. Three or more rollers (active or guiding); and
   2. Which, according to the manufacturer's technical specification, can be equipped with "numerical control" units or a computer control;

b. Rotor-forming mandrels designed to form cylindrical rotors of inside diameter between 75 mm and 400 mm.

Note: *2B209.a. includes machines which have only a single roller designed to deform metal plus two auxiliary rollers which support the mandrel, but do not participate directly in the deformation process.*

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

a. Centrifugal balancing machines designed for balancing flexible rotors having a length of 600 mm or more and having all of the following characteristics:
   1. Swing or journal diameter greater than 75 mm;
   2. Mass capability of from 0.9 to 23 kg ; and
   3. Capable of balancing speed of revolution greater than 5,000 r.p.m.;

b. Centrifugal balancing machines designed for balancing hollow cylindrical rotor components and having all of the following characteristics:
   1. Journal diameter greater than 75 mm;
   2. Mass capability of from 0.9 to 23 kg;
   3. Capable of balancing to a residual imbalance equal to or less than 0.01 kg x mm/kg per plane; and
   4. Belt drive type.

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

a. A capability of penetrating 0.6 m or more of hot cell wall (through-the-wall operation); or

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

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

2B226 Controlled atmosphere (vacuum or inert gas) induction furnaces, and power supplies therefor, as follows:

N.B: SEE ALSO 3B.

a. Furnaces having all of the following characteristics:
   1. Capable of operation above 1,123 K (850°C);
   2. Induction coils 600 mm or less in diameter; and
   3. Designed for power inputs of 5 kW or more;

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

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

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

a. Arc remelt and casting furnaces having both of the following characteristics:
   1. Consumable electrode capacities between 1,000 cm^3 and 20,000 cm^3, and
   2. Capable of operating with melting temperatures above 1,973 K (1,700°C);

b. Electron beam melting furnaces and plasma atomization and melting furnaces, having both of the following characteristics:
   1. A power of 50 kW or greater; and
   2. Capable of operating with melting temperatures above 1,473 K (1,200°C).

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

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

a. Rotor assembly equipment for assembly of gas centrifuge rotor tube sections, baffles, and end caps;
   Note: *2B228.a. includes precision mandrels, clamps, and shrink fit machines.*

b. Rotor straightening equipment for alignment of gas centrifuge rotor tube sections to a common axis;
   Technical Note:
   In 2B228.b. such equipment normally consists of precision measuring probes linked to a computer that subsequently controls the action of, for example, pneumatic rams used for aligning the rotor tube sections.

c. Bellows-forming mandrels and dies for producing single-convolution bellows.
   Technical Note:
   In 2B228.c. the bellows have all of the following characteristics:
   1. *Inside diameter between 75 mm and 400 mm;*
   2. *Length equal to or greater than 12.7 mm;*
   3. *Single convolution depth greater than 2 mm; and*
   4. *Made of high-strength aluminium alloys, maraging steel or high strength "fibrous or filamentary materials".*

2B230 "Pressure transducers" capable of measuring absolute pressures at any point in the range 0 to 13 kPa and having both of the following characteristics:

a. Pressure sensing elements made of or protected by aluminium, aluminium alloy, nickel or nickel alloy with more than 60% nickel by weight; and

b. Having either of the following characteristics:
   1. A full scale of less than 13 kPa and an 'accuracy' of better than ± 1% of full-scale; or
   2. A full scale of 13 kPa or greater and an 'accuracy' of better than ± 130 Pa.

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

2B231 Vacuum pumps having all of the following characteristics:

a. Input throat size equal to or greater than 380 mm;
b. Pumping speed equal to or greater than 15 m^3/s; and
c. Capable of producing an ultimate vacuum better than 13 mPa.

Technical Notes:
1. *The pumping speed is determined at the measurement point with nitrogen gas or air.*
2. *The ultimate vacuum is determined at the input of the pump with the input of the pump blocked off.*

2B232 Multistage light gas guns or other high-velocity gun systems (coil, electromagnetic, and electrothermal types, and 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;

2B350 b. continued

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;

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;
8. Zirconium or zirconium alloys;
9. Silicon carbide; or
10. Titanium carbide;

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;

2B350 continued

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 1,273 K (1,000°C), in which all surfaces in the waste supply system that come into direct contact with the waste products are made from or lined with any of the following materials:
1. Alloys with more than 25% nickel and 20% chromium by weight;
2. Ceramics; or
3. Nickel or alloys with more than 40% nickel by weight.

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 or chemicals specified in 1C350, at concentrations of less than 0.3 mg/m^3; or

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

2B352 Equipment capable of use in handling biological materials, as follows:

a. Complete biological containment facilities at P3, P4 containment level;
Technical Note:
P3 or P4 (BL3, BL4, L3, L4) containment levels are as specified in the WHO Laboratory Biosafety manual (Geneva, 1983).

b. Fermenters capable of cultivation of pathogenic "microorganisms", viruses or capable of toxin production, without the propagation of aerosols, and having a total capacity of 100 litres or more;
Technical Note:
Fermenters include bioreactors, chemostats and continuous-flow systems.

c. Centrifugal separators, capable of continuous separation without the propagation of aerosols, having all the following characteristics:
1. Flow rate exceeding 100 litres per hour;
2. Components of polished stainless steel or titanium;
3. Double or multiple sealing joints within the steam containment area; and
4. Capable of in-situ steam sterilisation in a closed state;
Technical Note:
Centrifugal separators include decanters.

d. Cross (tangential) flow filtration equipment, capable of continuous separation without the propagation of aerosols, having both of the following characteristics:
1. Equal to or greater than 5 m^2; 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. Equipment that incorporates or is contained in P3 or P4 containment housing, as follows:
1. Independently ventilated protective full or half suits;
2. Class III biological safety cabinets or isolators with similar performance standards;
Note: *In 2B352.f.2., isolators include flexible isolators, dry boxes, anaerobic chambers, glove boxes and laminar flow hoods.*

g. Chambers designed for aerosol challenge testing with "microorganisms" or "toxins" and having a capacity of 1 m^3 or greater.

2C Materials

None.

2D Software

2D001 "Software", other than that specified in 2D002, specially designed or modified for the "development", "production" or "use" of equipment specified in 2A001or 2B001 to 2B009.

2D002 "Software" for electronic devices, even when residing in an electronic device or system, enabling such devices or systems to function as a "numerical control" unit, capable of any of the following:

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

b. "Real time processing" of data to modify tool path, feed rate and spindle data, during the machining operation, by any of the following:
   1. Automatic calculation and modification of part program data for machining in two or more axes by means of measuring cycles and access to source data; or
   2. "Adaptive control" with more than one physical variable measured and processed by means of a computing model (strategy) to change one or more machining instructions to optimize the process.

Note: *2D002 does not control "software" specially designed or modified for the operation of machine tools not controlled by Category 2.*

2D101 "Software" specially designed or modified for the "use" of equipment specified in 2B104, 2B105, 2B109, 2B116, 2B117 or 2B119 to 2B122.
N.B.: SEE ALSO 9D004.

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

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

2E Technology

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

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

2E003 Other "technology", as follows:

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

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

1. "Technology" for the design of tools, dies or fixtures specially designed for any of the following processes:
   a. "Superplastic forming";
   b. "Diffusion bonding"; or
   c. "Direct-acting hydraulic pressing";

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

   a. "Superplastic forming" of aluminium alloys, titanium alloys or "superalloys":
      1. Surface preparation;
      2. Strain rate;
      3. Temperature;
      4. Pressure;

   b. "Diffusion bonding" of "superalloys" or titanium alloys:
      1. Surface preparation;
      2. Temperature;
      3. Pressure;

   c. "Direct-acting hydraulic pressing" of aluminium alloys or titanium alloys:
      1. Pressure;
      2. Cycle time;

   d. "Hot isostatic densification" of titanium alloys, aluminium alloys or "superalloys":
      1. Temperature;
      2. Pressure;
      3. Cycle time;

2E003 continued

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

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

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

f. "Technology" for the application of inorganic overlay coatings or inorganic surface modification coatings (specified in column 3 of the following table) to non-electronic substrates (specified in column 2 of the following table), by processes specified in column 1 of the following table and defined in the Technical Note.
Note: *The table and Technical Note appear after entry 2E301.*

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

2E201 "Technology" according to the General Technology Note for the "use" of equipment or "software" specified in 2A225, 2A226, 2B001, 2B006, 2B007.b., 2B007.c., 2B008, 2B009, 2B201, 2B204, 2B206, 2B207, 2B209, 2B225 to 2B232, 2D201 or 2D202.

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

TABLE - DEPOSITION TECHNIQUES

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

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

TABLE - DEPOSITION TECHNIQUES

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

TABLE - DEPOSITION TECHNIQUES

1. Coating Process (1)	2. Substrate	3. Resultant Coating
B.2. Ion assisted resistive heating Physical Vapour Deposition (PVD) (Ion Plating)	Ceramics (19) and Low-expansion glasses (14)	Dielectric layers (15) Diamond-like carbon (17)
	Carbon-carbon, Ceramic and Metal "matrix" "composites"	Dielectric layers (15)
	Cemented tungsten carbide (16), Silicon carbide	Dielectric layers (15)
	Molybdenum and Molybdenum alloys	Dielectric layers (15)
	Beryllium and Beryllium alloys	Dielectric layers (15)
	Sensor window materials (9)	Dielectric layers (15) Diamond-like carbon (17)
B.3. Physical Vapour Deposition (PVD): "Laser" Vaporization	Ceramics (19) and Low-expansion glasses (14)	Silicides Dielectric layers (15) Diamond-like carbon (17)
	Carbon-carbon, Ceramic and Metal "matrix" "composites"	Dielectric layers (15)
	Cemented tungsten carbide (16), Silicon carbide	Dielectric layers (15)
	Molybdenum and Molybdenum alloys	Dielectric layers (15)
	Beryllium and Beryllium alloys	Dielectric layers (15)
	Sensor window materials (9)	Dielectric layers (15) Diamond-like carbon

TABLE - DEPOSITION TECHNIQUES

1. Coating Process (1)	2. Substrate	3. Resultant Coating
B.4. Physical Vapour Deposition (PVD): Cathodic Arc Discharge	"Superalloys"	Alloyed silicides Alloyed aluminides (2) MCrAlX (5)
	Polymers (11) and Organic "matrix" "composites"	Borides Carbides Nitrides Diamond-like carbon (17)
C. Pack cementation (see A above for out-of-pack cementation) (10)	Carbon-carbon, Ceramic and Metal "matrix" "composites"	Silicides Carbides Mixtures thereof (4)
	Titanium alloys (13)	Silicides Aluminides Alloyed aluminides (2)
	Refractory metals and alloys (8)	Silicides Oxides
D. Plasma spraying	"Superalloys"	MCrAlX (5) Modified zirconia (12) Mixtures thereof (4) Abradable Nickel-Graphite Abradable materials containing Ni-Cr-Al Abradable Al-Si-Polyester Alloyed aluminides (2)
	Aluminium alloys (6)	MCrAlX (5) Modified zirconia (12) Silicides Mixtures thereof (4)
	Refractory metals and alloys (8)	Aluminides Silicides Carbides

TABLE - DEPOSITION TECHNIQUES

1. Coating Process (1)	2. Substrate	3. Resultant Coating
D. (continued)	Corrosion resistant steel (7)	MCrAlX (5) Modified zirconia (12) Mixtures thereof (4)
	Titanium alloys (13)	Carbides Aluminides Silicides Alloyed aluminides (2) Abradable Nickel-Graphite Abradable materials containing Ni-Cr-Al Abradable Al-Si-Polyester
E. Slurry Deposition	Refractory metals and alloys (8)	Fused silicides Fused aluminides except for resistance heating elements
	Carbon-carbon, Ceramic and Metal "matrix" "composites"	Silicides Carbides Mixtures thereof (4)
F. Sputter Deposition	"Superalloys"	Alloyed silicides Alloyed aluminides (2) Noble metal modified aluminides (3) MCrAlX (5) Modified zirconia (12) Platinum Mixtures thereof (4)
	Ceramics and Low-expansion glasses (14)	Silicides Platinum Mixtures thereof (4) Dielectic layers (15) Diamond-like carbon (17)

TABLE - DEPOSITION TECHNIQUES

1. Coating Process (1)	2. Substrate	3. Resultant Coating
F. (continued)	Titanium alloys (13)	Borides Nitrides Oxides Silicides Aluminides Alloyed aluminides (2) Carbides
	Carbon-carbon, Ceramic and Metal "matrix" "composites"	Silicides Carbides Refractory metals Mixtures thereof (4) Dielectric layers (15) Boron nitride
	Cemented tungsten carbide (16), Silicon carbide (18)	Carbides Tungsten Mixtures thereof (4) Dielectric layers (15) Boron nitride
	Molybdenum and Molybdenum alloys	Dielectric layers (15)
	Beryllium and Beryllium alloys	Borides Dielectric layers (15) Beryllium
	Sensor window materials (9)	Dielectric layers (15) Diamond-like carbon (17)
	Refractory metals and alloys (8)	Aluminides Silicides Oxides Carbides

TABLE - DEPOSITION TECHNIQUES

1. Coating Process (1)	2. Substrate	3. Resultant Coating
G. Ion Implantation	High temperature bearing steels	Additions of Chromium Tantalum or Niobium (Columbium)
	Titanium alloys (13)	Borides Nitrides
	Beryllium and Beryllium alloys	Borides
	Cemented tungsten carbide (16)	Carbides Nitrides

TABLE - DEPOSITION TECHNIQUES – NOTES

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

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

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

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

5. 'MCrAlX' refers to a coating alloy where M equals cobalt, iron, nickel or combinations thereof and X equals hafnium, yttrium, silicon, tantalum in any amount or other intentional additions over 0.01 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 to1.1 weight percent of yttrium.

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

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

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

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

10. "Technology" for single-step pack cementation of solid airfoils is not controlled by Category 2.

TABLE - DEPOSITION TECHNIQUES - NOTES

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

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

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

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

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

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

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

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

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

TABLE - DEPOSITION TECHNIQUES - TECHNICAL NOTE

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

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

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

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

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

b. Thermal Evaporation-Physical Vapour Deposition (TE-PVD) is an overlay coating process conducted in a vacuum with a pressure less than 0.1 Pa wherein a source of thermal energy is used to vaporize the coating material. This process results in the condensation, or deposition, of the evaporated species onto appropriately positioned substrates.

The addition of gases to the vacuum chamber during the coating process to synthesize compound coatings is an ordinary modification of the process.

The use of ion or electron beams, or plasma, to activate or assist the coating's deposition is also a common modification in this technique. The use of monitors to provide in-process measurement of optical characteristics and thickness of coatings can be a feature of these processes.

Specific TE-PVD processes are as follows:

1. Electron Beam PVD uses an electron beam to heat and evaporate the material which forms the coating;
2. Ion Assisted Resistive Heating PVD employs electrically resistive heating sources in combination with impinging ion beam(s) to produce a controlled and uniform flux of evaporated coating species;
3. "Laser" Vaporization uses either pulsed or continuous wave "laser" beams to vaporize the material which forms the coating;

TABLE - DEPOSITION TECHNIQUES - TECHNICAL NOTE

Processes specified in Column 1 of the Table - continued:

b. 4. Cathodic Arc Deposition employs a consumable cathode of the material which forms the coating and has an arc discharge established on the surface by a momentary contact of a ground trigger. Controlled motion of arcing erodes the cathode surface creating a highly ionized plasma. The anode can be either a cone attached to the periphery of the cathode, through an insulator, or the chamber. Substrate biasing is used for non line-of-sight deposition.

N.B. This definition does not include random cathodic arc deposition with non-biased substrates.

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

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

1. The metallic powders that are to be deposited (usually aluminium, chromium, silicon or combinations thereof);
2. An activator (normally a halide salt); and
3. An inert powder, most frequently alumina.

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

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

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

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

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

TABLE - DEPOSITION TECHNIQUES - TECHNICAL NOTE

Processes specified in Column 1 of the Table - continued:

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

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

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

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

CATEGORY 3 - ELECTRONICS

3A Systems, Equipment and Components

Note 1: *The control status of equipment and components described in 3A001 or 3A002, other than those described in 3A001.a.3. to 3A001.a.10. or 3A001.a.12., which are specially designed for or which have the same functional characteristics as other equipment is determined by the control status of the other equipment.*

Note 2: *The control status of integrated circuits described in 3A001.a.3. to 3A001.a.9. or 3A001.a.12. which are unalterably programmed or designed for a specific function for another equipment is determined by the control status of the other equipment.*

N.B.: *When the manufacturer or applicant cannot determine the control status of the other equipment, the control status of the integrated circuits is determined in 3A001.a.3. to 3A001.a.9. and 3A001.a.12. If the integrated circuit is a silicon-based "microcomputer microcircuit" or microcontroller microcircuit described in 3A001.a.3. having an operand (data) word length of 8 bit or less, the control status of the integrated circuit is determined in 3A001.a.3.*

3A001 Electronic components, as follows:

a. General purpose integrated circuits, as follows:

Note 1: *The control status of wafers (finished or unfinished), in which the function has been determined, is to be evaluated against the parameters of 3A001.a.*

Note 2: *Integrated circuits include the following types:*
"Monolithic integrated circuits";
"Hybrid integrated circuits";
"Multichip integrated circuits";
"Film type integrated circuits", including silicon-on-sapphire integrated circuits;
"Optical integrated circuits".

1. Integrated circuits, designed or rated as radiation hardened to withstand any of the following:
   a. A total dose of 5×10^3 Gy (silicon) or higher; or
   b. A dose rate upset of 5×10^6 Gy (silicon)/s or higher;

2. "Microprocessor microcircuits", "microcomputer microcircuits", microcontroller microcircuits, storage integrated circuits manufactured from a compound semiconductor, analogue-to-digital converters, digital-to-analogue converters, electro-optical or "optical integrated circuits" designed for "signal processing", field programmable logic devices, neural network integrated circuits, custom integrated circuits for which either the function is unknown or the control status of the equipment in which the

3A001 a. 2. continued

integrated circuit will be used is unknown, Fast Fourier Transform (FFT) processors, electrical erasable programmable read-only memories (EEPROMs), flash memories or static random-access memories (SRAMs), having any of the following:

a. Rated for operation at an ambient temperature above 398 K (125°C);
b. Rated for operation at an ambient temperature below 218 K (-55°C); or
c. Rated for operation over the entire ambient temperature range from 218 K (-55°C) to 398 K (125°C);

Note: 3A001.a.2. does not apply to integrated circuits for civil automobiles or railway train applications.

3. "Microprocessor microcircuits", "micro-computer microcircuits" and microcontroller microcircuits, having any of the following characteristics:

Note: 3A001.a.3. includes digital signal processors, digital array processors and digital coprocessors.

a. A "composite theoretical performance" ("CTP") of 3,500 million theoretical operations per second (Mtops) or more and an arithmetic logic unit with an access width of 32 bit 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. Storage integrated circuits manufactured from a compound semiconductor;

5. Analogue-to-digital and digital-to-analogue converter integrated circuits, as follows:

a. Analogue-to-digital converters having any of the following:

N.B. SEE ALSO 3A101

1. A resolution of 8 bit or more, but less than 12 bit, with a 'total conversion time' of less than 10 ns;
2. A resolution of 12 bit with a 'total conversion time' of less than 200 ns; or
3. A resolution of more than 12 bit with a 'total conversion time' of less than 2 µs;

b. Digital-to-analogue converters with a resolution of 12 bit or more, and a "settling time" of less than 10 ns;

Technical Notes:

1. A resolution of n bits corresponds to a quantisation of 2^n levels.
2. 'Total conversion time' is the inverse of sample rate.

6. Electro-optical and "optical integrated circuits" designed for "signal processing" having all of the following:

a. One or more than one internal "laser" diode;
b. One or more than one internal light detecting element; and
c. Optical waveguides;

7. Field programmable logic devices having any of the following:

a. An equivalent usable gate count of more than 30,000 (2 input gates);
b. A typical "basic gate propagation delay time" of less than 0.4 ns; or
c. A toggle frequency exceeding 133 MHz;

3A001 a. 7. continued

Note: *3A001.a.7. includes:*
- *Simple Programmable Logic Devices (SPLDs)*
- *Complex Programmable Logic Devices (CPLDs)*
- *Field Programmable Gate Arrays (FPGAs)*
- *Field Programmable Logic Arrays (FPLAs)*
- *Field Programmable Interconnects (FPICs)*

N.B.: *Field programmable logic devices are also known as field programmable gate or field programmable logic arrays.*

8. Not used;

9. Neural network integrated circuits;

10. Custom integrated circuits for which the function is unknown, or the control status of the equipment in which the integrated circuits will be used is unknown to the manufacturer, having any of the following:
    a. More than 208 terminals;
    b. A typical "basic gate propagation delay time" of less than 0.35 ns; or
    c. An operating frequency exceeding 3 GHz;

11. Digital integrated circuits, other than those described in 3A001.a.3 to 3A001.a.10. and 3A001.a.12., based upon any compound semiconductor and having any of the following:
    a. An equivalent gate count of more than 3000 (2 input gates); or
    b. A toggle frequency exceeding 1.2 GHz;

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 components, as follows:

1. Electronic vacuum tubes and cathodes, as follows:
   Note: *3A001.b.1. does not control tubes designed or rated to operate in the ITU allocated 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;

3A001 b. 1. a. continued

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. Being"space qualified";

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

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

2. Microwave integrated circuits or modules having all of the following:
   a. Containing "monolithic integrated circuits"; and
   b. Operating at frequencies exceeding 3 GHz;
   Note: *3A001.b.2. does not control circuits or modules for equipment designed or rated to operate in the ITU allocated bands at frequencies not exceeding 31 GHz.*

3. Microwave transistors rated for operation at frequencies exceeding 31 GHz;

4. Microwave solid state amplifiers, having any of the following:
   a. Operating frequencies exceeding 10.5 GHz and an "instantaneous bandwidth" of more than half an octave; or
   b. Operating 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 µs having any of the following:
   a. A band-pass bandwidth of more than 0.5% of centre frequency; or
   b. A band-stop bandwidth of less than 0.5% of centre frequency;

6. Microwave assemblies capable of operating at frequencies exceeding 31 GHz;

7. Mixers and converters designed to extend the frequency range of equipment described in 3A002.c., 3A002.e. or 3A002.f. beyond the limits stated therein;

8. Microwave power amplifiers containing tubes specified in 3A001.b. and having all of the following:
   a. Operating frequencies above 3 GHz;
   b. An average output power density exceeding 80 W/kg; and
   c. A volume of less than 400 cm^3;
   Note: *3A001.b.8. does not control equipment designed or rated for operation in an ITU allocated band.*

3A001 continued

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 exceeding 1 GHz, but not exceeding 2.5 GHz, and having any of the following:
      1. A frequency side-lobe rejection exceeding 55 dB;
      2. A product of the maximum delay time and the bandwidth (time in µs and bandwidth in MHz) of more than 100;
      3. A bandwidth greater than 250 MHz; or
      4. A dispersive delay of more than 10 µs; or
   c. A carrier frequency of 1 GHz or less, having any of the following:
      1. A product of the maximum delay time and the bandwidth (time in µs and bandwidth in MHz) of more than 100;
      2. A dispersive delay of more than 10 µs; or
      3. A frequency side-lobe rejection exceeding 55 dB and a bandwidth greater than 50 MHz;

2. Bulk (volume) acoustic wave devices (i.e., "signal processing" devices employing elastic waves) which permit the 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 and circuits containing components, manufactured from "superconductive" materials specially designed for operation at temperatures below the "critical temperature" of at least one of the "superconductive" constituents, with any of the following:
   1. Current switching for digital circuits using "superconductive" gates with a product of delay time per gate (in seconds) and power dissipation per gate (in watts) of less than 10^{-14} J; or
   2. Frequency selection at all frequencies using resonant circuits with Q-values exceeding 10,000;

e. High energy devices, as follows:

1. Batteries and photovoltaic arrays, as follows:
   Note: 3A001.e.1. does not control 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

3A001 e. 1. b. continued

operating in the temperature range from below 253 K (-20°C) to above 333 K (60°C);

Technical 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:

N.B.: SEE ALSO 3A201.a.

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 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 and solenoids specially designed to be fully charged or discharged in less than one second, having all of the following:

N.B.: SEE ALSO 3A201.b.

Note: 3A001.e.3. does not control "superconductive" electromagnets or solenoids specially designed for Magnetic Resonance Imaging (MRI) medical equipment.

a. Energy delivered during the discharge exceeding 10 kJ in the first second;

b. Inner diameter of the current carrying windings of more than 250 mm; and

c. Rated for a magnetic induction of more than 8 T or "overall current density" in the winding of more than 300 A/mm^2;

f. Rotary input type shaft absolute position encoders having any 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.

3A002 General purpose electronic equipment, as follows:

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

3A002 a. 1. continued

recording (HDDR) module), having any of the following:
a. A bandwidth exceeding 4 MHz per electronic channel or track;
b. A bandwidth exceeding 2 MHz per electronic channel or track and having more than 42 tracks; or
c. A time displacement (base) error, measured in accordance with applicable IRIG or EIA documents, of less than ± 0.1 μs;

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

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

Note: *3A002.a.2. does not control digital video magnetic tape recorders specially designed for television recording using a signal format, which may include a compressed signal format, standardised or recommended by the ITU, the IEC, the SMPTE, the EBU or the IEEE for civil television applications.*

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

Note: *3A002.a.3. does not control analogue magnetic tape recorders equipped with HDDR conversion electronics and configured to record only digital data.*

4. Equipment, having a maximum digital interface transfer rate exceeding 175 Mbit/s, designed to convert digital video magnetic tape recorders for use as digital instrumentation data recorders;

5. Waveform digitisers and transient recorders having all of the following:
a. Digitising rates equal to or more than 200 million samples per second and a resolution of 10 bits or more; and
b. A continuous throughput of 2 Gbit/s or more;

Technical 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.
Continuous throughput is the fastest data rate the instrument can output to mass storage without the loss of any information whilst sustaining the sampling rate and analogue-to-digital conversion.

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. "Signal analysers" capable of analysing frequencies exceeding 31 GHz;
2. "Dynamic signal analysers" having a "real-time bandwidth" exceeding 25.6 kHz;

Note: *3A002.c.2. does not control those "dynamic signal analysers" using only constant percentage bandwidth filters (also known as octave or fractional octave filters).*

3A002 continued

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: *3A002.d. does not control 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 40 GHz;

f. Microwave test receivers having all of the following:
1. A maximum operating frequency exceeding 40 GHz; and
2. Being capable of measuring amplitude and phase simultaneously;

g. Atomic frequency standards having any of the following:
1. Long-term stability (aging) less (better) than 1×10^{-11}/month; or
2. Being "space qualified".

Note: *3A002.g.1. does not control non-"space qualified" rubidium standards.*

3A101 Electronic equipment, devices and components, other than those specified in 3A001, as follows:

a. Analog-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: *3A101.b. above does not specify equipment specially designed for medical purposes.*

3A201 Electronic components, other than those specified in 3A001, as follows;

a. Capacitors having either of the following sets of characteristics:

1. a. Voltage rating greater than 1.4 kV;
   b. Energy storage greater than 10 J;
   c. Capacitance greater than 0.5 µF; and
   d. Series inductance less than 50 nH; or

2. a. Voltage rating greater than 750 V;
   b. Capacitance greater than 0.25 µF; and
   c. Series inductance less than 10 nH;

3A201 continued

b. Superconducting solenoidal electromagnets having all of the following characteristics:
   1. Capable of creating magnetic fields greater than 2 T;
   2. A ratio of length to inner diameter greater than 2;
   3. Inner diameter greater than 300 mm; and
   4. Magnetic field uniform to better than 1% over the central 50% of the inner volume;

   Note: *3A201.b. does not control magnets specially designed for and exported 'as parts of' medical nuclear magnetic resonance (NMR) imaging systems. The phrase '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 imaging systems.*

c. Flash X-ray generators or pulsed electron accelerators having either of the following sets of characteristics:
   1. a. An accelerator peak electron energy of 500 keV or greater but less than 25 MeV; and
      b. With a 'figure of merit' (K) of 0.25 or greater; or
   2. a. An accelerator peak electron energy of 25 MeV or greater; and
      b. A 'peak power' greater than 50 MW

   Note: *3A201.c. does not control accelerators that are component parts of devices designed for purposes other than electron beam or X-ray radiation (electron microscopy, for example) nor those designed for medical purposes:*

   Technical Notes:

   1. The 'figure of merit' K is defined as:

   $$K = 1.7 \times 10^3 V^{2.65} Q$$

   V is the peak electron energy in million electron volts.

   If the accelerator beam pulse duration is less than or equal to 1 μs, then Q is the total accelerated charge in Coulombs. If the accelerator beam pulse duration is greater than 1 μs, then Q is the maximum accelerated charge in 1 μs.

   Q equals the integral of i with respect to t, over the lesser of 1 μs or the time duration of the beam pulse ($Q = \int i dt$), where i is beam current in amperes and t is time in seconds.

   2. 'Peak power' = (peak potential in volts) x (peak beam current in amperes).

   3. In machines based on microwave accelerating cavities, the time duration of the beam pulse is the lesser of 1 μs or the duration of the bunched beam packet resulting from one microwave modulator pulse.

   4. In machines based on microwave accelerating cavities, the peak beam current is the average current in the time duration of a bunched beam packet.

3A225 Frequency changers or generators, other than those specified in 0B001.b.13., having all of the following characteristics:

a. Multiphase output capable of providing a power of 40 W or greater;
b. Capable of operating in the frequency range between 600 and 2000 Hz;
c. Total harmonic distortion better (less) than 10%; and
d. Frequency control better (less) than 0.1%.

Technical Note:
Frequency changers in 3A225 are also known as converters or inverters.

3A226 High-power direct current power supplies, other than those specified in 0B001.j.6., having both of the following characteristics:

a. Capable of continuously producing, over a time period of 8 hours, 100 V or greater with current output of 500 A or greater; and
b. Current or voltage stability better than 0.1% over a time period of 8 hours.

3A227 High-voltage direct current power supplies, other than those specified in 0B001.j.5., having both of the following characteristics:

a. Capable of continuously producing, over a time period of 8 hours, 20 kV or greater with current output of 1 A or greater; and
b. Current or voltage stability better than 0.1% over a time period of 8 hours.

3A228 Switching devices, as follows:

a. Cold-cathode tubes, whether gas filled or not, operating similarly to a spark gap, having all of the following characteristics:
   1. Containing three or more electrodes;
   2. Anode peak voltage rating of 2.5 kV or more;
   3. Anode peak current rating of 100 A or more; and
   4. Anode delay time of 10 μs or less;
   Note: *3A228 includes gas krytron tubes and vacuum sprytron tubes.*

b. Triggered spark-gaps having both of the following characteristics:
   1. An anode delay time of 15 μs or less; and
   2. 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 kV;
   2. Anode peak current rating of 500 A or more; and
   3. Turn-on time of 1 μs or less.

3A229 Firing sets and equivalent high-current pulse generators as follows:
N.B.: SEE ALSO MILITARY GOODS CONTROLS.

a. Explosive detonator firing sets designed to drive multiple controlled detonators specified in 3A232;

b. Modular electrical pulse generators (pulsers) having all of the following characteristics:
1. Designed for portable, mobile, or ruggedized-use;
2. Enclosed in a dust-tight enclosure;
3. Capable of delivering their energy in less than 15 μs;
4. Having an output greater than 100 A;
5. Having a 'rise time' of less than 10 μs into loads of less than 40 ohms;
6. No dimension greater than 254 mm;
7. Weight less than 25 kg; and
8. Specified for use over an extended temperature range 223 K (-50°C) to 373 K (100°C) or specified as suitable for aerospace applications.

Note: 3A229.b. includes xenon flash-lamp drivers.
Technical Note:
In 3A229.b.5. 'rise time' is defined as the time interval from 10% to 90% current amplitude when driving a resistive load.

3A230 High-speed pulse generators having both of the following characteristics:
a. Output voltage greater than 6 V into a resistive load of less than 55 ohms, and
b. 'Pulse transition time' less than 500 ps.
Technical Note:
In 3A230, 'pulse transition time' is defined as the time interval between 10% and 90% voltage amplitude.

3A231 Neutron generator systems, including tubes, having both of the following characteristics:
a. Designed for operation without an external vacuum system; and
b. Utilizing electrostatic acceleration to induce a tritium-deuterium nuclear reaction.

3A232 Detonators and multipoint initiation systems, as follows:
N.B.: SEE ALSO MILITARY GOODS CONTROLS.

a. Electrically driven explosive detonators, as follows:
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 5,000 mm^2 from a single firing signal with an initiation timing spread over the surface of less than 2.5 μs.

3A232 continued

Note: *3A232 does not control detonators using only primary explosives, such as lead azide.*

Technical Note:

In 3A232 the detonators of concern all utilise a small electrical conductor (bridge, bridge wire or foil) that explosively vapourises 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 vapourisation of the electrical conductor drives a flyer or slapper across a gap and the impact of the slapper on an explosive starts a chemical detonation. The slapper in some designs is driven by a magnetic force. The term exploding foil detonator may refer to either an EB or a slapper-type detonator. Also, the word initiator is sometimes used in place of the word detonator.

3A233 Mass spectrometers, other than those specified in 0B002.g., 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 having either of the following characteristics:
   1. A source chamber constructed from, lined with or plated with stainless steel or molybdenum and equipped with a cold trap capable of cooling to 193 K (-80°C) or less; or
   2. A source chamber constructed from, lined with or plated with materials resistant to UF_6;

f. Mass spectrometers equipped with a microfluorination ion source designed for actinides or actinide fluorides.

3B Test, Inspection and Production Equipment

3B001 Equipment for the manufacturing of semiconductor devices or materials, as follows, and specially designed components and accessories therefor:

a. "Stored programme controlled" equipment designed for epitaxial growth, as follows:
   1. Equipment capable of producing a layer thickness uniform to less than ± 2.5% across a distance of 75 mm or more;
   2. Metal organic chemical vapour deposition (MOCVD) reactors specially designed for compound semiconductor crystal growth by the chemical reaction between materials specified in 3C003 or 3C004;
   3. Molecular beam epitaxial growth equipment using gas or solid sources;

3B001 continued

b. "Stored programme controlled" equipment designed for ion implantation, having any of the following:
   1. A beam energy (accelerating voltage) exceeding 1MeV;
   2. Being specially designed and optimised to operate at a beam energy (accelerating voltage) of less than 2 keV;
   3. Direct write capability; or
   4. Being capable of high energy oxygen implant into a heated semiconductor material "substrate";

c. "Stored programme controlled" anisotropic plasma dry etching equipment, as follows:
   1. Equipment with cassette-to-cassette operation and load-locks, and having any of the following:
      a. Magnetic confinement; or
      b. Electron cyclotron resonance (ECR);
   2. Equipment specially designed for equipment specified in 3B001.e. and having any of the following:
      a. Magnetic confinement; or
      b. ECR;

d. "Stored programme controlled" plasma enhanced CVD equipment, as follows:
   1. Equipment with cassette-to-cassette operation and load-locks, and having any of the following:
      a. Magnetic confinement; or
      b. ECR;
   2. Equipment specially designed for equipment specified in 3B001.e. and having any of the following:
      a. Magnetic confinement; or
      b. ECR;

e. "Stored programme controlled" automatic loading multi-chamber central wafer handling systems, having all of the following:
   1. Interfaces for wafer input and output, to which more than two pieces of semiconductor processing equipment are to be connected; and
   2. Designed to form an integrated system in a vacuum environment for sequential multiple wafer processing;

   Note: *3B001.e. does not control automatic robotic wafer handling systems not designed to operate in a vacuum environment.*

f. "Stored programme controlled" lithography equipment, as follows:
   1. Align and expose step and repeat (direct step on wafer) or step and scan (scanner) equipment for wafer processing using photo-optical or X-ray methods, having any of the following:
      a. A light source wavelength shorter than 350 nm; or

3B001 f. 1. continued

b. Capable of producing a pattern with a 'minimum resolvable feature' size of 0.5 µm or less;
Technical Note:
The 'minimum resolvable feature' size is calculated by the following formula:

$$MRF = \frac{\text{(an exposure light source wavelength in µm) x (K factor)}}{\text{numerical aperture}}$$

where the K factor = 0.7
MRF = minimum resolvable feature size

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

g. Masks and reticles designed for integrated circuits specified in 3A001;

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

3B002 "Stored programme controlled" test equipment, specially designed for testing finished or unfinished semiconductor devices, as follows, and specially designed components and accessories therefor:

a. For testing S-parameters of transistor devices at frequencies exceeding 31 GHz;

b. For testing integrated circuits capable of performing functional (truth table) testing at a 'pattern rate' of more than 333 MHz;
Note: *3B002.b. does not control test equipment specially designed for testing:*
1. "Electronic assemblies" or a class of "electronic assemblies" for home or entertainment applications;
2. Uncontrolled electronic components, "electronic assemblies" or integrated circuits.
Technical Note:
For the purpose of this entry, 'pattern rate' is defined as the maximum frequency of digital operation of a tester. It is therefore equivalent to the highest data rate that a tester can provide in a non-multiplexed mode. It is also referred to as test speed, maximum digital frequency or maximum digital speed.

c. For testing microwave integrated circuits specified in 3A001.b.2.

3C Materials

3C001 Hetero-epitaxial materials consisting of a "substrate" having stacked epitaxially grown multiple layers of any of the following:

a. Silicon;

b. Germanium; or

c. III/V compounds of gallium or indium.

Technical 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 (e.g., gallium arsenide, gallium-aluminium arsenide, indium phosphide).

3C002 Resist materials, as follows, and "substrates" coated with controlled resists:

a. Positive resists designed for semiconductor lithography specially adjusted (optimised) for use at wavelengths below 350 nm;

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

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

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

Technical 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: *3C003 only controls 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: *3C004 does not control hydrides containing 20% molar or more of inert gases or hydrogen.*

3D Software

3D001 "Software" specially designed for the "development" or "production" of equipment specified in 3A001.b. to 3A002.g. or 3B.

3D002 "Software" specially designed for the "use" of "stored programme controlled" equipment specified in 3B.

3D003 Computer-aided-design (CAD) "software" designed 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.
Technical 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 1: *3D003 does not control "software" specially designed for schematic entry, logic simulation, placing and routing, layout verification or pattern generation tape.*

Note 2: *Libraries, design attributes or associated data for the design of semiconductor devices or integrated circuits are considered as "technology".*

3D101 "Software" specially designed or modified for the "use" of equipment specified in 3A101.b.

3E Technology

3E001 "Technology" according to the General Technology Note for the "development" or "production" of equipment or materials specified in 3A, 3B or 3C;

Note: *3E001 does not control "technology" for the "development" or "production" of:*
a. Microwave transistors operating at frequencies below 31 GHz;
b. Integrated circuits specified in 3A001.a.3. to 3A001.a.12., having all of the following:
1. Using "technology" of 0.7 µm or more, and
2. Not incorporating 'multi-layer structures'.
Technical Note:
The term 'multi-layer structures' in Note b.2. to 3E001 does not include 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 and super lattice devices;
c. "Superconductive" electronic devices;
d. Substrates of films of diamond for electronic components.
e. Substrates of silicon-on-insulator (SOI) for integrated circuits in which the insulator is silicon dioxide;
f. Substrates of silicon carbide for electronic components;
g. "Technology" according to the General Technology Note other than that specified in 3E001 for the "development" or "production" of "microprocessor microcircuits", "micro-computer microcircuits" and microcontroller microcircuits having a "composite theoretical performance" ("CTP") of 530 million theoretical operations per second (Mtops) or more and an arithmetic logic unit with an access width of 32 bits or more.
Note: *The decontrol note to 3E001 also applies to 3E002.g.*

3E101 "Technology" according to the General Technology Note for the "use" of equipment or "software" specified in 3A001.a.1. or 2., 3A101 or 3D101.

3E102 "Technology" according to the General Technology Note for the "development" of "software" specified in 3D101.

3E201 "Technology" according to the General Technology Note for the "use" of equipment specified in 3A001.e.2., 3A001.e.3., 3A201, 3A225 to 3A233.

CATEGORY 4 - COMPUTERS

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

Note 2: *Control units which directly interconnect the buses or channels of central processing units, "main storage" or disk controllers are not regarded as telecommunications equipment described in Category 5, Part 1 (Telecommunications).*

N.B.: *For the control status of "software" specially designed for packet switching, see 5D001.*

Note 3: *Computers, related equipment and "software" performing cryptographic, cryptanalytic, certifiable multi-level security or certifiable user isolation functions, or which limit electromagnetic compatibility (EMC), must also be evaluated against the performance characteristics in Category 5, Part 2 ("Information Security").*

4A Systems, Equipment and Components

4A001 Electronic computers and related equipment, as follows, and "electronic assemblies" and specially designed components therefor:

N.B.: SEE ALSO 4A101.

a. Specially designed to have any of the following characteristics:
   1. Rated for operation at an ambient temperature below 228 K (-45°C) or above 358 K (85°C);
      Note: *4A001.a.1. 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 5×10^3 Gy (silicon);
      b. Dose Rate Upset 5×10^6 Gy (silicon)/s; or
      c. Single Event Upset 1×10^{-7} Error/bit/day;

b. Having characteristics or performing functions exceeding the limits in Category 5, Part 2 ("Information Security").
   Note: *4A001.b. does not control electronic computers and related equipment when accompanying their user for the user's personal use.*

4A002 "Hybrid computers", as follows, and "electronic assemblies" and specially designed components therefor:

N.B.: SEE ALSO 4A102.

a. Containing "digital computers" specified in 4A003;
b. Containing analogue-to-digital converters having all 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:

Note 1: *4A003 includes the following:*

a. Vector processors;
b. Array processors;
c. Digital signal processors;
d. Logic processors;
e. Equipment designed for "image enhancement";
f. Equipment designed for "signal processing".

Note 2: *The control status of the "digital computers" and related equipment described in 4A003 is determined by the control status of other equipment or systems provided:*

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

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

N.B. 1: The control status of "signal processing" or "image enhancement" equipment specially designed for other equipment with functions limited to those required for the other equipment is determined by the control status of the other equipment even if it exceeds the "principal element" criterion.

N.B. 2: For the control status of "digital computers" or related equipment for telecommunications equipment, see Category 5, Part 1 (Telecommunications).

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

a. Designed or modified for "fault tolerance";

Note: *For the purposes of 4A003.a., "digital computers" and related equipment are not considered to be designed or modified for "fault tolerance" if they utilise any of the following:*

1. Error detection or correction algorithms in "main storage";
2. The interconnection of two "digital computers" so that, if the active central processing unit fails, an idling but mirroring central processing unit can continue the system's functioning;
3. The interconnection of two central processing units by data channels or by 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 6,500 million theoretical operations per second (Mtops);

4A003 continued

c. "Electronic assemblies" specially designed or modified for enhancing performance by aggregation of "computing elements" ("CEs") so that the "CTP" of the aggregation exceeds the limit in 4A003.b.;

Note 1: *4A003.c. applies only to "electronic assemblies" and programmable interconnections not exceeding the limit in 4A003.b. when shipped as unintegrated "electronic assemblies". It does not apply to "electronic assemblies" inherently limited by nature of their design for use as related equipment specified in 4A003.d. or 4A003.e.*

Note 2: *4A003.c. does not control "electronic assemblies" specially designed for a product or family of products whose maximum configuration does not exceed the limit of 4A003.b.*

d. Graphics accelerators and graphics coprocessors exceeding a "three dimensional Vector Rate" of 3,000,000;

e. Equipment performing analogue-to-digital conversions exceeding the limits in 3A001.a.5.;

f. Not used;

g. Equipment specially designed to provide external interconnection of "digital computers" or associated equipment which allows communications at data rates exceeding 80 Mbyte/s.

Note: *4A003.g. does not control internal interconnection equipment (e.g. backplanes, buses), passive interconnection equipment, "network access controllers" or "communications channel controllers".*

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 4A001.a.1., which are ruggedized and designed or modified for use in space launch vehicles specified in 9A004 or sounding rockets specified in 9A104.

4A102 "Hybrid computers" specially designed for modelling, simulation or design integration of space launch vehicles specified in 9A004 or sounding rockets specified in 9A104.

Note: *This control only applies when the equipment is supplied with "software" specified in 7D103 or 9D103.*

4B Test, Inspection and Production Equipment

None.

4C Materials

None.

4D Software

Note: *The control status of "software" for the "development", "production", or "use" of equipment described in other Categories is dealt with in the appropriate Category. The control status of "software" for equipment described in this Category is dealt with herein.*

4D001 "Software" specially designed or modified for the "development", "production" or "use" of equipment or "software" specified in 4A001 to 4A004, or 4D.

4D002 "Software" specially designed or modified to support "technology" specified in 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");
   Note: *4D003.c. does not control "software" when accompanying its user for the user's personal use.*

d. Operating systems specially designed for "real time processing" equipment which guarantees a "global interrupt latency time" of less than 20 μs.

4E Technology

4E001 "Technology" according to the General Technology Note, for the "development", "production" or "use" of equipment or "software" specified in 4A or 4D.

TECHNICAL NOTE ON "COMPOSITE THEORETICAL PERFORMANCE" ("CTP")

Abbreviations used in this Technical 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")
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 "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 groups 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.

TECHNICAL NOTE ON "CTP"

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: $\frac{1}{(t_{xp\ mult})}$ If neither add nor multiply is implemented use the fastest available arithmetic operation as follows: $\frac{1}{3*t_{xp}}$ See Notes X & Z
FP only (R_{fp})	$\max \frac{1}{t_{fp}\ add}, \frac{1}{t_{fp}\ mult}$ See Notes X & Y
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 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.

TECHNICAL NOTE ON "CTP"

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 a "CE" which performs 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:

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

"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 one 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.

TECHNICAL NOTE ON "CTP"

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.

TECHNICAL NOTE ON "CTP"

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, I/O shared connections/devices, I/O 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 "electronic assemblies" described by 4A003.c.

$$"CTP" = TP_1 + C_2 * TP_2 + ... + C_n * TP_n,$$

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:

$$C_2 = C_3 = C_4 = ... = C_n = 0.75$$

TECHNICAL NOTE ON "CTP"

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

$$C_i = \frac{0.75}{\sqrt{m}} \qquad (i = 2,...,n)$$

where m = the number of "CEs" or groups of "CEs" sharing access.

provided:

1. The TP_i of each "CE" or group of "CEs" does not exceed 30Mtops;
2. The "CEs" or groups of "CEs" share access to main memory (excluding cache 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 = $0.75 * k_i$ ($i = 2, \ldots, 32$) (see Note below)
= $0.60 * k_i$ ($i = 33, \ldots, 64$)
= $0.45 * k_i$ ($i = 65, \ldots, 256$)
= $0.30 * k_i$ ($i > 256$)

The value of C_i is based on the number of "CE"s, 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 limit for C_i. For example, in an aggregation of groups consisting of 3 "CEs" each, the 22nd 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 the fastest-to-slowest; i.e.:

$TP_1 \geq TP_2 \geq .... \geq TP_n$, 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 to be 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.

CATEGORY 5 - TELECOMMUNICATIONS AND "INFORMATION SECURITY"

Part 1 - TELECOMMUNICATIONS

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

Note 2: *"Digital computers", related equipment or "software", when essential for the operation and support of telecommunications equipment described in this Category, are regarded as specially designed components, provided they are the standard models customarily supplied by the manufacturer. This includes operation, administration, maintenance, engineering or billing computer systems.*

5A1 Systems, Equipment and Components

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 effects, both arising from a nuclear explosion;
2. Specially hardened to withstand gamma, neutron or ion radiation; or
3. Specially designed to operate outside the temperature range from 218 K (-55°C) to 397 K (124°C).
   Note: *5A001.a.3. applies only to electronic equipment.*

Note: *5A001.a.2. and 5A001.a.3. do not control equipment designed or modified for use on board satellites.*

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

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

2. Being radio equipment operating in the 1.5 MHz to 87.5 MHz band and having any of the following characteristics:
   a. Incorporating adaptive techniques providing more than 15 dB suppression of an interfering signal; or

5A001 b. 2. continued

b. Having all of the following:
1. Automatically predicting and selecting frequencies and "total digital transfer rates" per channel to optimise 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 MHz to 30 MHz frequency range or 250 W or more in the 30 MHz 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;

3. Being radio equipment employing "spread spectrum" techniques, including "frequency hopping" techniques, having any 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;
Note: *5A001.b.3.b. does not control radio equipment specially designed for use with civil cellular radio-communications systems.*

Note: *5A001.b.3 does not control equipment designed to operate at an output power of 1.0 Watt or less.*

4. Being digitally controlled radio receivers having all of the following:
a. More than 1,000 channels;
b. A "frequency switching time" of less than 1 ms;
c. Automatic searching or scanning of a part of the electromagnetic spectrum; and
d. Identification of the received signals or the type of transmitter; or
Note: *5A001.b.4. does not control radio equipment specially designed for use with civil cellular radio-communications systems.*

5. Employing functions of digital "signal processing" to provide voice coding at rates of less than 2,400 bit/s.

c. Optical fibre communication cables, optical fibres and accessories, as follows:

1. Optical fibres of more than 500 m in length, and specified by the manufacturer as being capable of withstanding a proof test tensile stress of 2×10^9 N/m^2 or more;
Technical Note:
Proof Test: on-line or off-line production screen testing that dynamically applies a prescribed tensile stress over a 0.5 to 3 m length of fibre at a running rate of 2 to 5 m/s while passing between capstans approximately 150 mm in diameter. The ambient temperature is a nominal 293 K (20°C) and relative humidity 40%. Equivalent national standards may be used for executing the proof test.

5A001 c. continued

2. Optical fibre cables and accessories designed for underwater use.
   Note: *5A001.c.2. does not control standard civil telecommunication cables and accessories.*
   N.B. 1: *For underwater umbilical cables, and connectors therefor, see 8A002.a.3.*
   N.B. 2: *For fibre-optic hull penetrators or connectors, see 8A002.c.*

d. "Electronically steerable phased array antennae" operating above 31 GHz.
   Note: *5A001.d. does not control "electronically steerable phased array antennae" for landing systems with instruments meeting ICAO standards covering microwave landing systems (MLS).*

5A101 Telemetering and telecontrol equipment usable for "missiles".

Note: *5A101 does not control 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 metres.*

5B1 Test, Inspection and Production Equipment

5B001 a. Equipment and specially designed components or accessories therefor, specially designed for the "development", "production" or "use" of equipment, functions or features specified in 5A001, 5B001, 5D001 or 5E001.
   Note: *5B001.a. does not control optical fibre characterization equipment not using semiconductor "lasers".*

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

1. Equipment employing digital techniques, including "Asynchronous Transfer Mode" ("ATM"), designed to operate at a "total digital transfer rate" exceeding 1.5 Gbit/s;

2. Equipment employing a "laser" and having any of the following:
   a. A transmission wavelength exceeding 1750 nm;
   b. Performing "optical amplification";
   c. Employing coherent optical transmission or coherent optical detection techniques (also called optical heterodyne or homodyne techniques); or
   d. Employing analogue techniques and having a bandwidth exceeding 2.5 GHz;
      Note: *5B001.b.2.d. does not control equipment specially designed for the "development" of commercial TV systems.*

3. Equipment employing "optical switching";

5B001 b. continued

4. Radio equipment employing quadrature-amplitude-modulation (QAM) techniques above level 128; or

5. Equipment employing "common channel signalling" operating in either non-associated or quasi- associated mode of operation.

5C1 Materials

None

5D1 Software

5D001_ a. "Software" specially designed or modified for the "development", "production" or "use" of equipment, functions or features specified by 5A001 or 5B001.

b. "Software" specially designed or modified to support "technology" specified in 5E001.

c. Specific "software" as follows:

1. "Software" specially designed or modified to provide characteristics, functions or features of equipment specified in 5A001 or 5B001;
2. "Software" which provides the capability of recovering "source code" of telecommunications "software" specified in 5D001;
3. "Software", other than in machine-executable form, specially designed for "dynamic adaptive routing".

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

1. Equipment employing digital techniques, including "Asynchronous Transfer Mode" ("ATM"), designed to operate at a "total digital transfer rate" exceeding 1.5 Gbit/s;

2. Equipment employing a "laser" and having any of the following:
   a. A transmission wavelength exceeding 1750 nm; or
   b. Employing analogue techniques and having a bandwidth exceeding 2.5 GHz;
   Note: *5D001.d.2.b. does not control "software" specially designed or modified for the "development" of commercial TV systems.*

5D001 d. continued

3. Equipment employing "optical switching"; or

4. Radio equipment employing quadrature-amplitude-modulation (QAM) techniques above level 128.

5D101 "Software" specially designed or modified for the "use" of equipment specified in 5A101.

5E1 Technology

5E001 a. "Technology" according to the General Technology Note for the "development", "production" or "use" (excluding operation) of equipment, functions or features or "software" specified in 5A001, 5B001 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 "development" of digital cellular radio systems;

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

c. "Technology" according to the General Technology Note for the "development" or "production" of any of the following telecommunication transmission or "stored programme controlled" switching equipment, functions or features:

1. Equipment employing digital techniques, including "Asynchronous Transfer Mode" ("ATM"), designed to operate at a "total digital transfer rate" exceeding 1.5 Gbit/s;

2. Equipment employing a "laser" and having any of the following:
   a. A transmission wavelength exceeding 1750 nm;
   b. Performing "optical amplification" using praseodymium-doped fluoride fibre amplifiers (PDFFA);
   c. Employing coherent optical transmission or coherent optical detection techniques (also called optical heterodyne or homodyne techniques);

5E001 c. 2. continued

d. Employing wavelength division multiplexing techniques exceeding 8 optical carriers in a single optical window; or

e. Employing analogue techniques and having a bandwidth exceeding 2.5 GHz;
Note: *5E001.c.2.e. does not control" technology" for the "development" or "production" of commercial TV systems.*

3. Equipment employing "optical switching";

4. Radio equipment having any of the following:
a. Quadrature-amplitude-modulation (QAM) techniques above level 128; or
b. Operating at input or output frequencies exceeding 31 GHz; or
Note: *5E001.c.4.b. does not control "technology" for the "development" or "production" of equipment designed or modified for operation in any ITU allocated band.*

5. Equipment employing "common channel signalling" operating in either non-associated or quasi- associated mode of operation.

5E101 "Technology" according to the General Technology Note for the "development", "production" or "use" of equipment specified in 5A101.

Part 2 - "INFORMATION SECURITY"

Note 1: *The control status of "information security" equipment, "software", systems, application specific "electronic assemblies", modules, integrated circuits, components or functions is determined in Category 5, Part 2 even if they are components or "electronic assemblies" of other equipment.*

Note 2: *Category 5 – Part 2 does not control products when accompanying their user for the user's personal use.*

Note 3: *Cryptography Note*

5A002 and 5D002 do not control goods that meet all of the following:

a. *Generally available to the public by being sold, without restriction, from stock at retail selling points by means of any of the following:*
   1. *Over-the-counter transactions;*
   2. *Mail order transactions;*
   3. *Electronic transactions; or*
   4. *Telephone call transactions;*

b. *The cryptographic functionality cannot easily be changed by the user;*

c. *Designed for installation by the user without further substantial support by the supplier;*

d. *Does not contain a "symmetric algorithm" employing a key length exceeding 64 bits; and*

e. *When necessary, details of the goods are accessible and will be provided, upon request, to the competent authorities of the Member State in which the exporter is established in order to ascertain compliance with conditions described in paragraphs a. to d. above.*

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

5A2 Systems, Equipment and Components

5A002 a. Systems, equipment, application specific "electronic assemblies", modules and integrated circuits for "information security", as follows, and other specially designed components therefor:

N.B.: *For the control of global navigation satellite systems receiving equipment containing or employing decryption (i.e. GPS or GLONASS), see 7A005.*

5A002 a. continued

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

Technical Notes:

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

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

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

Note: 5A002.a.1. includes equipment designed or modified to use "cryptography" employing analogue principles when implemented with digital techniques.

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

b. An "asymmetric algorithm" where the security of the algorithm is based on any of the following:
   1. Factorisation of integers in excess of 512 bits (e.g., RSA);
   2. Computation of discrete logarithms in a multiplicative group of a finite field of size greater than 512 bits (e.g., Diffie-Hellman over Z/pZ); or
   3. Discrete logarithms in a group other than mentioned in 5A002.a.1.b.2. in excess of 112 bits (e.g., Diffie-Hellman over an elliptic curve);

2. Designed or modified to perform cryptanalytic functions;

3. Not used;

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

5. Designed or modified to use cryptographic techniques to generate the spreading code for "spread spectrum" systems, including the hopping code for "frequency hopping" systems;

6. 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) or equivalent;

7. Communications cable systems designed or modified using mechanical, electrical or electronic means to detect surreptitious intrusion.

5A002 continued

Note: *5A002 does not control:*

a. "Personalised smart cards" where the cryptographic capability is restricted for use in equipment or systems excluded from control under entries b. to f. of this Note. If a "personalised smart card" has multiple functions, the control status of each function is assessed individually;

b. Receiving equipment for radio broadcast, pay television or similar restricted audience broadcast of the consumer type, without digital encryption except that exclusively used for sending the billing or programme-related information back to the broadcast providers;

c. Equipment where the cryptographic capability is not user-accessible and which is specially designed and limited to allow any of the following:
1. Execution of copy-protected software;
2. Access to any of the following:
a. Copy-protected read-only media; or
b. Information stored in encrypted form on media (e.g. in connection with the protection of intellectual property rights) when the media is offered for sale in identical sets to the public; or
3. One-time copying of copyright protected audio/video data.

d. Cryptographic equipment specially designed and limited for banking use or 'money transactions';
Technical Note:
'Money transactions' in 5A002. Note d. includes the collection and settlement of fares or credit functions.

e. Portable or mobile radiotelephones for civil use (e.g. for use with commercial civil cellular radiocommunications systems) that are not capable of end-to-end encryption;

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

5B2 Test, Inspection and Production Equipment

5B002 a. Equipment specially designed for:

1. The "development" of equipment or functions specified in 5A002, 5B002, 5D002 or 5E002 including measuring or test equipment;
2. The "production" of equipment or functions specified in 5A002, 5B002, 5D002 or 5E002, including measuring, test, repair or production equipment;

5B002 continued

b. Measuring equipment specially designed to evaluate and validate the "information security" functions specified in 5A002 or 5D002.

5C2 Materials

None.

5D2 Software

5D002 a. "Software" specially designed or modified for the "development", "production" or "use" of equipment or "software" specified in 5A002, 5B002 or 5D002;

b. "Software" specially designed or modified to support "technology" specified in 5E002;

c. Specific "software", as follows:

1. "Software" having the characteristics, or performing or simulating the functions of the equipment specified in 5A002 or 5B002;
2. "Software" to certify "software" specified in 5D002.c.1.

Note: *5D002 does not control:*

a. "Software" required for the "use" of equipment excluded from control under the Notes to 5A002;

b. "Software" providing any of the functions of equipment excluded from control under the Notes to 5A002.

5E2 Technology

5E002 "Technology" according to the General Technology Note for the "development", "production" or "use" of equipment or "software" specified in 5A002, 5B002 or 5D002."

CATEGORY 6 - SENSORS AND LASERS

6A Systems, Equipment and Components

6A001 Acoustics:

a. Marine acoustic systems, equipment and specially designed components therefor, as follows:

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

Note: *6A001.a.1. does not control:*

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

b. Acoustic beacons, as follows:

1. Acoustic emergency beacons;

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

a. Wide-swath bathymetric survey systems designed for sea bed topographic mapping, having all of the following:
1. Being designed to take measurements at an angle exceeding 20° from the vertical;
2. Being designed to measure depths exceeding 600 m below the water surface; and
3. Being designed to provide any of the following:
a. Incorporation of multiple beams any of which is less than 1.9°; or
b. Data accuracies of better than 0.3% 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 µPa at 1 m) for equipment with an operating frequency in the band from 10 kHz to 24 kHz inclusive;
3. Sound pressure level exceeding 235 dB (reference 1 µPa at 1 m) for equipment with an operating frequency in the band between 24 kHz and 30 kHz;
4. Forming beams of less than 1° on any axis and having an operating frequency of less than 100 kHz;
5. Designed to operate with an unambiguous display range exceeding 5,120 m; or
6. Designed to withstand pressure during normal operation at depths exceeding 1,000 m and having transducers with any of the following:
a. Dynamic compensation for pressure; or
b. Incorporating other than lead zirconate titanate as the transduction element;

6A001 a. 1. continued

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:

Note 1: *The control status of acoustic projectors, including transducers, specially designed for other equipment is determined by the control status of the other equipment.*

Note 2: *6A001.a.1.c. does not control electronic sources which direct the sound vertically only, or mechanical (e.g., air gun or vapour-shock gun) or chemical (e.g., explosive) sources.*

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

Technical Note:

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

3. Side-lobe suppression exceeding 22 dB;

d. Acoustic systems, equipment and specially designed components for determining the position of surface vessels or underwater vehicles designed to operate at a range exceeding 1,000 m with a positioning accuracy of less than 10 m rms (root mean square) when measured at a range of 1,000 m;

Note: *6A001.a.1.d. includes:*

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

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

2. Passive (receiving, whether or not related in normal application to separate active equipment) systems, equipment and specially designed components therefor, as follows:

a. Hydrophones having any of the following characteristics:

Note: *The control status of hydrophones specially designed for other equipment is determined by the control status of the other equipment.*

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;

6A001 a. 2. a continued

2. Having any of the following sensing elements:
   a. Optical fibres;
   b. Piezoelectric polymers; or
   c. Flexible piezoelectric ceramic materials;
3. A 'hydrophone sensitivity' better than -180 dB at any depth with no acceleration compensation;
4. When designed to operate at depths exceeding 35 m with acceleration compensation; or
5. Designed for operation at depths exceeding 1,000 m;

Technical 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 μPa. For example, a hydrophone of -160 dB (reference 1 V per μPa) would yield an output voltage of 10^{-8} V in such a field, while one of -180 dB sensitivity would yield only 10^{-9} V output. Thus, -160 dB is better than -180 dB.

b. Towed acoustic hydrophone arrays having any of the following:
   1. Hydrophone group spacing of less than 12.5 m;
   2. Designed or 'able to be modified' to operate at depths exceeding 35 m;
      Technical Note:
      'Able to be modified' in 6A001.a.2.b.2. means having provisions to allow a change of the wiring or interconnections to alter hydrophone group spacing or operating depth limits. These provisions are: spare wiring exceeding 10% of the number of wires, hydrophone group spacing adjustment blocks or internal depth limiting devices that are adjustable or that control more than one hydrophone group.
   3. Heading sensors specified in 6A001.a.2.d.;
   4. Longitudinally reinforced array hoses;
   5. An assembled array of less than 40 mm in diameter;
   6. Multiplexed hydrophone group signals designed to operate at depths exceeding 35 m or having an adjustable or removable depth sensing device in order to operate at depths exceeding 35 m; or
   7. Hydrophone characteristics specified in 6A001.a.2.a.;

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

6A001 a. 2. continued

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

e. Bottom or bay cable systems having any of the following:
1. Incorporating hydrophones specified in 6A001.a.2.a.; or
2. Incorporating multiplexed hydrophone group signal modules having all of the following characteristics:
a. Designed to operate at depths exceeding 35 m or having an adjustable or removable depth sensing device in order to operate at depths exceeding 35 m; and
b. Capable of being operationally interchanged with towed acoustic hydrophone array modules;

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

b. 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

N.B.: SEE ALSO 6A102.

a. Optical detectors, as follows:

Note: *6A002.a. does not control germanium or silicon photodevices.*

1. "Space-qualified" solid-state detectors, as follows:

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

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

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

6A002 a. continued

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 15 µm or less; and
3. Photocathodes, as follows:
a. S-20, S-25 or multialkali photocathodes with a luminous sensitivity exceeding 240 µA/lm;
b. GaAs or GaInAs photocathodes; or
c. Other III-V compound semiconductor photocathodes;
Note: 6A002.a.2.a.3.c. does not control compound semiconductor photocathodes with a maximum radiant sensitivity of 10 mA/W or less.

b. Specially designed components, as follows:
1. Microchannel plates having a hole pitch (centre-to-centre spacing) of 15 µm or less;
2. GaAs or GaInAs photocathodes;
3. Other III-V compound semiconductor photocathodes;
Note: 6A002.a.2.b.3. does not control compound semiconductor photocathodes with a maximum radiant sensitivity of 10 mA/W or less.

3. Non-"space-qualified" "focal plane arrays", as follows:

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

Note 1: 6A002.a.3. includes photoconductive arrays and photovoltaic arrays.

Note 2: 6A002.a.3. does not control:
a. Silicon "focal plane arrays";
b. Multi-element (not to exceed 16 elements) encapsulated photoconductive cells using either lead sulphide or lead selenide;
c. Pyroelectric detectors using any of the following:
1. Triglycine sulphate and variants;
2. Lead-lanthanum-zirconium titanate and variants;
3. Lithium tantalate;
4. Polyvinylidene fluoride and variants; or
5. Strontium barium niobate and variants.

a. Non-"space-qualified" "focal plane arrays", having all of the following:
1. Individual elements with a peak response within the wavelength range exceeding 900 nm but not exceeding 1,050 nm; and
2. A response "time constant" of less than 0.5 ns;

6A002 a. 3. continued

b. Non-"space-qualified" "focal plane arrays", having all of the following:
1. Individual elements with a peak response in the wavelength range exceeding 1,050 nm but not exceeding 1,200 nm; and
2. A response "time constant" of 95 ns or less;

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

b. "Monospectral imaging sensors" and "multispectral imaging sensors" designed for remote sensing applications, having any of the following:
1. An Instantaneous-Field-Of-View (IFOV) of less than 200 µrad (microradians); or
2. Being specified for operation in the wavelength range exceeding 400 nm but not exceeding 30,000 nm and having all the following;
a. Providing output imaging data in digital format; and
b. Being any of the following:
1. "Space-qualified"; or
2. Designed for airborne operation, using other than silicon detectors, and having an IFOV of less than 2.5 mrad (milliradians).

c. 'Direct view' imaging equipment operating in the visible or infrared spectrum, incorporating any of the following:
1. Image intensifier tubes specified in 6A002.a.2.a. ; or
2. "Focal plane arrays" specified in 6A002.a.3.
Technical Note:
'Direct view' refers to 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.
Note: *6A002.c. does not control 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, having a cooling source temperature below 218 K (-55°C), as follows:
a. Closed cycle type with a specified Mean-Time-To-Failure (MTTF), or Mean-Time-Between-Failures (MTBF), exceeding 2,500 hours;
b. Joule-Thomson (JT) self-regulating minicoolers having bore (outside) diameters of less than 8 mm;
3. Optical sensing fibres specially fabricated either compositionally or structurally, or modified by coating, to be acoustically, thermally, inertially, electromagnetically or nuclear radiation sensitive.

6A002 continued

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

6A003 Cameras

N.B.: SEE ALSO 6A203.

N.B.: For cameras specially designed or modified for underwater use, see 8A002.d. and 8A002.e.

Note: *Instrumentation cameras, specified in 6A003.a.3. to 6A003.a.5., with modular structures should be evaluated by their maximum capability, using "electronic assemblies" available according to the camera manufacturer's specifications.*

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/s;

   Note: *6A003.a.1. does not control cinema recording cameras designed for civil purposes.*

2. Mechanical high speed cameras, in which the film does not move, capable of recording at rates exceeding 1,000,000 frames/s for the full framing height of 35 mm film, or at proportionately higher rates for lesser frame heights, or at proportionately lower rates for greater frame heights;

3. Mechanical or electronic streak cameras having writing speeds exceeding 10mm/μs;

4. Electronic framing cameras having a speed exceeding 1,000,000 frames/s;

5. Electronic cameras, having all of the following:
   a. An electronic shutter speed (gating capability) of less than 1 μs per full frame; and
   b. A read out time allowing a framing rate of more than 125 full frames per second.

b. Imaging cameras, as follows:

Note: *6A003.b. does not control 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;

6A003 b. continued

2. Scanning cameras and scanning camera systems, having all of the following:
   a. Linear detector arrays with more than 8,192 elements per array; and
   b. Mechanical scanning in one direction;

3. Imaging cameras incorporating image intensifier tubes specified in 6A002.a.2.a.;

4. Imaging cameras incorporating "focal plane arrays" specified in 6A002.a.3.
   Note *6A003.b.4. does not control imaging cameras incorporating linear "focal plane arrays" with twelve elements or fewer, not employing time-delay-and-integration within the element, designed for any of the following:*
   a. Industrial or civilian intrusion alarm, traffic or industrial movement control or counting systems;
   b. Industrial equipment used for inspection or monitoring of heat flows in buildings, equipment or industrial processes;
   c. Industrial equipment used for inspection, sorting or analysis of the properties of materials;
   d. Equipment specially designed for laboratory use; or
   e. Medical equipment.

6A004 Optics

a. Optical mirrors (reflectors), as follows:

1. "Deformable mirrors" having either continuous or multi-element surfaces, and specially designed components therefor, capable of dynamically repositioning portions of the surface of the mirror at rates exceeding 100 Hz;

2. Lightweight monolithic mirrors having an average "equivalent density" of less than 30 kg/m^2 and a total mass exceeding 10 kg;

3. Lightweight "composite" or foam mirror structures having an average "equivalent density" of less than 30 kg/m^2 and a total mass exceeding 2 kg;

4. Beam steering mirrors more than 100 mm in diameter or length of major axis, which maintain a flatness of lambda/2 or better (lambda is equal to 633 nm) having 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 having any of the following:
   1. Exceeding 100 cm^3 in volume; or
   2. Exceeding 80 mm in diameter or length of major axis and 20 mm in thickness (depth).

6A004 continued

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. Raw substrates, processed substrates having surface coatings (single-layer or multi-layer, metallic or dielectric, conducting, semiconducting or insulating) or having protective films;

3. Segments or assemblies of mirrors designed to be assembled in space into an optical system with a collecting aperture equivalent to or larger than a single optic 1 m in diameter;

4. Manufactured from "composite" materials having a coefficient of linear thermal expansion equal to or less than 5×10^{-6} in any coordinate direction.

d. Optical control equipment, as follows:

1. Specially designed to maintain the surface figure or orientation of the "space-qualified" components specified in 6A004.c.1. or 6A004.c.3.;

2. Having steering, tracking, stabilisation or resonator alignment bandwidths equal to or more than 100 Hz and an accuracy of 10 µrad (microradians) or less;

3. Gimbals having all of the following:
   a. A maximum slew exceeding 5°;
   b. A bandwidth of 100 Hz or more;
   c. Angular pointing errors of 200 µrad (microradians) or less; and
   d. Having any of the following:
      1. Exceeding 0.15 m but not exceeding 1 m in diameter or major axis length and capable of angular accelerations exceeding 2 rad (radians)/s^2; or
      2. Exceeding 1 m in diameter or major axis length and capable of angular accelerations exceeding 0.5 rad (radians)/s^2;

4. Specially designed to maintain the alignment of phased array or phased segment mirror systems consisting of mirrors with a segment diameter or major axis length of 1 m or more.

e. 'Aspheric optical elements' having all of the following characteristics:
1. The largest dimension of the optical-aperture is greater than 400 mm;
2. The surface roughness is less than 1 nm (rms) for sampling lengths equal to or greater than 1 mm; and
3. The coefficient of linear thermal expansion's absolute magnitude is less than 3×10^{-6}/K at 25°C.

Technical Notes:

1. An 'aspheric optical element' is any element used in an optical system whose imaging surface or surfaces are designed to depart from the shape of an ideal sphere.

6A004 e. Technical Notes continued

2. *Manufacturers are not required to measure the surface roughness listed in 6A004.e.2. unless the optical element was designed or manufactured with the intent to meet, or exceed, the control parameter.*

Note *600A4.e. does not control aspheric optical elements having any of the following:*

a. *A largest optical-aperture dimension less than 1 m and a focal length to aperture ratio equal to or greater than 4.5:1;*
b. *A largest optical-aperture dimension equal to or greater than 1 m and a focal length to aperture ratio equal to or greater than 7:1;*
c. *Being designed as Fresnel, flyeye, stripe, prism or diffractive optical elements;*
d. *Being fabricated from borosilicate glass having a coefficient of linear thermal expansion greater than 2.5×10^{-6} /K at 25 °C; or*
e. *Being an x-ray optical element having inner mirror capabilities (e.g. tube-type mirrors).*

N.B. *For aspheric optical elements specially designed for lithography equipment, see 3B001.*

6A005 "Lasers", other than those specified in 0B001.g.5. or 0B001.h.6., components and optical equipment, as follows:

N.B.: SEE ALSO 6A205.

Note 1: *Pulsed "lasers" include those that run in a continuous wave (CW) mode with pulses superimposed.*

Note 2: *Pulse-excited "lasers" include those that run in a continuously excited mode with pulse excitation superimposed.*

Note 3: *The control 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 having any of the following:
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 having any of the following:
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 having any of the following:
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 having any of the following:
1. An output energy exceeding 1.5 J per pulse; or
2. An average or CW output power exceeding 30 W;

N.B. *For eximer "lasers" specially designed for lithography equipment, see 3B001*

2. Metal vapour "lasers", as follows:

a. Copper (Cu) "lasers" having an average or CW output power exceeding 20 W;

b. Gold (Au) "lasers" having an average or CW output power exceeding 5 W;

c. Sodium (Na) "lasers" having an output power exceeding 5 W;

d. Barium (Ba) "lasers" having an average or CW output power exceeding 2 W;

6A005 a. continued

3. Carbon monoxide (CO) "lasers" having any of the following:
   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 15 kW;
   b. A pulsed output having a "pulse duration" exceeding 10 µs and having any of the following:
      1. An average output power exceeding 10 kW; or
      2. A pulsed "peak power" exceeding 100 kW; or
   c. A pulsed output having a "pulse duration" equal to or less than 10 µs; and having any of the following:
      1. A pulse energy exceeding 5 J per pulse; 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", as follows:
      1. Oxygen Iodine (O_2-I) "lasers";
      2. Deuterium Fluoride-Carbon dioxide (DF-CO_2) "lasers";

6. Krypton ion or argon ion "lasers" having any of the following:
   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;

7. Other gas "lasers", having any of the following:
   Note: *6A005.a.7. does not control nitrogen "lasers".*

   a. An output wavelength not exceeding 150 nm and having any of the following:
      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 having any of the following:
      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 having any of the following:
      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.

6A005 continued

b. Semiconductor "lasers", having a wavelength of less than 950 nm or more than 2,000 nm, as follows:

1. Individual single-transverse mode semiconductor "lasers" having an average or CW output power exceeding 100 mW.

2. Individual, multiple-transverse mode semiconductor "lasers" and arrays of individual semiconductor "lasers", having any of the following:
   a. An output energy exceeding 500 μJ per pulse and a pulsed "peak power" exceeding 10 W; or
   b. An average or CW output power exceeding 10 W.

Technical Note:
Semiconductor "lasers" are commonly called "laser" diodes.
Note 1: 6A005.b. includes semiconductor "lasers" having optical output connectors (e.g. fibre optic pigtails).
Note 2: The control status of semiconductor "lasers" specially designed for other equipment is determined by the control status of the other equipment.

c. Solid state "lasers", as follows:

1. "Tunable" "lasers" having any of the following:

Note: 6A005.c.1. 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 having any of the following:
      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 having any of the following:
      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 having any of the following:
      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;

6A005 c. continued

2. Non-"tunable" "lasers", as follows:

Note: *6A005.c.2. includes atomic transition solid state "lasers".*

a. Neodymium glass "lasers", as follows:
   1. "Q-switched lasers" having any of the following:
      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 any of the following:
      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;

b. Neodymium-doped (other than glass) "lasers", having an output wavelength exceeding 1,000 nm but not exceeding 1,100 nm, as follows:

N.B.: *For neodymium-doped (other than glass) "lasers" having an output wavelength not exceeding 1,000 nm or exceeding 1,100 nm, see 6A005.c.2.c.*

   1. Pulse-excited, mode-locked, "Q-switched lasers" having a "pulse duration" of less than 1 ns and having any of the following:
      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" having a pulse duration equal to or more than 1 ns, and having any of the following:
      a. A single-transverse mode output having:
         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 having:
         1. A "peak power" exceeding 400 MW;
         2. An average output power exceeding 2 kW; or
         3. A pulsed energy exceeding 2 J;

   3. Pulse-excited, non-"Q-switched lasers", having:
      a. A single-transverse mode output having:
         1. A "peak power" exceeding 500 kW; or
         2. An average output power exceeding 150 W; or
      b. A multiple-transverse mode output having:
         1. A "peak power" exceeding 1 MW; or
         2. An average power exceeding 2 kW;

6A005 c. 2. b. continued

4. Continuously excited "lasers" having:
   a. A single-transverse mode output having:
      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 having:
      1. A "peak power" exceeding 1 MW; or
      2. An average or CW output power exceeding 2 kW;

c. Other non-"tunable" "lasers", having any of the following:

1. A wavelength less than 150 nm and having any of the following:
   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 having any of the following:
   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" having:
      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-transverse mode "lasers";
         b. 30 W for multiple-transverse mode "lasers";
   b. Non-"Q-switched lasers" having:
      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 having any of the following:
   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;

6A005 d. continued

2. A wavelength of 150 nm or more but not exceeding 800 nm and having any of the following:
   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 having 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 having any of the following:
   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 having any of the following:
   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. Components, as follows:

1. Mirrors cooled either by active cooling or by heat pipe cooling;
   Technical Note:
   Active cooling is a cooling technique for optical components using flowing fluids within the subsurface (nominally less than 1 mm below the optical surface) of the optical component to remove heat from the optic.

2. Optical mirrors or transmissive or partially transmissive optical or electro-optical components specially designed for use with controlled "lasers";

f. Optical equipment, as follows:

N.B.: For shared aperture optical elements, capable of operating in "Super-High Power Laser" ("SHPL") applications, see the Military Goods Lists.

1. Dynamic wavefront (phase) measuring equipment capable of mapping at least 50 positions on a beam wavefront having any of the following:
   a. Frame rates equal to or more than 100 Hz and phase discrimination of at least 5% of the beam's wavelength; or
   b. Frame rates equal to or more than 1,000 Hz and phase discrimination of at least 20% of the beam's wavelength;

2. "Laser" diagnostic equipment capable of measuring "SHPL" system angular beam steering errors of equal to or less than 10 μrad;

3. Optical equipment and components specially designed for a phased-array "SHPL" system for coherent beam combination to an accuracy of lambda/10 at the designed wavelength, or 0.1 μm, 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: *6A006 does not control instruments specially designed for biomagnetic measurements for medical diagnostics.*

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 any of the following:
   1. 0.05 nT rms/square root Hz at frequencies of less than 1 Hz;
   2. 1×10^{-3} nT rms/square root Hz at frequencies of 1 Hz or more but not exceeding 10 Hz; or
   3. 1×10^{-4} nT rms/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 6A006.a., 6A006.b. or 6A006.c.;

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 and having all of the following:

   1. Being 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));

   2. Being 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 μm 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:
N.B.: SEE ALSO 6A107.

a. Gravity meters designed or modified for ground use having a static accuracy of less (better) than 10 μgal;
Note: 6A007.a. does not control ground gravity meters of the quartz element (Worden) type.

b. Gravity meters designed for mobile platforms, having all of the following:
1. A static accuracy of less (better) than 0.7 mgal; and
2. An in-service (operational) accuracy of less (better) than 0.7 mgal having a time-to-steady-state registration of less than 2 minutes under any combination of attendant corrective compensations and motional influences;

c. Gravity gradiometers.

6A008 Radar systems, equipment and assemblies having any of the following characteristics, and specially designed components therefor:
N.B.: SEE ALSO 6A108.

Note: 6A008 does not control:
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';
Technical Note:
The 'centre operating frequency' equals one half of the sum of the highest plus the lowest specified operating frequencies.

c. Capable of operating simultaneously on more than two carrier frequencies;

d. Capable of operating in synthetic aperture (SAR), inverse synthetic aperture (ISAR) radar mode, or sidelooking airborne (SLAR) radar mode;

e. Incorporating "electronically steerable phased array antennae";

f. Capable of heightfinding non-cooperative targets;
Note: 6A008.f. does not control precision approach radar (PAR) equipment conforming to ICAO standards.

g. Specially designed for airborne (balloon or airframe mounted) operation and having Doppler "signal processing" for the detection of moving targets;

6A008 continued

h. Employing processing of radar signals using any of the following:
1. "Radar spread spectrum" techniques; or
2. "Radar frequency agility" techniques;

i. Providing ground-based operation with a maximum "instrumented range" exceeding 185 km;
Note: *6A008.i. does not control:*
a. Fishing ground surveillance radar;
b. Ground radar equipment specially designed for enroute air traffic control, provided that all the following conditions are met:
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;
c. Weather balloon tracking radars.

j. Being "laser" radar or Light Detection and Ranging (LIDAR) equipment, having any 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 μrad (microradians);
Note: *6A008.j. does not control LIDAR equipment specially designed for surveying or for meteorological observation.*

k. Having "signal processing" sub-systems using "pulse compression", with any of the following:
1. A "pulse compression" ratio exceeding 150; or
2. A pulse width of less than 200 ns; or

l. Having data processing sub-systems with any of the following:
1. "Automatic target tracking" providing, at any antenna rotation, the predicted target position beyond the time of the next antenna beam passage;
Note: *6A008.l.1. does not control 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: *6A008.l.4. does not control systems, equipment and assemblies used for marine traffic control.*

6A102 Radiation hardened detectors, other than those specified in 6A002, specially designed or modified for 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 (silicon).

Technical Note:

In 6A102, a detector is defined as 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 Gravity meters (gravimeters) and components for gravity meters and gravity gradiometers, as follows:

a. Gravity meters, other than those specified in 6A007.b, designed or modified for airborne or marine use, and having a static or operational accuracy of 7×10^{-6} m/s^2 (0.7 milligal) or less (better), and having a time-to-steady-state registration of two minutes or less;

b. Specially designed components for gravity meters specified in 6A007.b or 6A107.a. and gravity gradiometers specified in 6A007.c.

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 space launch vehicles specified in 9A004 or sounding rockets specified in 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 having both of the following characteristics:
a. Photocathode area of greater than 20 cm^2; and
b. Anode pulse rise time of less than 1 ns.

6A203 Cameras and components, other than those specified in 6A003, as follows:

a. Mechanical rotating mirror cameras, as follows, and specially designed components therefor:
   1. 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: *In 6A203.a. components of such cameras include their synchronizing electronics units and rotor assemblies consisting of turbines, mirrors and bearings.*

6A203 continued

b. Electronic streak cameras, electronic framing cameras, tubes and devices, as follows:
   1. Electronic streak cameras capable of 50 ns or less time resolution;
   2. Streak tubes for cameras specified in 6A203.b.1.;
   3. Electronic (or electronically shuttered) framing cameras capable of 50 ns or less frame exposure time;
   4. Framing tubes and solid-state imaging devices for use with cameras specified in 6A203.b.3., 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 Pockels cell electro-optical shuttering;
      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 6A203.b.3.;

c. Radiation-hardened TV cameras, or lenses therefor, specially designed or rated as radiation hardened to withstand a total radiation dose greater than 50×10^3 Gy(silicon) (5×10^6 rad (silicon)) without operational degradation.
   Technical Note:
   The term Gy(silicon) refers to the energy in Joules per kilogram absorbed by an unshielded silicon sample when exposed to ionising radiation.

6A205 "Lasers", "laser" amplifiers and oscillators, other than those specified in 0B001.g.5., 0B001.h.6. and 6A005; as follows:

a. Argon ion "lasers" having both of the following characteristics:
   1. Operating at wavelengths between 400 nm and 515 nm; and
   2. An average output power greater than 40 W;

b. Tunable pulsed single-mode dye laser oscillators having all of the following characteristics:
   1. Operating at wavelengths between 300 nm and 800 nm;
   2. An average output power greater than 1 W;
   3. A repetition rate greater than 1 kHz; and
   4. Pulse width less than 100 ns;

c. Tunable pulsed dye laser amplifiers and oscillators, having all of the following characteristics:
   1. Operating at wavelengths between 300 nm and 800 nm;
   2. An average output power greater than 30 W;
   3. A repetition rate greater than 1 kHz; and
   4. Pulse width less than 100 ns;
   Note: *6A205.c. does not control single mode oscillators;*

6A205 continued

d. Pulsed carbon dioxide "lasers" having all of the following characteristics:
   1. Operating at wavelengths between 9,000 nm and 11,000 nm;
   2. A repetition rate greater than 250 Hz;
   3. An average output power greater than 500 W; and
   4. Pulse width of less than 200 ns;

e. Para-hydrogen Raman shifters designed to operate at 16 micrometre output wavelength and at a repetition rate greater than 250 Hz;

f. Pulse-excited, Q-switched neodymium-doped (other than glass) "lasers", having all of the following characteristics:
   1. An output wavelength exceeding 1,000 nm but not exceeding 1,100 nm;
   2. A pulse duration equal to or more than 1 ns; and
   3. A multiple-transverse mode output having an average power exceeding 50 W.

6A225 Velocity interferometers for measuring velocities exceeding 1 km/s during time intervals of less than 10 microseconds.

Note: *6A225 includes velocity interferometers such as VISARs (Velocity interferometer systems for any reflector) and DLIs (Doppler laser interferometers).*

6A226 Pressure sensors, as follows:

a. Manganin gauges for pressures greater than 10 GPa;

b. Quartz pressure transducers for pressures greater than 10 GPa.

6B Test, Inspection and Production Equipment

6B004 Optical equipment, as follows:

a. Equipment for measuring absolute reflectance to an accuracy of ± 0.1% of the reflectance value;

b. Equipment other than optical surface scattering measurement equipment, having an unobscured aperture of more than 10 cm, specially designed for the non-contact optical measurement of a non-planar optical surface figure (profile) to an "accuracy" of 2 nm or less (better) against the required profile.

Note: *6B004 does not control microscopes.*

6B007 Equipment to produce, align and calibrate land-based gravity meters with a static accuracy of better than 0.1 mgal.

6B008 Pulse radar cross-section measurement systems having transmit pulse widths of 100 ns or less and specially designed components therefor.
N.B.: SEE ALSO 6B108.

6B108 Systems, other than those specified in 6B008, specially designed for radar cross section measurement usable for "missiles" and their subsystems.

6C Materials

6C002 Optical sensor materials, as follows:

a. Elemental tellurium (Te) of purity levels of 99.9995% or more;

b. Single crystals of cadmium zinc telluride (CdZnTe), with zinc content of less than 6% by weight, or cadmium telluride (CdTe), or mercury cadmium telluride (HgCdTe) of any purity level, including epitaxial wafers thereof.

6C004 Optical materials, as follows:

a. Zinc selenide (ZnSe) and zinc sulphide (ZnS) "substrate blanks" produced by the chemical vapour deposition process, having any of the following:
   1. A volume greater than 100 cm^3; or
   2. A diameter greater than 80 mm having a thickness of 20 mm or more;

b. Boules of the following electro-optic materials:
   1. Potassium titanyl arsenate (KTA);
   2. Silver gallium selenide ($AgGaSe_2$);
   3. Thallium arsenic selenide (Tl_3AsSe_3, also known as TAS);

c. Non-linear optical materials, having all of the following:
   1. Third order susceptibility (chi 3) of 10^{-6} m^2/V^2 or more; and
   2. A response time of less than 1 ms;

d. "Substrate blanks" of silicon carbide or beryllium beryllium (Be/Be) deposited materials exceeding 300 mm in diameter or major axis length;

6C004 continued

e. Glass, including fused silica, phosphate glass, fluorophosphate glass, zirconium fluoride (ZrF_4) and hafnium fluoride (HfF_4), having all of the following:
   1. A hydroxyl ion (OH-) concentration of less than 5 ppm;
   2. Integrated metallic purity levels of less than 1 ppm; and
   3. High homogeneity (index of refraction variance) less than 5×10^{-6};

f. Synthetically produced diamond material with an absorption of less than 10^{-5} cm^{-1} for wavelengths exceeding 200 nm but not exceeding 14,000 nm.

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 equipment specified in 6A004, 6A005, 6A008 or 6B008.

6D002 "Software" specially designed for the "use" of equipment specified in 6A002.b., 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;

   3. "Software" specially designed for acoustic beam forming for "real time processing" of acoustic data for passive reception using bottom or bay cable systems;

   4. "Source code" for "real time processing" of acoustic data for passive reception using bottom or bay cable systems;

6D003 continued

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"; or
   b. Accepting radar target data from more than four primary radars;

2. "Software" for the design or "production" of radomes which:
   a. Are specially designed to protect the "electronically steerable phased array antennae" specified in 6A008.e.; and
   b. Result in an antenna pattern having an 'average side lobe level' more than 40 dB below the peak of the main beam level.
   Technical Note:
   'Average side lobe level' in 6D003.d.2.b. is measured over the entire array excluding the angular extent of the main beam and the first two side lobes on either side of the main beam.

6D102 "Software" specially designed or modified for the "use" of goods specified in 6A108.

6D103 "Software" which processes post-flight, recorded data, enabling determination of vehicle position throughout its flight path, specially designed or modified for "missiles".

6E Technology

6E001 "Technology" according to the General Technology Note for the "development" of equipment, materials or "software" specified in 6A, 6B, 6C or 6D.

6E002 "Technology" according to the General Technology Note for the "production" of equipment or materials specified in 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};

N.B.: *See also 2E003.f.*

2. Optical fabrication "technology" using single point diamond turning techniques to produce surface finish accuracies of better than 10 nm rms on non-planar surfaces exceeding 0.5 m^2;

b. "Technology" "required" for the "development", "production" or "use" of specially designed diagnostic instruments or targets in test facilities for "SHPL" testing or testing or evaluation of materials irradiated by "SHPL" beams;

c. "Technology" "required" for the "development" or "production" of fluxgate "magnetometers" or fluxgate "magnetometer" systems, having any of the following:

1. A "noise level" of less than 0.05 nT rms per square root Hz at frequencies of less than 1 Hz; or
2. A "noise level" of less than 1×10^{-3} nT rms per square root Hz at frequencies of 1 Hz or more.

6E101 "Technology" according to the General Technology Note for the "use" of equipment or "software" specified in 6A002, 6A007.b. and c., 6A008, 6A102, 6A107, 6A108, 6B108, 6D102 or 6D103.

Note: *6E101 only specifies "technology" for equipment specified in 6A008 when it is designed for airborne applications and is usable in "missiles".*

6E201 "Technology" according to the General Technology Note for the "use" of equipment specified in 6A003, 6A005.a.1.c., 6A005.a.2.a., 6A005.c.1.b., 6A005.c.2.c.2., 6A005.c.2.d.2.b., 6A202, 6A203, 6A205, 6A225 or 6A226.

CATEGORY 7 - NAVIGATION AND AVIONICS

7A Systems, Equipment and Components

N.B. 1: For automatic pilots for underwater vehicles, see Category 8. For radar, see Category 6.

N.B. 2: For inertial navigation equipment for ships or submersibles see the Military Goods Controls

7A001 Accelerometers designed for use in inertial navigation or guidance systems and having any of the following characteristics, and specially designed components therefor:
N.B.: SEE ALSO 7A101.

a. A "bias" "stability" of less (better) than 130 micro g with respect to a fixed calibration value over a period of one year;
b. A "scale factor" "stability" of less (better) than 130 ppm with respect to a fixed calibration value over a period of one year; or
c. Specified to function at linear acceleration levels exceeding 100 g.

7A002 Gyros having any of the following characteristics, and specially designed components therefor:
N.B.: SEE ALSO 7A102.

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; or

b. Specified to function at linear acceleration levels exceeding 100 g.

7A003 Inertial navigation systems (gimballed or strapdown) and inertial equipment designed for "aircraft", land vehicle or "spacecraft" for attitude, guidance or control having any of the following characteristics, and specially designed components therefor:
N.B.: SEE ALSO 7A103.

a. Navigation error (free inertial) subsequent to normal alignment of 0.8 nautical mile per hour (50% Circular Error Probable (CEP)) or less (better); or
b. Specified to function at linear acceleration levels exceeding 10 g.

Note 1: The parameters of 7A003.a. are applicable with any of the following environmental conditions:
   1. Input random vibration with an overall magnitude of 7.7 g rms in the first half hour and a total test duration of one and one half hour per axis in each of the three perpendicular axes, when the random vibration meets the following:

7A003 Note 1. 1. continued

a. A constant power spectral density (PSD) value of 0.04 g^2/Hz over a frequency interval of 15 to 1,000 Hz; and

b. The PSD attenuates with frequency from 0.04 g^2/Hz to 0.01 g^2/Hz over a frequency interval from 1,000 to 2,000 Hz; or

2. A roll and yaw rate of equal to or more than +2.62 radian/s (150 deg/s); or

3. According to national standards equivalent to 1. or 2. above.

Note 2: 7A003 does not control inertial navigation systems which are certified for use on "civil aircraft" by civil authorities of a "participating state".

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.
N.B.: SEE ALSO 7A104.

7A005 Global navigation satellite systems (i.e. GPS or GLONASS) receiving equipment having any of the following characteristics, and specially designed components therefor:
N.B.: SEE ALSO 7A105.

a. Employing decryption; or
b. A null-steerable antenna.

7A006 Airborne altimeters operating at frequencies other than 4.2 to 4.4 GHz inclusive, having any of the following characteristics:
N.B.: SEE ALSO 7A106.

a. "Power management"; or
b. Using phase shift key modulation.

7A007 Direction finding equipment operating at frequencies above 30 MHz and having all of the following characteristics, and specially designed components therefor:

a. "Instantaneous bandwidth" of 1 MHz or more;
b. Parallel processing of more than 100 frequency channels; and
c. Processing rate of more than 1,000 direction finding results per second and per frequency channel.

7A101 Accelerometers, other than those specified in 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 inertial navigation systems or in guidance systems of all types and specially designed components therefor.

Note: 7A101 does not specify accelerometers which are specially designed and developed as MWD (Measurement While Drilling) Sensors for use in downhole well service operations.

7A102 All types of gyros, other than those specified in 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 equipment and systems, other than those specified in 7A003, as follows; and specially designed components therefor:

a. Inertial or other equipment using accelerometers or gyros specified in 7A001, 7A002, 7A101 or 7A102 and systems incorporating such equipment;
Note: *7A103.a. does not specify equipment containing accelerometers specified 7A001 where such accelerometers are specially designed and developed as MWD (Measurement While Drilling) sensors for use in down-hole well services operations.*

b. Integrated flight instrument systems, which include gyrostabilisers or automatic pilots, designed or modified for use in space launch vehicles specified in 9A004 or sounding rockets specified in 9A104.

7A104 Gyro-astro compasses and other devices, other than those specified in 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 7A005, capable of providing navigation information under the following operational conditions and designed or modified for use in space launch vehicles specified in 9A004 or sounding rockets specified in 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 7A006, of radar or laser radar type, designed or modified for use in space launch vehicles specified in 9A004 or sounding rockets specified in 9A104.

7A115 Passive sensors for determining bearing to specific electromagnetic source (direction finding equipment) or terrain characteristics, designed or modified for use in space launch vehicles specified in 9A004 or sounding rockets specified in 9A104.

Note: *7A115 includes sensors for the following equipment:*
a. Terrain contour mapping equipment;
b. Imaging sensor equipment (both active and passive);
c. Passive interferometer equipment.

7A116 Flight control systems, as follows; designed or modified for use in space launch vehicles specified in 9A004 or sounding rockets specified in 9A104.

a. Hydraulic, mechanical, electro-optical, or electro-mechanical flight control systems (including 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 7A.

Note: *7B001 does not control test, calibration or alignment equipment for Maintenance Level I or Maintenance Level II.*

Technical Notes:

1. *Maintenance Level I*
The failure of an inertial navigation unit is detected on the aircraft by indications from the control and display unit (CDU) or by the status message from the corresponding sub-system. By following the manufacturer's manual, the cause of the failure may be localised at the level of the malfunctioning line replaceable unit (LRU). The operator then removes the LRU and replaces it with a spare.

2. *Maintenance Level II*
The defective LRU is sent to the maintenance workshop (the manufacturer's or that of the operator responsible for level II maintenance). At the maintenance workshop, the malfunctioning LRU is tested by various appropriate means to verify and localise the defective shop replaceable assembly (SRA) module responsible for the failure. This SRA is removed and replaced by an operative spare. The defective SRA (or possibly the complete LRU) is then shipped to the manufacturer.
N.B. Maintenance Level II does not include the removal of controlled accelerometers or gyro sensors from the SRA.

7B002 Equipment, as follows, specially designed to characterize mirrors for ring "laser" gyros:
N.B.: SEE ALSO 7B102.

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 7A.

Note: *7B003 includes:*

a. Gyro tuning test stations;
b. Gyro dynamic balance stations;
c. Gyro run-in/motor test stations;
d. Gyro evacuation and fill stations;
e. Centrifuge fixtures for gyro bearings;
f. Accelerometer axis align stations.

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 7A117.

7C Materials

None.

7D Software

7D001 "Software" specially designed or modified for the "development" or "production" of equipment specified in 7A. or 7B.

7D002 "Source code" for the "use" of any inertial navigation equipment including inertial equipment not controlled by 7A003 or 7A004, or Attitude and Heading Reference Systems (AHRS).

Note: *7D002 does not control "source code" for the "use" of gimballed AHRS.*

Technical Note:
AHRS generally differ from inertial navigation systems (INS) in that an AHRS provides attitude and heading information and normally does not provide the acceleration, velocity and position information associated with an INS.

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 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 7A003 by continuously combining inertial data with any of the following navigation data:
1. Doppler radar velocity;
2. Global navigation satellite systems (i.e., GPS or GLONASS) reference data; or
3. Terrain data from data bases;

c. "Source code" for integrated avionics or mission systems which combine sensor data and employ "expert systems";

d. "Source code" for the "development" of any of the following:
1. Digital flight management systems for "total control of flight";
2. Integrated propulsion and flight control systems;
3. Fly-by-wire or fly-by-light control systems;
4. Fault-tolerant or self-reconfiguring "active flight control systems";
5. Airborne automatic direction finding equipment;
6. Air data systems based on surface static data; or
7. Raster-type head-up displays or three dimensional displays;

e. Computer-aided-design (CAD) "software" specially designed for the "development" of "active flight control systems", helicopter multi-axis fly-by-wire or fly-by-light controllers or helicopter "circulation controlled anti-torque or circulation-controlled direction control systems" whose "technology" is specified in 7E004.b., 7E004.c.1. or 7E004.c.2.

7D101 "Software" specially designed or modified for the "use" of equipment specified in 7A001 to 7A006, 7A101 to 7A106, 7A115, 7A116.a., 7A116.b., 7B001, 7B002, 7B003, 7B102 or 7B103.

7D102 Integration "software" as follows:

a. Integration "software" for the equipment specified in 7A103.b.;

b. Integration "software" specially designed for the equipment specified in 7A003 or 7A103.a.

7D103 "Software" specially designed for modelling or simulation of the "guidance sets" specified in 7A117 or for their design integration with the space launch vehicles specified in 9A004 or sounding rockets specified in 9A104.

Note: *"Software" specified in 7D103 remains controlled when combined with specially designed hardware specified in 4A102.*

7E Technology

7E001 "Technology" according to the General Technology Note for the "development" of equipment or "software" specified in 7A, 7B or 7D.

7E002 "Technology" according to the General Technology Note for the "production" of equipment specified in 7A or 7B.

7E003 "Technology" according to the General Technology Note for the repair, refurbishing or overhaul of equipment specified in 7A001 to 7A004.

Note: *7E003 does not control maintenance "technology" directly associated with calibration, removal or replacement of damaged or unserviceable LRUs and SRAs of a "civil aircraft" as described in Maintenance Level I or Maintenance Level II.*
N.B.: *See Technical Notes to 7B001.*

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 7A001 or 7A002;
5. Electric actuators (i.e., electromechanical, electrohydrostatic and integrated actuator package) specially designed for "primary flight control";
6. "Flight control optical sensor array" specially designed for implementing "active flight control systems";

b. "Development" "technology", as follows, for "active flight control systems" (including fly-by-wire or fly-by-light):

1. Configuration design for interconnecting multiple microelectronic processing elements (on-board computers) to achieve "real time processing" for control law implementation;
2. Control law compensation for sensor location or dynamic airframe loads, i.e., compensation for sensor vibration environment or for variation of sensor location from the centre of gravity;
3. Electronic management of data redundancy or systems redundancy for fault detection, fault tolerance, fault isolation or reconfiguration;
Note: *7E004.b.3. does not control "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;

7E004 b. continued

5. Integration of digital flight control, navigation and propulsion control data into a digital flight management system for "total control of flight";
   Note: *7E004.b.5. does not control:*
   a. "Development" "technology" for integration of digital flight control, navigation and propulsion control data into a digital flight management system for "flight path optimisation";
   b. "Development" "technology" for "aircraft" flight instrument systems integrated solely for VOR, DME, ILS or MLS navigation or approaches.
6. Full authority digital flight control or multisensor mission management systems employing "expert systems";
   N.B.: *For "technology" for Full Authority Digital Engine Control ("FADEC"), see 9E003.a.9.*

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" according to the General Technology Note for the "use" of equipment specified in 7A001 to 7A006, 7A101 to 7A106, 7A115 to 7A117, 7B001, 7B002, 7B003, 7B102, 7B103, 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 subsystems;
c. Design "technology" for the determination of hardening criteria of 7E102.a. and 7E102.b.

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

8A Systems, Equipment and Components

8A001 Submersible vehicles and surface vessels, as follows:

Note: *For the control status of equipment for submersible vehicles, see:*
Category 5, Part 2 "Information Security" for encrypted communication equipment;
Category 6 for sensors;
Categories 7 and 8 for navigation equipment;
Category 8A for underwater equipment.

a. Manned, tethered submersible vehicles designed to operate at depths exceeding 1,000 m;

b. Manned, untethered submersible vehicles, having any of the following:
   1. Designed to 'operate autonomously' and having a lifting capacity of all the following:
      a. 10% or more of their weight in air; and
      b. 15 kN or more;
   2. Designed to operate at depths exceeding 1,000 m; or
   3. Having all of the following:
      a. Designed to 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;

Technical Notes:
1. *For the purposes of 8A001.b., 'operate autonomously' means fully submerged, without snorkel, all systems working and cruising at minimum speed at which the submersible can safely control its depth dynamically by using its depth planes only, with no need for a support vessel or support base on the surface, sea-bed or shore, and containing a propulsion system for submerged or surface use.*
2. *For the purposes of 8A001.b., 'range' means half the maximum distance a submersible vehicle can cover.*

c. Unmanned, tethered submersible vehicles designed to operate at depths exceeding 1,000 m, having any of the following:
   1. Designed for self-propelled manoeuvre using propulsion motors or thrusters specified in 8A002.a.2.; or
   2. Having a fibre optic data link;

d. Unmanned, untethered submersible vehicles, having any of the following:
   1. Designed for deciding a course relative to any geographical reference without real-time human assistance;
   2. Having an acoustic data or command link; or
   3. Having a fibre optic data or command link exceeding 1,000 m;

8A001 continued

e. Ocean salvage systems with a lifting capacity exceeding 5 MN for salvaging objects from depths exceeding 250 m and having any of the following:
   1. Dynamic positioning systems capable of position keeping within 20 m of a given point provided by the navigation system; or
   2. Seafloor navigation and navigation integration systems for depths exceeding 1,000 m with positioning accuracies to within 10 m of a predetermined point;

f. Surface-effect vehicles (fully skirted variety) having all of the following characteristics:
   1. A maximum design speed, fully loaded, exceeding 30 knots in a significant wave height of 1.25 m (Sea State 3) or more;
   2. A cushion pressure exceeding 3,830 Pa; and
   3. A light-ship-to-full-load displacement ratio of less than 0.70;

g. Surface-effect vehicles (rigid sidewalls) with a maximum design speed, fully loaded, exceeding 40 knots in a significant wave height of 3.25 m (Sea State 5) or more;

h. Hydrofoil vessels with active systems for automatically controlling foil systems, with a maximum design speed, fully loaded, of 40 knots or more in a significant wave height of 3.25 m (Sea State 5) or more;

i. 'Small waterplane area vessels' having any of the following:
   1. 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
   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.

   Technical Note:
   A 'small waterplane area vessel' is defined by the following formula: waterplane area at an operational design draught less than 2 x (displaced volume at the operational design draught)$^{2/3}$.

8A002 Systems and equipment, as follows:

Note: *For underwater communications systems, see Category 5, Part 1 - Telecommunications.*

a. Systems and 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;

8A002 continued

b. Systems specially designed or modified for the automated control of the motion of submersible vehicles specified in 8A001 using navigation data and having closed loop servo-controls:
   1. Enabling a vehicle to move within 10 m of a predetermined point in the water column;
   2. Maintaining the position of the vehicle within 10 m of a predetermined point in the water column; or
   3. Maintaining the position of the vehicle within 10 m while following a cable on or under the seabed;

c. Fibre optic hull penetrators or connectors;

d. Underwater vision systems, as follows:
   1. Television systems and television cameras, as follows:
      a. Television systems (comprising camera, monitoring and signal transmission equipment) having a limiting resolution when measured in air of more than 800 lines and specially designed or modified for remote operation with a submersible vehicle;
      b. Underwater television cameras having a limiting resolution when measured in air of more than 1,100 lines;
      c. Low light level television cameras specially designed or modified for underwater use containing all of the following:
         1. Image intensifier tubes specified in 6A002.a.2.a.; and
         2. More than 150,000 "active pixels" per solid state area array;
         Technical 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 IEEE Standard 208/1960 or any equivalent standard.
   2. Systems, specially designed or modified for remote operation with an underwater vehicle, employing techniques to minimise the effects of back scatter, including range-gated illuminators or "laser" systems;

e. Photographic still cameras specially designed or modified for underwater use below 150 m having a film format of 35 mm or larger, and having any of the following:
   1. Annotation of the film with data provided by a source external to the camera;
   2. Automatic back focal distance correction; or
   3. Automatic compensation control specially designed to permit an underwater camera housing to be usable at depths exceeding 1,000 m;

f. 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 and a flash rate of more than 5 flashes per second;
   2. Argon arc light systems specially designed for use below 1,000 m;

8A002 continued

h. "Robots" specially designed for underwater use, controlled by using a dedicated "stored programme controlled" computer, having any of the following:
   1. Systems that control the "robot" using information from sensors which measure force or torque applied to an external object, distance to an external object, or tactile sense between the "robot" and an external object; or
   2. The ability to exert a force of 250 N or more or a torque of 250 Nm or more and using titanium based alloys or "fibrous or filamentary" "composite" materials in their structural members;

i. Remotely controlled articulated manipulators specially designed or modified for use with submersible vehicles, having any of the following:
   1. 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 controlled" 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 controlled" computer are counted when determining the number of degrees of freedom of movement.*

j. Air independent power systems, specially designed for underwater use, as follows:

   1. Brayton or Rankine cycle engine air independent power systems having any of the following:
      a. Chemical scrubber or absorber systems specially designed to remove carbon dioxide, carbon monoxide and particulates from recirculated engine exhaust;
      b. Systems specially designed to use a monoatomic gas;
      c. Devices or enclosures specially designed for underwater noise reduction in frequencies below 10 kHz, or special mounting devices for shock mitigation; or
      d. Systems 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;

8A002 j. continued

3. Fuel cell air independent power systems with an output exceeding 2 kW having any of the following:
   a. Devices or enclosures specially designed for underwater noise reduction in frequencies below 10 kHz or special mounting devices for shock mitigation; or
   b. Systems 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;

4. Stirling cycle engine air independent power systems, having all of the following:
   a. Devices or enclosures specially designed for underwater noise reduction in frequencies below 10 kHz or special mounting devices for shock mitigation; and
   b. Specially designed exhaust systems which discharge the products of combustion against a pressure of 100 kPa or more;

k. Skirts, seals and fingers, having any of the following:
   1. Designed for cushion pressures of 3,830 Pa or more, operating in a significant wave height of 1.25 m (Sea State 3) or more and specially designed for surface effect vehicles (fully skirted variety) specified in 8A001.f.; or
   2. Designed for cushion pressures of 6,224 Pa or more, operating in a significant wave height of 3.25 m (Sea State 5) or more and specially designed for surface effect vehicles (rigid sidewalls) specified in 8A001.g.;

l. Lift fans rated at more than 400 kW specially designed for surface effect vehicles specified in 8A001.f. or 8A001.g.;

m. Fully submerged subcavitating or supercavitating hydrofoils specially designed for vessels specified in 8A001.h.;

n. Active systems specially designed or modified to control automatically the sea-induced motion of vehicles or vessels specified in 8A001.f., 8A001.g., 8A001.h. or 8A001.i.;

o. Propellers, power transmission systems, power generation systems and noise reduction systems, as follows:

   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 8A001.f., 8A001.g., 8A001.h. or 8A001.i.:
      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;

8A002 o. continued

2. Water-screw propeller, power generation systems or transmission systems designed for use on vessels, as follows:
   a. Controllable-pitch propellers and hub assemblies rated at more than 30 MW;
   b. Internally liquid-cooled electric propulsion engines with a power output exceeding 2.5 MW;
   c. "Superconductive" propulsion engines, or permanent magnet electric propulsion engines, with a power output exceeding 0.1 MW;
   d. Power transmission shaft systems, incorporating "composite" material components, capable of transmitting more than 2 MW;
   e. Ventilated or base-ventilated propeller systems rated at more than 2.5 MW;

3. Noise reduction systems designed for use on vessels of 1,000 tonnes displacement or more, as follows:
   a. Systems that attenuate underwater noise at frequencies below 500 Hz and consist of compound acoustic mounts for the acoustic isolation of diesel engines, diesel generator sets, gas turbines, gas turbine generator sets, propulsion motors or propulsion reduction gears, specially designed for sound or vibration isolation, 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 having 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;

q. Self-contained, closed or semi-closed circuit (rebreathing) diving and underwater swimming apparatus.
   Note: *8A002.q. does not control an individual apparatus for personal use when accompanying its user.*

8B Test, Inspection and Production Equipment

8B001 Water tunnels, having a background noise of less than 100 dB (reference 1 μPa, 1 Hz), in the frequency range from 0 to 500 Hz, designed for measuring acoustic fields generated by a hydro-flow around propulsion system models.

8C **Materials**

8C001 'Syntactic foam' designed for underwater use, having all of the following:

a. Designed for marine depths exceeding 1,000 m; and

b. A density less than 561 kg/m^3.

Technical Note:
'Syntactic foam' consists of hollow spheres of plastic or glass embedded in a resin matrix.

8D **Software**

8D001 "Software" specially designed or modified for the "development", "production" or"use" of equipment or materials specified in 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" according to the General Technology Note for the "development" or "production" of equipment or materials specified in 8A, 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;

b. "Technology" for the overhaul or refurbishing of equipment specified in 8A001, 8A002.b., 8A002.j., 8A002.o. or 8A002.p.

CATEGORY 9 - PROPULSION SYSTEMS, SPACE VEHICLES AND RELATED EQUIPMENT

9A Systems, Equipment and Components

N.B.: For propulsion systems designed or rated against neutron or transient ionizing radiation, see the Military Goods Controls.

9A001 Aero gas turbine engines incorporating any of the "technologies" specified in 9E003.a., as follows:
N.B.: SEE ALSO 9A101.

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 "participating state";
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 not exceeding 0.219 kg/kWh in the power range from 35 to 100%, and specially designed assemblies and components therefor.

Note: The term 'marine gas turbine engines' includes those industrial, or aero-derivative, gas turbine engines adapted for a ship's electric power generation or propulsion.

9A003 Specially designed assemblies and components, incorporating any of the "technologies" specified in 9E003.a., for the following gas turbine engine propulsion systems:

a. Specified in 9A001;
b. Whose design or production origins are either non-"participating states" or unknown to the manufacturer.

9A004 Space launch vehicles and "spacecraft".
N.B.: SEE ALSO 9A104.

Note: 9A004 does not control payloads.

N.B.: For the control status of products contained in "spacecraft" payloads, see the appropriate Categories.

9A005 Liquid rocket propulsion systems containing any of the systems or components specified in 9A006 .
N.B.: SEE ALSO 9A105 and 9A119.

9A006 Systems and components specially designed for liquid rocket propulsion systems, as follows:

N.B.: SEE ALSO 9A106 and 9A108.

a. Cryogenic refrigerators, flightweight dewars, cryogenic heat pipes or cryogenic systems specially designed for use in space vehicles and capable of restricting cryogenic fluid losses to less than 30% per year;

b. Cryogenic containers or closed-cycle refrigeration systems capable of providing temperatures of 100 K (-173°C) or less for "aircraft" capable of sustained flight at speeds exceeding Mach 3, launch vehicles or "spacecraft";

c. Slush hydrogen storage or transfer systems;

d. High pressure (exceeding 17.5 MPa) turbo pumps, pump components or their associated gas generator or expander cycle turbine drive systems;

e. High-pressure (exceeding 10.6 MPa) thrust chambers and nozzles therefor;

f. Propellant storage systems using the principle of capillary containment or positive expulsion (i.e., with flexible bladders);

g. Liquid propellant injectors, with individual orifices of 0.381 mm or smaller in diameter (an area of 1.14×10^{-3} cm^2 or smaller for non-circular orifices) specially designed for liquid rocket engines;

h. One-piece carbon-carbon thrust chambers or one-piece carbon-carbon exit cones with densities exceeding 1.4 g/cm^3 and tensile strengths exceeding 48 MPa.

9A007 Solid rocket propulsion systems with any of the following:

N.B.: SEE ALSO 9A119.

a. Total impulse capacity exceeding 1.1 MNs;

b. Specific impulse of 2.4 kNs/kg or more when the nozzle flow is expanded to ambient sea level conditions for an adjusted chamber pressure of 7 MPa;

c. Stage mass fractions exceeding 88% and propellant solid loadings exceeding 86%;

d. Any of the components specified in 9A008; or

e. Insulation and propellant bonding systems using direct-bonded motor designs to provide a 'strong mechanical bond' or a barrier to chemical migration between the solid propellant and case insulation material.
Technical Note:
For the purposes of 9A007.e., a 'strong mechanical bond' means bond strength equal to or more than propellant strength.

9A008 Components, as follows, specially designed for solid rocket propulsion systems:
N.B.: SEE ALSO 9A108.

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;
Technical Note:
For the purposes of 9A008.a., 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;
Technical 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 any of the following:
1. Omni-axial movement exceeding ± 5°;
2. Angular vector rotations of 20°/s or more; or
3. Angular vector accelerations of $40°/s^2$ or more.

9A009 Hybrid rocket propulsion systems with:
N.B.: SEE ALSO 9A109 and 9A119.

a. Total impulse capacity exceeding 1.1 MNs; or
b. Thrust levels exceeding 220 kN in vacuum exit conditions.

9A010 Specially designed components, systems and structures for launch vehicles, launch vehicle propulsion systems or "spacecraft", as follows:
N.B.: SEE ALSO 1A002 AND 9A110.

a. Components and structures each exceeding 10 kg, specially designed for launch vehicles manufactured using metal "matrix", "composite", organic "composite", ceramic "matrix" or intermetallic reinforced materials specified in 1C007 or 1C010;
Note: The weight cut-off is not relevant for nose cones.

b. Components and structures specially designed for launch vehicle propulsion systems specified in 9A005 to 9A009 manufactured using metal matrix, composite, organic composite, ceramic matrix or intermetallic reinforced materials specified in 1C007 or 1C010;

c. Structural components and isolation systems specially designed to control actively the dynamic response or distortion of "spacecraft" structures;

d. Pulsed liquid rocket engines with thrust-to-weight ratios equal to or more than 1 kN/kg and a response time (the time required to achieve 90% of total rated thrust from start-up) of less than 30 ms.

9A011 Ramjet, scramjet or combined cycle engines and specially designed components therefor.
N.B.: SEE ALSO 9A111 and 9A118.

9A101 Lightweight turbojet and turbofan engines (including turbocompound engines) usable in "missiles", other than those specified in 9A001, as follows;

a. Engines having both of the following characteristics:
1. Maximum thrust value greater than 1,000 N (achieved un-installed) excluding civil certified engines with a maximum thrust value greater than 8,890 N (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.
N.B.: SEE ALSO 9A004.

9A105 Liquid propellant rocket engines, as follows:
N.B.: SEE ALSO 9A119.

a. Liquid propellant rocket engines usable in "missiles", other than those specified in 9A005, having a total impulse capacity of 1.1 MNs or greater;

b. Liquid propellant rocket engines, usable in complete rocket systems or unmanned air vehicles, capable of a range of 300 km, other than those specified in 9A005 or 9A105.a., having a total impulse capacity of 0.841 MNs or greater.

9A106 Systems or components, other than those specified in 9A006, usable in "missiles", as follows, specially designed for liquid rocket propulsion systems:

a. Ablative liners for thrust or combustion chambers;

b. Rocket nozzles;

c. Thrust vector control sub-systems;
Technical Note:
Examples of methods of achieving thrust vector control specified in 9A106.c. are:
1. *Flexible nozzle;*
2. *Fluid or secondary gas injection;*
3. *Movable engine or nozzle;*
4. *Deflection of exhaust gas stream (jet vanes or probes); or*
5. *Thrust tabs.*

9A106 continued

d. Liquid and slurry propellant (including oxidisers) 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 2,000 Hz.

Note: *The only servo valves and pumps specified in 9A106.d., are the following:*

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 r.p.m. or with discharge pressures equal to or greater than 7 MPa.

9A107 Solid propellant rocket engines, usable in complete rocket systems or unmanned air vehicles, capable of a range of 300 km, other than those specified in 9A007, having total impulse capacity of 0.841 MNs or greater.

N.B.: SEE ALSO 9A119.

9A108 Components, other than those specified in 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.

Technical Note:

Examples of methods of achieving thrust vector control specified in 9A108.c. are:

1. Flexible nozzle;

2. Fluid or secondary gas injection;

3. Movable engine or nozzle;

4. Deflection of exhaust gas stream (jet vanes or probes); or

5. Thrust tabs.

9A109 Hybrid rocket motors, usable in "missiles", other than those specified in 9A009, and specially designed components therefor.

N.B.: SEE ALSO 9A119.

9A110 Composite structures, laminates and manufactures thereof, other than those specified in 9A010, specially designed for use in space launch vehicles specified in 9A004 or sounding rockets specified in 9A104 or the subsystems specified in 9A005, 9A007, 9A105.a., 9A106 to 9A108, 9A116 or 9A119.
N.B.: SEE ALSO 1A002.

9A111 Pulse jet engines, usable in "missiles", and specially designed components therefor.
N.B.: SEE ALSO 9A011 and 9A118.

9A115 Launch support equipment, designed or modified for space launch vehicles specified in 9A004 or sounding rockets specified in 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. Reentry vehicles;

b. Heat shields and components therefor fabricated of ceramic or ablative materials;

c. Heat sinks and components therefor fabricated of light-weight, high heat capacity materials;

d. 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 9A011 or 9A111.

9A119 Individual rocket stages, usable in complete rocket systems or unmanned air vehicles, capable of a range of 300 km, other than those specified in 9A005, 9A007, 9A009, 9A105, 9A107 and 9A109.

9B Test, Inspection and Production Equipment

9B001 Specially designed equipment, tooling and fixtures, as follows, for manufacturing or measuring gas turbine blades, vanes or tip shroud castings:

a. Directional solidification or single crystal casting equipment;

b. Ceramic cores or shells;

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 9E003.a.

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 temperatures in excess of 773 K (500°C), and specially designed components or accessories therefor.

9B004 Tools, dies or fixtures for the solid state joining of "superalloy", titanium or intermetallic airfoil-to-disk combinations described in 9E003.a.3. or 9E003.a.6. for gas turbines.

9B005 On-line (real time) control systems, instrumentation (including sensors) or automated data acquisition and processing equipment, specially designed for use with any of the following wind tunnels or devices:

N.B.: SEE ALSO 9B105.

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;
Technical Note:
Test section size in 9B005.a. means the diameter of the circle, or the side of the square, or the longest side of the rectangle, at the largest test section location.

b. Devices for simulating flow-environments at speeds exceeding Mach 5, including hot-shot tunnels, plasma arc tunnels, shock tubes, shock tunnels, gas tunnels and light gas guns; or

c. Wind tunnels or devices, other than two-dimensional sections, capable of simulating Reynolds number flows exceeding 25×10^6.

9B006 Acoustic vibration test equipment capable of producing sound pressure levels of 160 dB or more (referenced to 20 μPa) with a rated output of 4 kW or more at a test cell temperature exceeding 1,273 K (1,000°C), and specially designed quartz heaters therefor.

N.B.: SEE ALSO 9B106.

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.

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.
N.B.: SEE ALSO 9B005.

9B106 Environmental chambers and anechoic chambers, as follows:

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 range 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 μPa) or with a rated power output of 4 kW or greater; and
   2. Altitudes of 15,000 m or greater; or
   3. Temperature range 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 9A005 to 9A009, 9A011, 9A101, 9A105 to 9A109, 9A111, 9A116 to 9A119.

9B116 Specially designed "production facilities" for the space launch vehicles specified in 9A004, or systems, sub-systems, and components specified in 9A005 to 9A009, 9A011, 9A101, 9A104 to 9A109, 9A111, or 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

9C110 Resin impregnated fibre prepregs and metal coated fibre preforms therefor, for composite structures, laminates and manufactures specified in 9A110, 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.
N.B.: SEE ALSO 1C010 and 1C210.

Note: *The only resin impregnated fibre prepregs specified in entry 9C110 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.*

9D Software

9D001 "Software" specially designed or modified for the "development" of equipment or "technology" specified in 9A, 9B or 9E003.

9D002 "Software" specially designed or modified for the "production" of equipment specified in 9A or 9B.

9D003 "Software" specially designed or modified for the "use" of "full authority digital electronic engine controls" ("FADEC") for propulsion systems specified in 9A or equipment specified in 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. 2D or 3D viscous "software" validated with wind tunnel or flight test data required for detailed engine flow modelling;

b. "Software" for testing aero gas turbine engines, assemblies or components, specially designed to collect, reduce and analyse data in real time, and capable of feedback control, including the dynamic adjustment of test articles or test conditions, as the test is in progress;

c. "Software" specially designed to control directional solidification or single crystal casting;

d. "Software" in "source code", "object code" or machine code required for the "use" of active compensating systems for rotor blade tip clearance control.
Note: *9D004.d. does not control "software" embedded in uncontrolled 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 or modified for the "use" of goods specified in 9B105, 9B106, 9B116 or 9B117.

9D103 "Software" specially designed for modelling, simulation or design integration of the space launch vehicles specified in 9A004 or sounding rockets specified in 9A104, or the subsystems specified in 9A005, 9A007, 9A105.a., 9A106, 9A108, 9A116 or 9A119.

Note: *"Software" specified in 9D103 remains controlled when combined with specially designed hardware specified in 4A102.*

9D104 "Software" specially designed or modified for the "use" of goods specified in 9A001, 9A005, 9A006.d., 9A006.g., 9A007.a., 9A008.d., 9A009.a., 9A010.d., 9A011, 9A101, 9A105, 9A106.c., 9A106.d., 9A107, 9A108.c., 9A109, 9A111, 9A115.a., 9A116.d., 9A117 or 9A118.

9D105 "Software" which coordinates the function of more than one subsystem, specially designed or modified for "use" in space launch vehicles specified in 9A004 or sounding rockets specified in 9A104.

9E Technology

Note: *"Development" or "production" "technology" specified in 9E001 to 9E003 for gas turbine engines remains controlled when used as "use" "technology" for repair, rebuild and overhaul. Excluded from control are: technical data, drawings or documentation for maintenance activities directly associated with calibration, removal or replacement of damaged or unserviceable line replaceable units, including replacement of whole engines or engine modules.*

9E001 "Technology" according to the General Technology Note for the "development" of equipment or "software" specified in 9A001.c., 9A004 to 9A011, 9B or 9D.

9E002 "Technology" according to the General Technology Note for the "production" of equipment specified in 9A001.c., 9A004 to 9A011, or 9B.

N.B.: For "technology" for the repair of controlled structures, laminates or materials, see 1E002.f.

9E003 Other "technology", as follows:

a. "Technology" "required" for the "development" or "production" of any of the following gas turbine engine components or systems:

1. Gas turbine blades, vanes or tip shrouds made from directionally solidified (DS) or single crystal (SC) alloys having (in the 001 Miller Index Direction) a stress-rupture life exceeding 400 hours at 1,273 K (1,000°C) at a stress of 200 MPa, based on the average property values;

2. Multiple domed combustors operating at average burner outlet temperatures exceeding 1,813 K (1,540°C) or combustors incorporating thermally decoupled combustion liners, non-metallic liners or non-metallic shells;

3. Components manufactured from any of the following:
   a. Organic "composite" materials designed to operate above 588 K (315°C);
   b. Metal "matrix" "composite", ceramic "matrix", intermetallic or intermetallic reinforced materials specified in 1C007; or
   c. "Composite" material specified in 1C010 and manufactured with resins specified in 1C008.

4. 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;

5. Cooled turbine blades, vanes or tip-shrouds, other than those described in 9E003.a.1., exposed to gas path temperatures of 1,643 K (1,370°C) or more;

6. Airfoil-to-disk blade combinations using solid state joining;

7. Gas turbine engine components using "diffusion bonding" "technology" specified in 2E003.b.;

8. Damage tolerant gas turbine engine rotating components using powder metallurgy materials controlled by 1C002.b.;

9. "FADEC" for gas turbine and combined cycle engines and their related diagnostic components, sensors and specially designed components;

10. Adjustable flow path geometry and associated control systems for:
    a. Gas generator turbines;
    b. Fan or power turbines;
    c. Propelling nozzles;

    Note 1: *Adjustable flow path geometry and associated control systems in 9E003.a.10. do not include inlet guide vanes, variable pitch fans, variable stators or bleed valves for compressors.*

    Note 2: *9E003.a.10. does not control "development" or "production" "technology" for adjustable flow path geometry for reverse thrust.*

11. Wide chord hollow fan blades without part-span support;

9E003 continued

b. "Technology" "required" for the "development" or "production" of any of the following:
   1. Wind tunnel aero-models equipped with non-intrusive sensors capable of transmitting data from the sensors to the data acquisition system; or
   2. "Composite" propeller blades or 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, ECM or EDM hole drilling processes to produce holes having any of the following sets of characteristics:
   1. All of the following:
      a. Depths more than four times their diameter;
      b. Diameters less than 0.76 mm; and
      c. Incidence angles equal to or less than 25°; or
   2. All of the following:
      a. Depths more than five times their diameter;
      b. Diameters less than 0.4 mm; and
      c. Incidence angles of more than 25°;
      Technical Note:
      For the purposes of 9E003.c., 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 any of the following:
   1. The "development" of helicopter power transfer systems or tilt rotor or tilt wing "aircraft" power transfer systems; or
   2. The "production" of helicopter power transfer systems or tilt rotor or tilt wing "aircraft" power transfer systems;

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 80/1269/EEC, ISO 2534 or national equivalents; and
      c. A power density of more than 700 kW/m^3 of box volume;

   Technical Note:
   'Box volume' in 9E003.e.1.a 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.

9E003 e. continued

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 1C007:
1. Cylinder liners;
2. Pistons;
3. Cylinder heads; and
4. One or more other components (including exhaust ports, turbochargers, 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
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.
Technical Note:
High output diesel engines: diesel engines with a specified brake mean effective pressure of 1.8 MPa or more at a speed of 2,300 r.p.m., provided the rated speed is 2,300 r.p.m. or more.

9E101 "Technology" according to the General Technology Note for the "development" or "production" of goods specified in 9A101, 9A104 to 9A111 or 9A115 to 9A119.

9E102 "Technology" according to the General Technology Note for the "use" of space launch vehicles specified in 9A004, or goods specified in 9A005 to 9A011, 9A101, 9A104 to 9A111, 9A115 to 9A119, 9B105, 9B106, 9B115, 9B116, 9B117, 9D101 or 9D103.

ANNEX II

List referred to in Article 3 of the Decision and Article 6(1)(a) of Regulation (EC) No 3381/94
(Common list of destinations for which simplified formalities may be applicable)

1. General authorizations may be adopted in licensing dual-use goods to certain destinations, particularly for exports to the following states, which are adherents to, or fully co-operating with, all relevant regimes on non-proliferation and the control of sensitive goods:

   Australia

   Canada

   Japan

   New Zealand

   Norway

   Switzerland

   United States

2. This does not exclude the adoption of such procedures for exports to other destinations.

3. Member States should inform each other and the Commission of simplified procedures they apply to other destinations.

ANNEX III

Guidelines referred to in Article 4 of the Decision and Article 8 of Regulation (EC) N°□3381/94

(Agreement of Member States on Guidelines)

The following factors will be taken into account by Member States in deciding whether to grant an export authorization :

(a) their commitments under international agreements on non-proliferation and the control of sensitive goods;

(b) their obligations under sanctions imposed by the UN Security Council, or agreed within the European Union or in other international organisations (notably embargoes on trade, on arms and military equipment, or on dual-use goods);

(c) considerations of national foreign and security policy, including, where relevant, those covered by the criteria they agreed at the European Council in Luxembourg in June 1991 and in Lisbon in June 1992 with regard to the export of conventional arms;

(d) considerations about intended end-use and the risk of diversion.

Member States will exchange views on these guidelines as appropriate, in order to review them as necessary.

ANNEX IV

List referred to in Article 5 of the Decision and Article 19(1)(b) of Regulation (EC) No 3381/94

(Common list of dual-use goods in intra-Community trade which is subject to authorization during the interim period)

NB: The descriptions below are abbreviated titles of the respective entries. For full details, see Annex I.

NSG – TRIGGER LIST PART 1 OF INFCIRC 254

(These products are also covered by Article 21 of the Regulation (EC) No 3381/94)

0B001	Plant for the separation of isotopes of "natural uranium", "depleted uranium" and "special fissile materials".
0B002	Auxiliary equipment for enrichment plants.
0B004	Heavy water, deuterium or deuterium compound production equipment and components.
0B006	Plant for the reprocessing of irradiated "nuclear reactor" fuel elements.
0B007	Plant for the conversion of plutonium.
0C002	Only the following fissile materials: (a) separated plutonium; (b) "uranium enriched in the isotopes 235 or 233" to more than 20%.
0D001	As it relates to 0B001, 0B002, 0B004, 0B006, 0B007 and 0C002.
0E001	As it relates to 0B001, 0B002, 0B004, 0B006, 0B007 and 0C002.

COMMUNITY STRATEGIC CONTROL

3A002.g	Atomic frequency standards.
4A001.b	Electronic computers and related equipment and "electronic assemblies" and specially designed components therefor, having characteristics or performing functions exceeding the limits in Category 5 (Part 2 - "Information Security").
4D003.c	"Software" having characteristics or performing functions exceeding the limits in Category 5 Part 2 ("Information Security"). except: "Software" having characteristics or performing functions described in 1. of Category 5 Part 2 of this Annex and without end-to-end encryption or decryption capability.
Category 5	All goods specified in Part 2 - "Information Security", other than:

1. Portable or mobile radiotelephones designed to recognised national, regional or international civil standards, e.g. portable or mobile radiotelephones for use with commercial civil cellular radiocommunications systems;

2. Commercial civil cellular radiocommunication base stations having all of the following:
   (a) limited to supporting radiotelephones which are not capable of employing cryptographic techniques on message traffic between handsets except over direct links between radiotelephones and base stations (known as the Air Interface); and
   (b) not capable of employing cryptographic techniques on message traffic except over the air interface;

3. Equipment specified in 5B002 for equipment described in 2. above;

4. "Software" when incorporated as part of the goods whose characteristics or performing functions are described in 1. to 3. above;

5. Goods that meet all of the following:
   (a) Generally available to the public by being sold, without restriction, from stock at retail selling points by means of any of the following:
      1. Over-the-counter transactions
      2. Mail order transactions
      3. Electronic transactions; or
      4. Telephone order transactions;

   (b) The cryptographic functionality cannot easily be changed by the user;

   (c) Designed for installation by the user without further substantial support by the supplier; and

   (d) When necessary, details of the goods are accessible and will be provided, upon request, to the competent authorities of the Member State in which the exporter is established in order to ascertain compliance with conditions described in paragraphs a. to c. above;

6. "Technology" for the "use" of goods described in 1. to 5. above.

6A001 Acoustics.

6D003.a "Software" for the real time processing of acoustic data.

STEALTH TECHNOLOGY

1C001 Materials specially designed for use as absorbers of electromagnetic waves, or intrinsically conductive polymers.

1D103 "Software" specially designed for analysis of reduced observables such as radar reflectivity, ultraviolet/infrared signatures and acoustic signatures.

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.

MTCR TECHNOLOGY

9A005	Liquid rocket propulsion systems.
9A007.a	Solid rocket propulsion systems with a total impulse capacity exceeding 1.1 MNs.
9A008.d	Movable nozzle or secondary fluid injection thrust vector control systems, specially designed for solid rocket propulsion systems.
9A009.a	Hybrid rocket propulsion systems with total impulse capacity exceeding 1.1 MNs.
9A108.c	Thrust vector control sub-systems, specially designed for solid rocket propulsion systems.
9A119	Individual rocket stages.
9B115	Specially designed "production equipment" for the systems, sub-systems and components specified in 9A005, 9A007.a, 9A008.d, 9A108.c and 9A119.
9B116	Specially designed "production facilities" for the systems, sub-systems and components specified in 9A005, 9A007.a, 9A008.d, 9A108.c and 9A119.
9D001	"Software" required for the "development" of equipment or "technology" specified in 9A005, 9A007.a, 9A008.d, 9A108.c, 9A119, 9B115 and 9B116.
9D101	"Software" specially designed for the "use" of goods specified in 9B116.
9D103	"Software" specially designed for modelling, simulation or design integration of the systems specified in 9A007.a, 9A108.c or 9A119.
9E001	"Technology" for the "development" of equipment specified in 9A005, 9A007.a, 9A008.d., 9B115, 9B116.
9E002	"Technology" for the "production" of equipment specified in 9A005, 9A007.a, 9A008.d., 9B115 and 9B116.
9E101	"Technology" for the "development" or "production" of equipment specified in 9A108.c. or 9A119.

CHEMICAL WEAPONS CONVENTION

1C351.d.4	Ricin.
1C351.d.5	Saxitoxin.

The goods specified in 0B001, 0B002, 0B004, 0B006, 0B007, 0C002, 4D003.c and Category 5, Part 2 are also subject to the provisions of Article 7(2) of Regulation (EC) No 3381/94 in respect of all destinations, including those which are listed in Annex II to the Decision.

ANNEX V

LIST REFERRED TO IN ARTICLE 6 OF THE DECISION AND ARTICLE 20(1) OF REGULATION (EC) No 3381/94

NB: Xa = exceptions regarding which, at the end of the transitional period, a decision will be taken on whether the goods are to be included permanently within the scope of the rules on dual-use goods.

Xb = exceptions which will be eliminated in the course of the transitional period.

HEADINGS	DK	D	EL	E	F	I	AT	P	FI	SE	UK
0A001							Xa		Xa	Xa	
0B003									Xa		
0B005							Xa		Xa	Xa	
0C001							Xa		Xa	Xa	

HEADINGS	DK	D	EL	E	F	I	AT	P	FI	SE	UI
0C002							Xa		Xa	Xa	
0C003							Xa		Xa	Xa	
0C004							Xa		Xa	Xa	
0C005									Xa	Xa	
0D001									Xa		
0E001									Xa	Xa (*)	
1A102				Xb	Xb						
1A202					Xa						
1B001				Xb							
1B002				Xb							
1B101_				Xb							
1B115				Xb							
1B116				Xb	Xa						
1B226					Xa						
1B231					Xa (1)						
1B233					Xa						
1C007				Xb							
1C012					Xa						
1C101	Xa		Xa		Xa						
1C107				Xb							
1C107.c,d					Xb						
1C111			Xa	Xb							
1C116				Xb	Xa						
1C117				Xb							
1C216					Xa						
1C233					Xa (1)						
1C235					Xa (1)						

(*) Limited to goods under headings 0A001, 0B005, 0B009, 0C003, 0C004, and 0C005.

HEADINGS	DK	D	EL	E	F	I	AT	P	FI	SE	UK
1C239					Xa						Xa
1C350			Xa								
1C350/4	Xa				Xa						
1C350/23	Xa		Xa	Xa	Xa						
1C350/29	Xa				Xa						
1C351		Xa									
1C352		Xa									
1C353		Xa									
1D001				Xb							
1D101				Xb							
1E001	Xa			Xb							
1E002				Xb							
1E101	Xa			Xb	Xa (2)						
1E102	Xa			Xb	Xa (3)						
1E103				Xb							
1E104				Xb							
1E201					Xa (1)						
2B004				Xb							
2B104				Xb							
2B109				Xb							
2B116				Xb							
2D001				Xb							
2D101				Xb							
2E001				Xb	Xb (4)						
2E002				Xb	Xb (4)						
2E101				Xb	Xb (5)						
3A001.a.1				Xb							
3A001.a.2				Xb							
3A001.e.1.c					Xa						
3A101.a				Xb							
3A101.b				Xb							
3A201.a.c					Xa						
3A228					Xa						
3A229					Xa						Xa
3A231					Xa						
3A232					Xa						Xa
3D101				Xb							
3E001				Xb							
3E101				Xb	Xa						
3E102				Xb							
3E201					Xa						
4A001.a.1				Xb							
4A001.a.2				Xb	Xa						

HEADINGS	DK	D	EL	E	F	I	AT	P	FI	SE	UK
4A101				Xb							
4A102				Xb							
4E001				Xb							
5A101			Xa	Xb	Xa						
5E101				Xb							
6A002				Xb							
6A002.a.1,b, d.1, e					Xa						
6A003.a.5,b.1,b.2					Xa						
6A004.c					Xa						
6A007.b & c				Xb							
6A008				Xb							
6A102				Xb	Xa						
6A107				Xb							
6A108				Xb							
6A108.a					Xa						
6A203					Xa						
6A225					Xa						
6A226					Xa						
6D001				Xb							
6D002				Xb							
6D003				Xb							
6D102				Xb	Xa (6)						
6D103				Xb							
6E001				Xb							
6E002				Xb							
6E101				Xb	Xa (7)						
6E201					Xa (8)						
7A001.a,b,c				Xb							
7A001.c					Xa						
7A002.a & b				Xb							
7A002.b					Xa						
7A003	Xa			Xb	Xa			Xa			
7A004				Xb	Xa						
7A005				Xb	Xa						
7A006				Xb							
7A101				Xb							
7A102			Xa	Xb							
7A103				Xb	Xa						
7A104				Xb							
7A105				Xb							
7A106				Xb							

HEADINGS	DK	D	EL	E	F	I	AT	P	FI	SE	UK
7A115				Xb	Xa						
7A116			Xa	Xb							
7A117	Xa		Xa	Xb	Xa			Xa			
7B001				Xb	Xa						
7B002				Xb							
7B003	Xa			Xb				Xa			
7B102				Xb							
7B103	Xa			Xb	Xa			Xa			
7D001	Xa			Xb	Xa						
7D002				Xb	Xa						
7D003				Xb	Xa						
7D101	Xa			Xb	Xa			Xa			
7D102				Xb	Xa						
7D103				Xb	Xa			Xa			
7E001	Xa			Xb							
7E002	Xa			Xb							
7E003	Xa			Xa	Xb (9)						
7E004.b.5				Xb	Xa						
7E101	Xa			Xb	Xa (10)			Xa			
7E102				Xb	Xa						
7E104				Xb	Xa						
8A002.o.3 and p					Xa						
8D002					Xa						
8E002.a					Xa						
9A001				Xb							
9A004	Xa			Xb	Xa			Xa			
9A006			Xa	Xb							
9A007	Xa		Xa	Xb							
9A007.a								Xa			
9A008 (other than d)			Xa	Xb							
9A009			Xa	Xb							
9A010				Xb							
9A011				Xb	Xa						
9A101				Xb							
9A104	Xa			Xb	Xa			Xa			
9A105	Xa		Xa	Xb	Xa			Xa			
9A106.b				Xb				Xa			
9A106.c	Xa			Xb	Xa						
9A106 (other than b and c)				Xb							
9A107				Xb							

HEADINGS	DK	D	EL	E	F	I	AT	P	FI	SE	U
9A108 (other than c)				Xb							
9A109			Xa	Xb	Xa						
9A110				Xb							
9A111				Xb							
9A115			Xa	Xb							
9A116	Xa		Xa	Xb	Xa			Xa			
9A117			Xa	Xb	Xa						
9A118			Xa	Xb	Xa						
9B005				Xb							
9B105			Xa	Xb	Xa						
9B106				Xb	Xa						
9B117				Xb	Xa						
9D001	Xa			Xb	Xa (11)			Xa			
9D002	Xa			Xb							
9D003				Xb							
9D004				Xb							
9D101	Xa			Xb	Xa			Xa			
9D103				Xb	Xa						
9E001	Xa			Xb	Xa (12)			Xa			
9E002	Xa			Xb	Xa (13)			Xa			
9E003				Xb							
9E101	Xa			Xb	Xa (14)			Xa			
9E102	Xa			Xb	Xa (15)			Xa			

Notes to the column for France:

(1) articles proposed by France for the revised Dublin declaration; withdrawn from Annex 5 if included in Dublin declaration

(2) limited to goods under 1C001, 1C101, 1C107.b., 1D103

(3) limited to goods under 1D103

(4) limited to goods under 2B104

(5) except for goods under 2B104

(6) limited to goods under 6A108.a.

(7) limited to goods under 6A102, 6A108.a., 6B108

(8) limited to goods under 6A003a.5., b.1., b.2., 6A203, 6A225

(9) limited to goods under 7A001.c., 7A002.b., 7A003, 7A004

(10) limited to goods under 7A001.c., 7A002.b., 7A003 to 7A005, 7A103, 7A115, 7A117, 7B103, 7D101 (limited to goods under 7A001.c., 7A002.b., 7A003 to 7A005, 7A103, 7A115, 7B103), 7D102, 7D103

(11) except for goods under 9A001, 9A002, 9A003, 9A010 and 9A110

(12) except for goods under 9A001, 9A002, 9A003, 9A010 and 9A110

(13) limited to goods under 9A110 and 9A011

(14) except for goods under 9A110, 9A111

(15) limited to goods under 9A004, 9A005, 9A007.a., 9A008.d., 9A011, 9A104, 9A105, 9A106.c., 9A109, 9A115 to 9A119."