



# Defence and Strategic Goods List Amendment 2006

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I, BRENDAN NELSON, Minister for Defence, make this instrument under paragraph 112 (2A) (aa) of the *Customs Act 1901*.

Dated 25 August 2006

BRENDAN NELSON  
Minister for Defence

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## 1 Name of instrument

This instrument is the *Defence and Strategic Goods List Amendment 2006*.

## 2 Commencement

This instrument will commence on the day after it is registered on the Federal Register of Legislative Instruments.

## 3 Amendment of Defence and Strategic Goods List

For paragraph 112 (2A) (aa) of the *Customs Act 1901*, the Defence and Strategic Goods List, mentioned in regulation 13E of the *Customs (Prohibited Exports) Regulations 1958*, is amended as set out in Schedule 1.

*Note* Under regulation 13E of the *Customs (Prohibited Exports) Regulations 1958*, the Defence and Strategic Goods List is recognised as part of Australia's export controls.

# **Schedule 1      Amendment of Defence and Strategic Goods List**

(section 3)

## **[1]      Defence and Strategic Goods List**

*substitute*



**Australian Government**  

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**Department of Defence**

# **DEFENCE AND STRATEGIC GOODS LIST**

**November 1996**

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**PREFACE**

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The Defence and Strategic Goods List (DSGL) is identified in regulation 13E of the *Customs (Prohibited Exports) Regulations 1958* as the document titled 'Defence and Strategic Goods List':

(a) formulated and published for the purpose of paragraph 112 (2A) (aa) of the *Customs Act 1901* by the Minister for Defence; and

(b) dated November 1996;

as amended by the Minister for Defence and in force from time to time.

Goods included in the list may not be exported from Australia unless a licence or permission has been granted by the Minister or an authorised person and that licence or permission is produced to a Collector of Customs before exportation: regulation 13E of the *Customs (Prohibited Exports) Regulations 1958*.

The DSGL was first published in 1996 when the *Customs (Prohibited Exports) Regulations* were consolidated and revised as a result of an Australian National Audit Office review of the Defence export control activity.

The DSGL includes equipment, assemblies and components, associated test, inspection and production equipment, materials, software and technology and is divided into two parts.

**PART 1** covers defence and related goods - those goods and technologies designed or adapted for use by armed forces or goods that are inherently lethal. These goods include:

- *Military Goods* – those goods or technology that is designed or adapted for military purposes including parts and accessories thereof.
- *Non Military Lethal Goods (NMLG)* – that equipment that is inherently lethal, incapacitating or destructive such as non-military firearms, non-military ammunition and commercial explosives and initiators.

**PART 2** covers those goods that have a dual use. Dual-use goods comprise equipment and technologies developed to meet commercial needs but which may be used either as military components or for the development or production of military systems or weapons of mass destruction. This part is further subdivided into and is made up of the following 10 categories:

- *Category 0* – Nuclear Materials;
- *Category 1* – Materials, Chemicals, Microorganisms and Toxins;
- *Category 2* – Materials Processing;
- *Category 3* – Electronics;
- *Category 4* – Computers;
- *Category 5* – Telecommunications and Information Security;
- *Category 6* – Sensors and Lasers;

- *Category 7* – Navigation and Avionics;
- *Category 8* – Marine;
- *Category 9* – Propulsion Systems, Space Vehicles and Related Equipment.

The DSGL is amended from time to time to reflect changes in the various multilateral non-proliferation and export control regimes of which Australia is a member.

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<b>NOTES</b>
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## **GENERAL NOTES**

1. The Notes, Technical Notes and Nota Bene (N.B.) appearing in the Defence and Strategic Goods List form an integral part of the control text.
2. The object of the controls contained in the Defence and Strategic Goods List 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. Goods specified in the Defence and Strategic Goods List include both new and used goods.
4. Terms in "quotations" are defined terms. Refer to the 'Definitions of Terms' section of the Defence and Strategic Goods List. Words and terms appearing under 'Definitions of Terms', if used in their undefined forms, take their common or dictionary meanings.

## **PART 1 - MUNITIONS LIST**

### **ML 8**

Specially formulated pharmaceutical products containing ML8 materials are not controlled.

### **ML 10**

Absence of items from the Munitions List and absence of configuration for military use would mean that an aircraft would not be considered military.

## **PART 2 - DUAL-USE GOODS AND TECHNOLOGIES**

### **General Technology Note**

The transfer of "technology" according to the General Technology Note, for "production" or "development" of items on this list shall be treated with vigilance.

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**General Technology Note**

Controls on intangible "technology" are to be exercised as far as the scope of legislation† will allow.

**General Software Note**

The transfer of "software", for "production" or "development" of items on this list shall be treated with vigilance.

**Medical equipment**

Equipment specially designed for medical end-use that incorporates an item controlled in the Dual-Use List is not controlled.

**Category 6**

The control text contained in 6A002.a. Nota Bene, 6A002.a.3. Nota Bene, 6A002.a.3.c. Nota Bene, 6A002.a.3.f., 6A003.b.4. and 6A003.b.4. Notes 1, 2 and 3 is valid until 05 December 2007.

**Category 9**

"Development" or "production" "technology" controlled by 9E 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.

† *Australia's export control legislation on the intangible transfers of "software" and "technology" is the Weapons of Mass Destruction (Prevention of Proliferation) Act 1995. The object of this Act is to ensure that goods are not supplied or exported, and services are not provided, in circumstances where the goods will or may be used in, or the services will or may assist a Weapons of Mass Destruction (WMD) program.*

*A WMD program means a plan or program for the development, production, acquisition or stockpiling of nuclear, biological or chemical weapons or missiles capable of delivering such weapons.*

*The provision of services includes doing anything that confers a benefit on, grants a right or privilege to, provides a facility for, or otherwise assists, someone.*

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**DEFINITIONS OF TERMS**

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Definitions of terms between 'single quotation marks' are given in a Technical Note to the relevant item.

Definitions of terms between "double quotation marks" are as follows:

*N.B.: 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 ML7) means any modification or selection (such as altering purity, shelf life, virulence, dissemination characteristics, or resistance to UV radiation) designed to increase the effectiveness in producing casualties in humans or animals, degrading equipment or damaging crops or the environment.

"Additives" (ML8) means substances used in explosive formulations to improve their properties.

"Aircraft" (1 7 9 ML8 ML9 ML10) 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.

"Allocated by the ITU" (3 5) means the allocation of frequency bands according to the current edition of the ITU Radio Regulations for primary, permitted and secondary services.

*N.B.: Additional and alternative allocations are not included.*

"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.*

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"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'.

Technical Notes:

1. "Basic gate propagation delay time" is not to be confused with the input/output delay time of a complex "monolithic integrated circuit".
2. 'Family' consists of all integrated circuits to which all of the following are applied as their manufacturing methodology and specifications except their respective functions:
  - a. The common hardware and software architecture;
  - b. The common design and process technology; and
  - c. The common basic characteristics.

"Basic scientific research" (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.

"Biocatalysts" (ML7 ML22) means enzymes or other biological compounds which bind to and accelerate the degradation of CW agents.

Technical Note:

'Enzymes' means "biocatalysts" for specific chemical or biochemical reactions.

"Biopolymers" (ML7 ML22) means biological macromolecules as follows:

- a. Enzymes for specific chemical or biochemical reactions;
- b. Antibodies, monoclonal, polyclonal or anti-idiotypic;
- c. Specially designed or specially processed receptors;

Technical Notes:

1. 'Anti-idiotypic antibodies' means antibodies which bind to the specific antigen binding sites of other antibodies;
2. 'Monoclonal antibodies' means proteins which bind to one antigenic site and are produced by a single clone of cells;
3. 'Polyclonal antibodies' means a mixture of proteins which bind to the specific antigen and are produced by more than one clone of cells;
4. 'Receptors' means biological macromolecular structures capable of binding ligands, the binding of which affects physiological functions.

"Camming" (2) means axial displacement in one revolution of the main spindle measured in a plane perpendicular to the spindle faceplate, at a point next to the circumference of the spindle faceplate (Reference: ISO 230/1 1986, paragraph 5.63).

"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".

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"CE" (4) is equivalent to "computing element".

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

"Chemical mixture" (1) means a solid, liquid or gaseous product made up of two or more components which do not react together under the conditions under which the mixture is stored.

"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 ML10) 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 unauthorised use. "Cryptography" is limited to the transformation of information using one or more 'secret parameters' (e.g., crypto variables) or associated key management.

Technical Note:

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

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

"Data-Based Referenced Navigation" ("DBRN") (7) Systems means systems which use various sources of previously measured geo-mapping data integrated to provide accurate navigation information under dynamic conditions. Data sources include bathymetric maps, stellar maps, gravity maps, magnetic maps or 3-D digital terrain maps.

"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.

Note: *When determining the "data signalling rate", servicing and administrative channels shall be excluded.*

Technical Note:

*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.

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"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.

*Technical Note:*

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

"Digital transfer rate" (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 gram" (1) of "special fissile material" means:

- a. For plutonium isotopes and uranium-233, the isotope weight in grams;
- b. For uranium enriched 1 per cent or greater in the isotope uranium-235, the element weight in grams 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 grams multiplied by 0.0001

"Electronic assembly" (2 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.

*Technical Notes:*

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.
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 ML17) means grippers, 'active tooling units' and any other tooling that is attached to the baseplate on the end of a "robot" manipulator arm.

Technical Note:

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

"Energetic materials" (ML 4 ML8 ML908 ML909) mean substances or mixtures that react chemically to release energy required for their intended application. "Explosives", "pyrotechnics" and "propellants" are subclasses of energetic materials.

"Equivalent Density" (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 "program" and capable of any of the following:

- a. Modifying automatically the "source code" introduced by the user;
- b. Providing knowledge linked to a class of problems in quasi-natural language;
- or
- c. Acquiring the knowledge required for their development (symbolic training).

"Explosives" (ML8 ML18 ML909) mean solid, liquid or gaseous substances or mixtures of substances which, in their application as primary, booster, or main charges in warheads, demolition and other applications, are required to detonate.

"Expression Vectors" (ML7) mean carriers (e.g., plasmid or virus) used to introduce genetic material into host cells.

"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 2 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".

Technical Note:

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'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.

"First generation image intensifier tubes" (ML15) means electrostatically focused tubes, employing input and output fibre optic or glass face plates, multi-alkali photocathodes (S-20 or S-25), but not microchannel plate amplifiers.

"Fixed" (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 optimisation" (7) is a procedure that minimises deviations from a four-dimensional (space and time) desired trajectory based on maximising 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.

*Note:* This definition does not include a stack of single detector elements or any two, three or four element detectors provided time delay and integration is not performed within the element.

"Fractional bandwidth" (3) means the "instantaneous bandwidth" divided by the centre frequency, expressed as a percentage.

"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.

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"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".

"Guidance set" (7) means systems that integrate the process of measuring and computing a vehicle's position and velocity (i.e. navigation) with that of computing and sending commands to the vehicle's 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.

Technical Notes:

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.
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.

"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.

Technical Note:

*'Cryptanalysis' is the analysis of a cryptographic system or its inputs and outputs to derive confidential variables or sensitive data, including clear text (ISO 7498-2-1988 (E), paragraph 3.3.18).*

"Instantaneous bandwidth" (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 radar.



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"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.

"In the public domain" (GTN NTN GSN ML22), 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").

"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 ML5 ML9 ML19) 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".*

"Lighter-than-air vehicles" (ML10) mean balloons and airships that rely on hot air or on lighter-than-air gases such as helium or hydrogen for their lift.

"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).

*Technical Note:*

*'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<sub>6</sub>" (0) may be copper, stainless steel, aluminium, aluminium oxide, aluminium alloys, nickel or alloy containing 60 weight percent or more nickel and UF<sub>6</sub>-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.

Technical Note:

*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.

*Technical Note:*

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

*Note: This definition includes chip sets which are designed to operate together to provide the function of a "microprocessor microcircuit".*

"Microorganisms" (1 2) means bacteria, viruses, mycoplasmas, 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.

"Microprogram" means a sequence of elementary instructions maintained in a special storage, the execution of which is initiated by the introduction of its reference instruction register.

"Missiles" (1 3 6 7 9) means complete rocket systems and unmanned aerial 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.

*Technical Note:*

*'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 "microprogram" 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.

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"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.

*Technical Note:*

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

"Multispectral imaging sensors" (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  $S_{pp}^2 = 8N_o(f_2-f_1)$ , where  $S_{pp}$  is the peak-to-peak value of the signal (e.g., nanoteslas),  $N_o$  is the power spectral density (e.g., (nanotesla)<sup>2</sup>/Hz) and  $(f_2-f_1)$  defines the bandwidth of interest.

"Nuclear reactor" (0 ML17) 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.

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"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. (See [www.wassenaar.org](http://www.wassenaar.org))

"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.

"Precursors" (ML8) means specialty chemicals used in the manufacture of military explosives.

"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 manoeuvring 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 7 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" (7 9) means equipment and specially designed software therefor integrated into installations for "development" or for one or more phases of "production".

"Program" (2 4 5 6) means a sequence of instructions to carry out a process in, or convertible into, a form executable by an electronic computer.

"Propellants" (ML8) Substances or mixtures that react chemically to produce large volumes of hot gases at controlled rates to perform mechanical work.

"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.

"Pyrotechnic(s)" (ML4 ML8 ML909) means mixtures of solid or liquid fuels and oxidizers which, when ignited, undergo an energetic chemical reaction at a controlled rate intended to produce specific time delays, or quantities of heat, noise, smoke, visible light or infrared radiation. Pyrophorics are a subclass of pyrotechnics, which contain no oxidizers but ignite spontaneously on contact with air.

"Quantum cryptography" (5) means a family of techniques for the establishment of a shared key for "cryptography" by measuring the quantum-mechanical properties of a physical system (including those physical properties explicitly governed by quantum optics, quantum field theory, or quantum electrodynamics).

"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" (2 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" (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 5 6 9 ML22), as applied to "technology" or "software", refers to only that portion of "technology" or "software" which is peculiarly responsible for achieving or

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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).

"Riot control agents" (ML7) mean substances which, under the expected conditions of use for riot control purposes, rapidly produce in humans sensory irritation or disabling physical effects which disappear within a short time following termination of exposure. (Tear gases are a subset of "riot control agents".)

"Robot" (2 8 ML17) 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.

Note: *The above definition does not include the following devices:*

1. *Manipulation mechanisms which are only manually / teleoperator controllable;*
2. *Fixed sequence manipulation mechanisms which are automated moving devices, operating according to mechanically fixed programmed motions. The program 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 program 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 program pattern. Variations or modifications of the program 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 program 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'.

*Technical Note:*

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

"Run-out" (2) (out-of-true running) means radial displacement in one revolution of the main spindle measured in a plane perpendicular to the spindle axis at a point on the external or internal revolving surface to be tested (Reference: ISO 230/1-1986, paragraph 5.61).

"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" (6) is equivalent to "super high power laser".

"Signal analysers" (3) mean 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 "programs" or "microprograms" fixed in any tangible medium of expression.

"Solidify rapidly" means a process involving the solidification of molten material at cooling rates exceeding 1 000 K/sec.

"Source code" (or source language) (4 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 9) is Young's modulus in pascals, equivalent to  $N/m^2$  divided by specific weight in  $N/m^3$ , measured at a temperature of  $(296 \pm 2)$  K  $((23 \pm 2)^\circ C)$  and a relative humidity of  $(50 \pm 5)\%$ .



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"Specific tensile strength" (0 1 9) is ultimate tensile strength in pascals, equivalent to  $N/m^2$  divided by specific weight in  $N/m^3$ , measured at a temperature of  $(296 \pm 2)$  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.

"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.

"States (not) Party to the Chemical Weapon Convention" (1) are those states for which the Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons has (not) entered into force. (See [www.opcw.org](http://www.opcw.org))

"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.

Technical Notes:

1. 'Discrete component': a separately packaged 'circuit element' with its own external connections.
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) mean nickel-, cobalt- or iron-base alloys having strengths superior to any alloys in the AISI 300 series at temperatures over 922 K ( $649^\circ C$ ) under severe environmental and operating conditions.

"Superconductive" (1 3 6 8 ML18 ML20) 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.

Technical Note:

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

"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.

Technical Note:

*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.

Technical Note:

*'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 a product. The information takes the form of technical data or technical assistance. Controlled "technology" for the Dual-Use List is defined in the General Technology Note and in the Dual-Use List. Controlled "technology" for the Munitions List is specified in ML22.

Technical Notes:

1. *'Technical data' may take forms such as blueprints, plans, diagrams, models, formulae, tables, engineering designs and specifications, manuals and instructions written or recorded on other media or devices such as disk, tape, read-only memories.*
2. *'Technical assistance' may take forms such as instruction, skills, training, working knowledge, consulting services. 'Technical assistance' may involve transfer of 'technical data'.*

"Terminal interface equipment" (4) means equipment at which information enters or leaves the telecommunication system, e.g., telephone, data device, computer, facsimile device.

"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).

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"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".

"Unmanned aerial vehicle" ("UAV") (9) means any "aircraft" capable of initiating flight and sustaining controlled flight and navigation without any human presence on board.

"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 1 2 4 5 6 7 8 9 ML21 ML22) 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 "programs" 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 in a pharmaceutical formulation licensed by, or having marketing or clinical trial authorisation from, the regulatory authorities of either the country of manufacture or of use, which is intended to stimulate a protective immunological response in humans or animals in order to prevent disease in those to whom or to which it is administered.

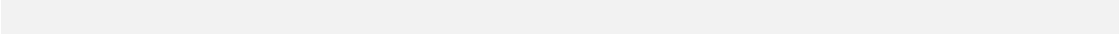
"Vacuum Atomisation" (1) means a process to reduce a molten stream of metal to droplets of a diameter of 500 micrometre or less by the rapid evolution of a dissolved gas upon exposure to a vacuum.

"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'.

*Technical Note:*

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



## ACRONYMS AND ABBREVIATIONS

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

<b>ACRONYM OR ABBREVIATION</b>	<b>MEANING</b>
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
ASNO	Australian Safeguards and Non-proliferation Office
ASTM	the American Society for Testing and Materials
ATC	air traffic control
AVLIS	atomic vapour laser isotope separation
C <sup>3</sup> I	command, communications, control & intelligence
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
DEW	directed energy weapon systems
DME	distance measuring equipment
DS	directionally solidified
EB-PVD	electron beam physical vapour deposition
EBU	European Broadcasting Union
ECM	electro-chemical machining
ECR	electron cyclotron resonance
EDM	electrical discharge machines
EEPROMS	electrically erasable programmable read only memory
EIA	Electronic Industries Association
EMC	electromagnetic compatibility
EMCDB	elastomer modified cast double based propellants
FFT	Fast Fourier Transform
GLONASS	global navigation satellite system
GPS	global positioning system
HBT	hetero-bipolar transistors
HDDR	high density digital recording
HEMT	high electron mobility transistors
ICAO	International Civil Aviation Organisation
IEC	International Electro-technical Commission

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<b>ACRONYM OR ABBREVIATION</b>	<b>MEANING</b>
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
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
MPEG	Moving Picture Experts Group (ISO/IEC JTC1/SC29/WG11)
MRI	magnetic resonance imaging
MTBF	mean-time-between-failures
Mtops	million theoretical operations per second
MTTF	mean-time-to-failure
NBC	Nuclear, Biological and Chemical
NDT	non-destructive test
PAR	precision approach radar
PIN	personal identification number
ppm	parts per million
PSD	power spectral density
QAM	quadrature-amplitude-modulation
RF	radio frequency
RPV	remotely piloted air vehicle
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
UAV	unmanned aerial vehicle
UTS	ultimate tensile strength
UV	ultraviolet
VOR	very high frequency omni-directional range
YAG	yttrium/aluminium garnet

<b>PART 1 - MUNITIONS LIST</b>
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*Note 1 Terms in "quotations" are defined terms. Refer to the 'Definitions of Terms' section.*

*Note 2 Chemicals are listed by name and CAS number. Chemicals of the same structural formula (including hydrates) are controlled regardless of name or CAS number. CAS numbers are shown to assist in identifying whether a particular chemical or mixture is controlled, irrespective of nomenclature. CAS numbers cannot be used as unique identifiers because some forms of the listed chemical have different CAS numbers, and mixtures containing a listed chemical may also have different CAS numbers.*

ML1. Smooth-bore weapons with a calibre of less than 20 mm, other arms and automatic weapons with a calibre of 12.7 mm (calibre 0.50 inches) or less and accessories, as follows, and specially designed components therefor:

a. Rifles, carbines, revolvers, pistols, machine pistols and machine guns:

*Note ML1.a. does not control the following:*

- 1. Muskets, rifles and carbines manufactured earlier than 1938;*
- 2. Reproductions of muskets, rifles and carbines the originals of which were manufactured earlier than 1890;*
- 3. Revolvers, pistols and machine guns manufactured earlier than 1890, and their reproductions;*

*N.B. For these goods and specially designed components therefor, see Items ML901, ML903 and ML904.*

b. Smooth-bore weapons, as follows:

- 1. Smooth-bore weapons specially designed for military use;*
- 2. Other smooth-bore weapons, as follows:*
  - a. Of the fully automatic type;*
  - b. Of the semi-automatic or pump-action type;*

c. Weapons using caseless ammunition;

d. Silencers, special gun-mountings, clips, weapons sights and flash suppressors for arms controlled by sub-items ML1.a., ML1.b. or ML1.c.

*Note 1 ML1. does not control smooth-bore weapons used for hunting or sporting purposes. These weapons must not be specially designed for military use or of the fully automatic firing type. For these, see Item ML901.*

*Note 2 ML1. does not control firearms specially designed for dummy ammunition and which are incapable of firing any controlled ammunition. For these, see Item ML901.*

*Note 3 ML1. does not control weapons using non-centre fire cased ammunition and which are not of the fully automatic firing type. For these, see Item ML901.*

ML1. continued

Note 4 *ML1.d. does not control optical weapon sights without electronic image processing, with a magnification of 4 times or less, provided they are not specially designed or modified for military use.*

ML2. Smooth-bore weapons with a calibre of 20 mm or more, other weapons or armament with a calibre greater than 12.7 mm (calibre 0.50 inches), projectors and accessories, as follows, and specially designed components therefor:

a. Guns, howitzers, cannon, mortars, anti-tank weapons, projectile launchers, military flame throwers, recoilless rifles and signature reduction devices therefor;

Note *ML2.a. includes injectors, metering devices, storage tanks and other specially designed components for use with liquid propelling charges for any of the equipment controlled by ML2.a.*

b. Military smoke, gas and pyrotechnic projectors or generators.

Note *ML2.b. does not control signal pistols.*

c. Weapons sights.

ML3. Ammunition and fuze setting devices, as follows, and specially designed components therefor:

a. Ammunition for the weapons controlled by ML1., ML2. or ML12.;

b. Fuze setting devices specially designed for ammunition controlled by ML3.a.

Note 1 *Specially designed components include:*

- a. *Metal or plastic fabrications such as primer anvils, bullet cups, cartridge links, rotating bands and munitions metal parts;*
- b. *Safing and arming devices, fuzes, sensors and initiation devices;*
- c. *Power supplies with high one-time operational output;*
- d. *Combustible cases for charges;*
- e. *Submunitions including bomblets, minelets and terminally guided projectiles.*

Note 2 *ML3.a. does not control ammunition crimped without a projectile (blank star) and dummy ammunition with a pierced powder chamber. For this, and other ammunition not covered by Item ML3, see Item ML902.*

Note 3 *ML3.a. does not control cartridges specially designed for any of the following purposes:*

- a. *Signalling;*
- b. *Bird scaring; or*
- c. *Lighting of gas flares at oil wells.*



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ML4. Bombs, torpedoes, rockets, missiles, other explosive devices and charges and related equipment and accessories, as follows, specially designed for military use, and specially designed components therefor:

*N.B. For guidance and navigation equipment, see ML11, Note 7.*

- a. Bombs, torpedoes, grenades, smoke canisters, rockets, mines, missiles, depth charges, demolition-charges, demolition-devices and demolition-kits, "pyrotechnic" devices, cartridges and simulators (i.e. equipment simulating the characteristics of any of these items);

*Note ML4.a. includes:*

- 1. Smoke grenades, fire bombs, incendiary bombs and explosive devices;*
- 2. Missile rocket nozzles and re-entry vehicle nosetips.*

- b. Equipment specially designed for the handling, control, activation, powering with one-time operational output, launching, laying, sweeping, discharging, decoying, jamming, detonation or detection of items controlled by ML4.a.

*Note 1 ML4.b. includes:*

- a. Mobile gas liquefying equipment capable of producing 1,000 kg or more per day of gas in liquid form;*
- b. Buoyant electric conducting cable suitable for sweeping magnetic mines.*

*Note 2 ML4.b. does not include detonators or other equipment for the detonation of non-military explosives covered by ML908. For these, see ML909.*

*Technical Note*

*Hand-held devices, limited by design solely to the detection of metal objects and incapable of distinguishing between mines and other metal objects, are not considered to be specially designed for the detection of items controlled by ML4.a.*

ML5. Fire control, and related alerting and warning equipment, and related systems, test and alignment and countermeasure equipment, as follows, specially designed for military use, and specially designed components and accessories therefor:

- a. Weapon sights, bombing computers, gun laying equipment and weapon control systems;
- b. Target acquisition, designation, range-finding, surveillance or tracking systems; detection, data fusion, recognition or identification equipment; and sensor integration equipment;
- c. Countermeasure equipment for items controlled by ML5.a. or ML5.b.
- d. Field test or alignment equipment, specially designed for items controlled by ML5.a. or ML5.b.

ML6. Ground vehicles and components, as follows:

*N.B.* For guidance and navigation equipment, see ML11, Note 7.

- a. Ground vehicles and components therefor, specially designed or modified for military use;

*Technical Note*

*For the purposes of ML6.a. the term ground vehicles includes trailers.*

- b. All wheel-drive vehicles capable of off-road use which have been manufactured or fitted with materials to provide ballistic protection to level III (NIJ 0108.01, September 1985, or comparable national standard) or better.

*N.B.* See also ML13.a.

*Note 1* ML6.a. includes:

- a. Tanks and other military armed vehicles and military vehicles fitted with mountings for arms or equipment for mine laying or the launching of munitions controlled under ML4;
- b. Armoured vehicles;
- c. Amphibious and deep water fording vehicles;
- d. Recovery vehicles and vehicles for towing or transporting ammunition or weapon systems and associated load handling equipment.

*Note 2* Modification of a ground vehicle for military use controlled by ML6.a. entails a structural, electrical or mechanical change involving one or more specially designed military components. Such components include:

- a. Pneumatic tyre casings of a kind specially designed to be bullet-proof or to run when deflated;
- b. Tyre inflation pressure control systems, operated from inside a moving vehicle;
- c. Armoured protection of vital parts, (e.g., fuel tanks or vehicle cabs);
- d. Special reinforcements or mountings for weapons;
- e. Black-out lighting.

*Note 3* ML6. does not control civil automobiles or trucks designed or modified for transporting money or valuables, having armoured or ballistic protection.

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- ML7. Chemical or biological toxic agents, "riot control agents", radioactive materials, related equipment, components, and materials, as follows:
- a. Biological agents and radioactive materials "adapted for use in war" to produce casualties in humans or animals, degrade equipment or damage crops or the environment;
  - b. Chemical warfare (CW) agents including:
    1. CW nerve agents:
      - a. O-Alkyl (equal to or less than C<sub>10</sub>, including cycloalkyl) alkyl (Methyl, Ethyl, n-Propyl or Isopropyl) - phosphonofluoridates, such as:  
Sarin (GB):O-Isopropyl methylphosphonofluoridate (CAS 107-44-8); and  
Soman (GD):O-Pinacolyl methylphosphonofluoridate (CAS 96-64-0);
      - b. O-Alkyl (equal to or less than C<sub>10</sub>, including cycloalkyl) N,N-dialkyl (Methyl, Ethyl, n-Propyl or Isopropyl) phosphoramidocyanidates, such as: Tabun (GA):O-Ethyl N,N-dimethylphosphoramidocyanidate (CAS 77-81-6);
      - c. O-Alkyl (H or equal to or less than C<sub>10</sub>, including cycloalkyl) S-2-dialkyl (Methyl, Ethyl, n-Propyl or Isopropyl)-aminoethyl alkyl (Methyl, Ethyl, n-Propyl or Isopropyl) phosphonothiolates and corresponding alkylated and protonated salts, such as:  
VX: O-Ethyl S-2-diisopropylaminoethyl methyl phosphonothiolate (CAS 50782-69-9);
    2. CW vesicant agents:
      - a. Sulphur mustards, such as:
        1. 2-Chloroethylchloromethylsulphide (CAS 2625-76-5);
        2. Bis(2-chloroethyl) sulphide (CAS 505-60-2);
        3. Bis(2-chloroethylthio) methane (CAS 63869-13-6);
        4. 1,2-bis (2-chloroethylthio) ethane (CAS 3563-36-8);
        5. 1,3-bis (2-chloroethylthio) -n-propane (CAS 63905-10-2);
        6. 1,4-bis (2-chloroethylthio) -n-butane (CAS 142868-93-7);
        7. 1,5-bis (2-chloroethylthio) -n-pentane (CAS 142868-94-8);
        8. Bis (2-chloroethylthiomethyl) ether (CAS 63918-90-1);
        9. Bis (2-chloroethylthioethyl) ether (CAS 63918-89-8);
      - b. Lewisites, such as:
        1. 2-chlorovinylchloroarsine (CAS 541-25-3);
        2. Tris (2-chlorovinyl) arsine (CAS 40334-70-1);
        3. Bis (2-chlorovinyl) chloroarsine (CAS 40334-69-8);
      - c. Nitrogen mustards, such as:
        1. HN1: bis (2-chloroethyl) ethylamine (CAS 538-07-8);
        2. HN2: bis (2-chloroethyl) methylamine (CAS 51-75-2);
        3. HN3: tris (2-chloroethyl) amine (CAS 555-77-1);

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ML7. continued

3. CW incapacitating agents, such as:
- 3-Quinuclidinyl benzilate (BZ) (CAS 6581-06-2);

*Note 1:* For exports to "States not Party to the Chemical Weapons Convention", ML7 does not control "chemical mixtures" containing 3-Quinuclidinyl benzilate (BZ) in which BZ does not constitute more than 1% by the weight of the mixture.

*Note 2:* For exports to "States Party to the Chemical Weapons Convention", ML7 does not control "chemical mixtures" containing 3-Quinuclidinyl benzilate (BZ) in which BZ does not constitute more than 30% by the weight of the mixture.

4. CW defoliants, such as:
  - Butyl 2-chloro-4-fluorophenoxyacetate (LNF);
  - 2,4,5-trichlorophenoxyacetic acid mixed with 2,4-dichlorophenoxyacetic acid (Agent Orange).
- c. CW binary precursors and key precursors, as follows:
  - Alkyl (Methyl, Ethyl, n-Propyl or Isopropyl) Phosphonyl Difluorides, such as: DF: Methyl Phosphonyldifluoride (CAS 676-99-3);
  - O-Alkyl (H or equal to or less than C<sub>10</sub>, including cycloalkyl) O-2-dialkyl (Methyl, Ethyl, n-Propyl or Isopropyl) aminoethyl alkyl (Methyl, Ethyl, n-Propyl or Isopropyl) phosphonites and corresponding alkylated and protonated salts, such as:  
QL: O-Ethyl-2-di-isopropylaminoethyl methylphosphonite (CAS 57856-11-8);
  - Chlorosarin: O-Isopropyl methylphosphonochloridate (CAS 1445-76-7);
  - Chlorosoman: O-Pinacolyl methylphosphonochloridate (CAS 7040-57-5);
- d. "Riot control agents", active constituent chemicals and combinations thereof, including:
  - $\alpha$ -Bromobenzeneacetonitrile, (Bromobenzyl cyanide) (CA) (CAS 5798-79-8);
  - [(2-chlorophenyl) methylene] propanedinitrile, (o-Chlorobenzylidenemalononitrile) (CS) (CAS 2698-41-1);
  - 2-Chloro-1-phenylethanone, Phenylacetyl chloride (o-chloroacetophenone) (CN) (CAS 532-27-4);
  - Dibenz-(b,f)-1,4-oxazepine, (CR) (CAS 257-07-8);
  - 10-Chloro-5,10-dihydrophenarsazine, (Phenarsazine chloride), (Adamsite), (DM) (CAS 578-94-9);
  - N-Nonanoylmorpholine, (MPA) (CAS 5299-64-9);

*Note 1* ML7.d. does not control "riot control agents" individually packaged for personal self defence purposes.

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ML7. 4. continued

Note 2 *ML7.d. does not control active constituent chemicals, and combinations thereof identified and packaged for food production or medical purposes.*

- e. Equipment specially designed or modified for military use, for the dissemination of any of the following and specially designed components therefor:
  - 1. Materials or agents controlled by ML7.a., ML7.b. or d.; or
  - 2. CW made up of precursors controlled by ML7.c.
  
- f. Protective and decontamination equipment, specially designed components therefor, and specially formulated chemical mixtures, as follows:
  - 1. Equipment, specially designed or modified for military use, for defence against materials controlled by ML7.a., ML7.b. or d. and specially designed components therefor;
  - 2. Equipment, specially designed or modified for military use, for the decontamination of objects contaminated with materials controlled by ML7.a. or ML7.b. and specially designed components therefor;
  - 3. Chemical mixtures specially developed/formulated for the decontamination of objects contaminated with materials controlled by ML7.a. or ML7.b.;

Note *ML7.f.1. includes:*

- a. *Air conditioning units specially designed or modified for nuclear, biological or chemical filtration;*
- b. *Protective clothing.*

N.B. *For civil gas masks, protective and decontamination equipment see also entry IA004.*

- g. Equipment, specially designed or modified for military use, for the detection or identification of materials controlled by ML7.a., ML7.b. or d. and specially designed components therefor;

Note *ML7.g. does not control personal radiation monitoring dosimeters.*

N.B. *See also entry IA004.*

- h. "Biopolymers" specially designed or processed for the detection or identification of CW agents controlled by ML7.b., and the cultures of specific cells used to produce them;
  
- i. "Biocatalysts" for the decontamination or degradation of CW agents, and biological systems therefor, as follows:
  - 1. "Biocatalysts" specially designed for the decontamination or degradation of CW agents controlled by ML7.b. resulting from directed laboratory selection or genetic manipulation of biological systems;
  - 2. Biological systems, as follows: "expression vectors", viruses or cultures of cells containing the genetic information specific to the production of "biocatalysts" controlled by ML7.i.1.;

ML7. 4. continued

- Note 1 *ML7.b. and ML7.d. do not control:*
- a. *Cyanogen chloride (CAS 506-77-4);*
  - b. *Hydrocyanic acid (CAS 74-90-8);*
  - c. *Chlorine (CAS 7782-50-5);*
  - d. *Carbonyl chloride (phosgene) (CAS 75-44-5);*
  - e. *Diphosgene (trichloromethyl-chloroformate) (CAS 503-38-8);*
  - f. *Deleted*
  - g. *Xylyl bromide, ortho: (CAS 89-92-9), meta: (CAS 620-13-3), para: (CAS 104-81-4);*
  - h. *Benzyl bromide (CAS 100-39-0);*
  - i. *Benzyl iodide (CAS 620-05-3);*
  - j. *Bromo acetone (CAS 598-31-2);*
  - k. *Cyanogen bromide (CAS 506-68-3);*
  - l. *Bromo methylethylketone (CAS 816-40-0);*
  - m. *Chloro acetone (CAS 78-95-5);*
  - n. *Ethyl iodoacetate (CAS 623-48-3);*
  - o. *Iodo acetone (CAS 3019-04-3);*
  - p. *Chloropicrin (CAS 76-06-2).*
- Note 2 *The cultures of cells and biological systems listed in ML7.h. and ML7.i.2. are exclusive and these sub-items do not control cells or biological systems for civil purposes, such as agricultural, pharmaceutical, medical, veterinary, environmental, waste management, or in the food industry.*
- Note 3 *The export of chemicals listed in ML7.b.1 and b.2, ML7.c.1, c.2, c.3 and c.4 in any concentration requires permission and prior consultation with ASNO.*
- Note 4 *ML7 does not control "chemical mixtures" containing one or more of the chemicals specified in entries ML7.b.4, ML7.d.1, d.2, d.3, d.4, d.5 and d.6 in which no individually specified chemical constitutes more than 30% by the weight of the mixture.*
- N.B. *See also entries 1A004, 1C350, 1C351, 1C352, 1C353, 1C354 and 1C450.*

ML8. "Energetic materials", and related substances, as follows:

*N.B. See also entry IC011.*

Technical Notes

1. For the purposes of this entry, mixture refers to a composition of two or more substances with at least one substance being listed in the ML8 sub-items.
  2. Any substance listed in the ML8 sub-items is controlled by this list, even when utilized in an application other than that indicated. (e.g., TAGN is predominantly used as an explosive but can also be used either as a fuel or an oxidizer.)
- a. "Explosives", as follows, and mixtures thereof:
1. ADNBF (aminodinitrobenzofuroxan or 7-amino-4,6-dinitrobenzofurazane-1-oxide) (CAS 97096-78-1);
  2. BNCP (cis-bis (5-nitrotetrazolato) tetra amine-cobalt (III) perchlorate) (CAS 117412-28-9);
  3. CL-14 (diamino dinitrobenzofuroxan or 5,7-diamino-4,6-dinitrobenzofurazane-1-oxide) (CAS 117907-74-1);
  4. CL-20 (HNIW or Hexanitrohexaazaisowurtzitane) (CAS 135285-90-4); chlathrates of CL-20 (see also ML8.g.3. and g.4. for its "precursors");
  5. CP (2-(5-cyanotetrazolato) penta amine-cobalt (III) perchlorate) (CAS 70247-32-4);
  6. DADE (1,1-diamino-2,2-dinitroethylene, FOX7);
  7. DATB (diaminotrinitrobenzene) (CAS 1630-08-6);
  8. DDFP (1,4-dinitrodifurazanopiperazine);
  9. DDPO (2,6-diamino-3,5-dinitropyrazine-1-oxide, PZO) (CAS 194486-77-6);
  10. DIPAM (3,3'-diamino-2,2',4,4',6,6'-hexanitrobiphenyl or dipicramide) (CAS 17215-44-0);
  11. DNGU (DINGU or dinitroglycoluril) (CAS 55510-04-8);
  12. Furazans, as follows:
    - a. DAAOF (diaminoazoxyfurazan);
    - b. DAAzF (diaminoazofurazan) (CAS 78644-90-3);
  13. HMX and derivatives (see also ML8.g.5. for its "precursors"), as follows:
    - a. HMX (Cyclotetramethylenetetranitramine, octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazine, 1,3,5,7-tetranitro-1,3,5,7-tetra-cyclooctane, octogen or octogene) (CAS 2691-41-0);
    - b. difluoroaminated analogs of HMX;
    - c. K-55 (2,4,6,8-tetranitro-2,4,6,8-tetraazabicyclo [3,3,0]-octanone-3, tetranitrosemiglycouril or keto-bicyclic HMX) (CAS 130256-72-3);
  14. HNAD (hexanitroadamantane) (CAS 143850-71-9);
  15. HNS (hexanitrostilbene) (CAS 20062-22-0);
  16. Imidazoles, as follows:
    - a. BNNII (Octahydro-2,5-bis(nitroimino)imidazo [4,5-d]imidazole);
    - b. DNI (2,4-dinitroimidazole) (CAS 5213-49-0);
    - c. FDIA (1-fluoro-2,4-dinitroimidazole);
    - d. NTDNIA (N-(2-nitrotriazolo)-2,4-dinitroimidazole);
    - e. PTIA (1-picryl-2,4,5-trinitroimidazole);
  17. NTNMH (1-(2-nitrotriazolo)-2-dinitromethylene hydrazine);
  18. NTO (ONTA or 3-nitro-1,2,4-triazol-5-one) (CAS 932-64-9);
  19. Polynitrocubanes with more than four nitro groups;

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ML8. a. continued

20. PYX (2,6-Bis(picrylamino)-3,5-dinitropyridine) (CAS 38082-89-2);
  21. RDX and derivatives, as follows:
    - a. RDX (cyclotrimethylenetrinitramine, cyclonite, T4, hexahydro-1,3,5-trinitro-1,3,5-triazine, 1,3,5-trinitro-1,3,5-triaza-cyclohexane, hexogen or hexogene) (CAS 121-82-4);
    - b. Keto-RDX (K-6 or 2,4,6-trinitro-2,4,6-triazacyclohexanone) (CAS 115029-35-1);
  22. TAGN (triaminoguanidinenitrate) (CAS 4000-16-2);
  23. TATB (triaminotrinitrobenzene) (CAS 3058-38-6) (see also ML8.g.7 for its "precursors");
  24. TEDDZ (3,3,7,7-tetrakis(difluoroamine) octahydro-1,5-dinitro-1,5-diazocine);
  25. Tetrazoles, as follows:
    - a. NTAT (nitrotriazol aminotetrazole);
    - b. NTNT (1-N-(2-nitrotriazolo)-4-nitrotetrazole);
  26. Tetryl (trinitrophenylmethylnitramine) (CAS 479-45-8);
  27. TNAD (1,4,5,8-tetranitro-1,4,5,8-tetraazadecalin) (CAS 135877-16-6) (see also ML8.g.6. for its "precursors");
  28. TNAZ (1,3,3-trinitroazetidine) (CAS 97645-24-4) (see also ML8.g.2. for its "precursors");
  29. TNGU (SORGUYL or tetranitroglycoluril) (CAS 55510-03-7);
  30. TNP (1,4,5,8-tetranitro-pyridazino[4,5-d]pyridazine) (CAS 229176-04-9);
  31. Triazines, as follows:
    - a. DNAM (2-oxy-4,6-dinitroamino-s-triazine) (CAS 19899-80-0);
    - b. NNHT (2-nitroimino-5-nitro-hexahydro-1,3,5-triazine) (CAS 130400-13-4);
  32. Triazoles, as follows:
    - a. 5-azido-2-nitrotriazole;
    - b. ADHTDN (4-amino-3,5-dihydrazino-1,2,4-triazole dinitramide) (CAS 1614-08-0);
    - c. ADNT (1-amino-3,5-dinitro-1,2,4-triazole);
    - d. BDNTA ([bis-dinitrotriazole]amine);
    - e. DBT (3,3'-dinitro-5,5-bi-1,2,4-triazole) (CAS 30003-46-4);
    - f. DNBT (dinitrobistriazole) (CAS 70890-46-9);
    - g. NTDNA (2-nitrotriazole 5-dinitramide) (CAS 75393-84-9);
    - h. NTDNT (1-N-(2-nitrotriazolo) 3,5-dinitrotriazole);
    - i. PDNT (1-picryl-3,5-dinitrotriazole);
    - j. TACOT (tetranitrobenzotriazolobenzotriazole) (CAS 25243-36-1);
  33. Any explosive not listed elsewhere in ML8.a. with a detonation velocity exceeding 8,700 m/s at maximum density or a detonation pressure exceeding 34 GPa (340 kbar);
  34. Other organic explosives not listed elsewhere in ML8.a. yielding detonation pressures of 25 GPa (250 kbar) or more that will remain stable at temperatures of 523K (250°C) or higher for periods of 5 minutes or longer.
- b. "Propellants", as follows:
1. Any United Nations (UN) Class 1.1 solid "propellant" with a theoretical specific impulse (under standard conditions) of more than 250 seconds for non-metallized, or more than 270 seconds for aluminized compositions;



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ML8. b. continued

2. Any UN Class 1.3 solid "propellant" with a theoretical specific impulse (under standard conditions) of more than 230 seconds for non-halogenized, 250 seconds for non-metallized compositions and 266 seconds for metallized compositions;
  3. "Propellants" having a force constant of more than 1,200 kJ/kg;
  4. "Propellants" that can sustain a steady-state linear burning rate of more than 38 mm/s under standard conditions (as measured in the form of an inhibited single strand) of 6.89 MPa (68.9 bar) pressure and 294K (21°C);
  5. Elastomer modified cast double base (EMCDB) "propellants" with extensibility at maximum stress of more than 5% at 233K (-40°C);
  6. Any "propellant" containing substances listed in ML8.a.
- c. "Pyrotechnics", fuels and related substances, as follows, and mixtures thereof:
1. Aircraft fuels specially formulated for military purposes;
  2. Alane (aluminium hydride) (CAS 7784-21-6);
  3. Carboranes; decaborane (CAS 17702-41-9); pentaboranes (CAS 19624-22-7 and 18433-84-6) and their derivatives;
  4. Hydrazine and derivatives, as follows (see also ML8.d.8. and d.9. for oxidising hydrazine derivatives):
    - a. Hydrazine (CAS 302-01-2) in concentrations of 70% or more;
    - b. Monomethyl hydrazine (CAS 60-34-4);
    - c. Symmetrical dimethyl hydrazine (CAS 540-73-8);
    - d. Unsymmetrical dimethyl hydrazine (CAS 57-14-7);
  5. Metal fuels in particle form whether spherical, atomized, spheroidal, flaked or ground, manufactured from material consisting of 99 % or more of any of the following:
    - a. Metals and mixtures thereof, as follows:
      1. Beryllium (CAS 7440-41-7) in particle sizes of less than 60 µm;
      2. Iron powder (CAS 7439-89-6) with particle size of 3 µm or less produced by reduction of iron oxide with hydrogen;
    - b. Mixtures, which contain any of the following:
      1. Zirconium (CAS 7440-67-7), magnesium (CAS 7439-95-4) or alloys of these in particle sizes of less than 60 µm;
      2. Boron (CAS 7440-42-8) or boron carbide (CAS 12069-32-8) fuels of 85% purity or higher and particle sizes of less than 60 µm;
  6. Military materials containing thickeners for hydrocarbon fuels specially formulated for use in flame throwers or incendiary munitions, such as metal stearates or palmates (e.g. octal (CAS 637-12-7)) and M1, M2, and M3 thickeners;
  7. Perchlorates, chlorates and chromates composited with powdered metal or other high energy fuel components;
  8. Spherical aluminium powder (CAS 7429-90-5) with a particle size of 60 µm or less, manufactured from material with an aluminium content of 99% or more;
  9. Titanium subhydride (TiH<sub>n</sub>) of stoichiometry equivalent to n= 0.65-1.68.

Note 1 *Aircraft fuels controlled by ML8.c.1. are finished products not their constituents.*

ML8. c. continued

Note 2 *ML8.c.4.a. does not control hydrazine mixtures specially formulated for corrosion control.*

Note 3 *Explosives and fuels containing the metals or alloys listed in ML8.c.5. are controlled whether or not the metals or alloys are encapsulated in aluminium, magnesium, zirconium, or beryllium.*

Note 4 *ML8.c.5.b.2. does not control boron and boron carbide enriched with boron-10 (20% or more of total boron-10 content.)*

## d. Oxidizers, as follows, and mixtures thereof:

1. ADN (ammonium dinitramide or SR 12) (CAS 140456-78-6);
2. AP (ammonium perchlorate) (CAS 7790-98-9);
3. Compounds composed of fluorine and any of the following:
  - a. Other halogens;
  - b. Oxygen; or
  - c. Nitrogen;

Note 1 *ML8.d.3 does not control chlorine trifluoride.*  
Note 2 *ML8.d.3 does not control nitrogen trifluoride in its gaseous state.*
4. DNAD (1,3-dinitro-1,3-diazetidine) (CAS 78246-06-7);
5. HAN (hydroxylammonium nitrate) (CAS 13465-08-2);
6. HAP (hydroxylammonium perchlorate) (CAS 15588-62-2);
7. HNF (hydrazinium nitroformate) (CAS 20773-28-8);
8. Hydrazine nitrate (CAS 37836-27-4);
9. Hydrazine perchlorate (CAS 27978-54-7);
10. Liquid oxidisers comprised of or containing inhibited red fuming nitric acid (IRFNA) (CAS 8007-58-7);  
Note *ML8.d.10 does not control non-inhibited fuming nitric acid.*

## e. Binders, plasticizers, monomers, polymers, as follows:

1. AMMO (azidomethylmethyloxetane and its polymers) (CAS 90683-29-7) (see also ML8.g.1. for its "precursors");
2. BAMO (bisazidomethylmethyloxetane and its polymers) (CAS 17607-20-4) (see also ML8.g.1. for its "precursors");
3. BDNPA (bis (2,2-dinitropropyl)acetal) (CAS 5108-69-0);
4. BDNPF (bis (2,2-dinitropropyl)formal) (CAS 5917-61-3);
5. BTTN (butanetrioltrinitrate) (CAS 6659-60-5) (see also ML8.g.8. for its "precursors");
6. Energetic monomers, plasticizers and polymers containing nitro, azido, nitrate, nitraza or difluoroamino groups specially formulated for military use;
7. FAMA0 (3-difluoroaminomethyl-3-azidomethyl oxetane) and its polymers;
8. FEFO (bis-(2-fluoro-2,2-dinitroethyl) formal) (CAS 17003-79-1);
9. FPF-1 (poly-2,2,3,3,4,4-hexafluoropentane-1,5-diol formal) (CAS 376-90-9);
10. FPF-3 (poly-2,4,4,5,5,6,6-heptafluoro-2-tri-fluoromethyl-3-oxaheptane-1,7-diol formal);
11. GAP (glycidylazide polymer) (CAS 143178-24-9) and its derivatives;

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ML8. e. continued

12. HTPB (hydroxyl terminated polybutadiene) with a hydroxyl functionality equal to or greater than 2.2 and less than or equal to 2.4, a hydroxyl value of less than 0.77 meq/g, and a viscosity at 30°C of less than 47 poise (CAS 69102-90-5);
  13. Low (less than 10,000) molecular weight, alcohol functionalised, poly(epichlorohydrin); poly(epichlorohydrindiol) and triol;
  14. NENAs (nitrate ethylnitramine compounds) (CAS 17096-47-8, 85068-73-1, 82486-83-7, 82486-82-6 and 85954-06-9);
  15. PGN (poly-GLYN, polyglycidyl nitrate or poly(nitratomethyl oxirane) (CAS 27814-48-8);
  16. Poly-NIMMO (poly nitratomethylmethyloxetane) or poly-NMMO (poly[3-Nitratomethyl-3-methyloxetane]) (CAS 84051-81-0);
  17. Polynitroorthocarbonates;
  18. TVOPA (1,2,3-tris[1,2-bis(difluoroamino)ethoxy] propane or tris vinoxyl propane adduct) (CAS 53159-39-0).
- f. "Additives", as follows:
1. Basic copper salicylate (CAS 62320-94-9);
  2. BHEGA (bis-(2-hydroxyethyl) glycolamide) (CAS 17409-41-5);
  3. BNO (butadienenitrile oxide) (CAS 9003-18-3);
  4. Ferrocene derivatives, as follows:
    - a. Butacene (CAS 125856-62-4);
    - b. Catocene (2,2-bis-ethylferrocenyl propane) (CAS 37206-42-1);
    - c. Ferrocene carboxylic acids;
    - d. n-butyl-ferrocene (CAS 31904-29-7);
    - e. Other adducted polymer ferrocene derivatives;
  5. Lead beta-resorcyate (CAS 20936-32-7);
  6. Lead citrate (CAS 14450-60-3);
  7. Lead-copper chelates of beta-resorcyate or salicylates (CAS 68411-07-4);
  8. Lead maleate (CAS 19136-34-6);
  9. Lead salicylate (CAS 15748-73-9);
  10. Lead stannate (CAS 12036-31-6);
  11. MAPO (tris-1-(2-methyl)aziridinyl phosphine oxide) (CAS 57-39-6); BOBBA 8 (bis(2-methyl aziridinyl) 2-(2-hydroxypropanoxy) propylamino phosphine oxide); and other MAPO derivatives;
  12. Methyl BAPO (bis(2-methyl aziridinyl) methylamino phosphine oxide) (CAS 85068-72-0);
  13. N-methyl-p-nitroaniline (CAS 100-15-2);
  14. 3-Nitroaza-1,5-pentane diisocyanate (CAS 7406-61-9);
  15. Organo-metallic coupling agents, as follows:
    - a. Neopentyl[diallyl]oxy, tri[diethyl]phosphato-titanate (CAS 103850-22-2); also known as titanium IV, 2,2[bis 2-propenolato-methyl, butanolato, tris (diethyl) phosphato] (CAS 110438-25-0); or LICA 12 (CAS 103850-22-2);
    - b. Titanium IV, [(2-propenolato-1) methyl, n-propanolatomethyl] butanolato-1, tris[diethyl] pyrophosphate or KR3538;
    - c. Titanium IV, [(2-propenolato-1)methyl, n-propanolatomethyl] butanolato-1, tris(diethyl)phosphate;
  16. Polycyanodifluoroaminoethyleneoxide;

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ML8. f. continued

17. Polyfunctional aziridine amides with isophthalic, trimesic (BITA or butylene imine trimesamide), isocyanuric or trimethyladipic backbone structures and 2-methyl or 2-ethyl substitutions on the aziridine ring;
18. Propyleneimine (2-methylaziridine) (CAS 75-55-8);
19. Superfine iron oxide (Fe<sub>2</sub>O<sub>3</sub>) with a specific surface area more than 250 m<sup>2</sup>/g and an average particle size of 3.0 nm or less;
20. TEPAN (tetraethylenepentaamineacrylonitrile) (CAS 68412-45-3); cyanoethylated polyamines and their salts;
21. TEPANOL (tetraethylenepentaamineacrylonitrileglycidol) (CAS 68412-46-4); cyanoethylated polyamines adducted with glycidol and their salts;
22. TPB (triphenyl bismuth) (CAS 603-33-8).

g. "Precursors", as follows:

*N.B.* In ML8.g. the references are to controlled "Energetic Materials" manufactured from these substances.

1. BCMO (bischloromethyloxetane) (CAS 142173-26-0)  
(see also ML8.e.1. and e.2.);
2. Dinitroazetidine-t-butyl salt (CAS 125735-38-8) (see also ML8.a.28.);
3. HBIW (hexabenzylhexaazaisowurtzitane) (CAS 124782-15-6)  
(see also ML8.a.4.);
4. TAIW (tetraacetyldibenzylhexaazaisowurtzitane) (see also ML8.a.4.);
5. TAT (1,3,5,7 tetraacetyl-1,3,5,7,-tetraaza cyclo-octane) (CAS 41378-98-7)  
(see also ML8.a.13.);
6. 1,4,5,8-tetraazadecalin (CAS 5409-42-7) (see also ML8.a.27.);
7. 1,3,5-trichlorobenzene (CAS 108-70-3) (see also ML8.a.23.);
8. 1,2,4-trihydroxybutane (1,2,4-butanetriol) (CAS 3068-00-6)  
(see also ML8.e.5.).

Note 5 For charges and devices see ML4.

Note 6 ML8. does not control the following substances unless they are compounded or mixed with the "energetic material" mentioned in ML8.a. or powdered metals in ML8.c.:

- a. Ammonium picrate;
- b. Black powder;
- c. Hexanitrodiphenylamine;
- d. Difluoroamine;
- e. Nitrostarch;
- f. Potassium nitrate;
- g. Tetranitronaphthalene;
- h. Trinitroanisol;
- i. Trinitronaphthalene;
- j. Trinitroxylene;
- k. N-pyrrolidinone; 1-methyl-2-pyrrolidinone;
- l. Dioctylmaleate;
- m. Ethylhexylacrylate;

ML8. g. continued

- n. Triethylaluminium (TEA), trimethylaluminium (TMA), and other pyrophoric metal alkyls and aryls of lithium, sodium, magnesium, zinc or boron;
- o. Nitrocellulose;
- p. Nitroglycerin (or glyceroltrinitrate, trinitroglycerine) (NG);
- q. 2,4,6-trinitrotoluene (TNT);
- r. Ethylenediaminedinitrate (EDDN);
- s. Pentaerythritoltetranitrate (PETN);
- t. Lead azide, normal and basic lead styphnate, and primary explosives or priming compositions containing azides or azide complexes;
- u. Triethyleneglycoldinitrate (TEGDN);
- v. 2,4,6-trinitroresorcinol (styphnic acid);
- w. Diethyldiphenyl urea; dimethyldiphenyl urea; methylethyldiphenyl urea [Centralites];
- x. N,N-diphenylurea (unsymmetrical diphenylurea);
- y. Methyl-N,N-diphenylurea (methyl unsymmetrical diphenylurea);
- z. Ethyl-N,N-diphenylurea (ethyl unsymmetrical diphenylurea);
- aa. 2-Nitrodiphenylamine (2-NDPA);
- bb. 4-Nitrodiphenylamine (4-NDPA);
- cc. 2,2-dinitropropanol;
- dd. Nitroguanidine (see entry IC011.d).

N.B. See also item ML908.

ML9. Vessels of war, special naval equipment and accessories, as follows, and components therefor, specially designed for military use:

N.B. For guidance and navigation equipment, see ML11, Note 7.

- a. Combatant vessels and vessels (surface or underwater) specially designed or modified for offensive or defensive action, whether or not converted to non-military use, regardless of current state of repair or operating condition, and whether or not they contain weapon delivery systems or armour, and hulls or parts of hulls for such vessels;
- b. Engines, as follows:
  - 1. Diesel engines specially designed for submarines with both of the following characteristics:
    - a. A power output of 1.12 MW (1,500 hp.) or more; and
    - b. A rotary speed of 700 rpm or more;
  - 2. Electric motors specially designed for submarines having all of the following characteristics:
    - a. A power output of more than 0.75 MW (1,000 hp.);
    - b. Quick reversing;
    - c. Liquid cooled; and
    - d. Totally enclosed;
  - 3. Non-magnetic diesel engines specially designed for military use with a power output of 37.3 kW (50 hp.) or more and with a non-magnetic content in excess of 75% of total mass;

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ML9. continued

- c. Underwater detection devices specially designed for military use and controls thereof;
- d. Submarine and torpedo nets;
- e. Deleted;
- f. Hull penetrators and connectors specially designed for military use that enable interaction with equipment external to a vessel;  
*Note ML9.f. includes connectors for vessels which are of the single-conductor, multi-conductor, coaxial or waveguide type, and hull penetrators for vessels, both of which are capable of remaining impervious to leakage from without and of retaining required characteristics at marine depths exceeding 100 m; and fibre-optic connectors and optical hull penetrators specially designed for "laser" beam transmission regardless of depth. It does not include ordinary propulsive shaft and hydrodynamic control-rod hull penetrators.*
- g. Silent bearings, with gas or magnetic suspension, active signature or vibration suppression controls, and equipment containing those bearings, specially designed for military use.

ML10. "Aircraft", "lighter-than-air vehicles", unmanned airborne vehicles, aero-engines and "aircraft" equipment, related equipment and components, specially designed or modified for military use, as follows:

*N.B. For guidance and navigation equipment, see ML11, Note 7.*

- a. Combat "aircraft" and specially designed components therefor;
- b. Other "aircraft" and "lighter-than-air vehicles" specially designed or modified for military use, including military reconnaissance, assault, military training, transporting and airdropping troops or military equipment, logistics support, and specially designed components therefor;
- c. Unmanned airborne vehicles and related equipment, specially designed or modified for military use, as follows, and specially designed components therefor:
  - 1. Unmanned airborne vehicles including remotely piloted air vehicles (RPVs), autonomous programmable vehicles and "lighter-than-air vehicles";
  - 2. Associated launchers and ground support equipment;
  - 3. Related equipment for command and control.
- d. Aero-engines specially designed or modified for military use, and specially designed components therefor;
- e. Airborne equipment, including airborne refuelling equipment, specially designed for use with the "aircraft" controlled by ML10.a. or ML10.b. or the aero-engines controlled by ML10.d., and specially designed components therefor;

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ML10. continued

- f. Pressure refuellers, pressure refuelling equipment, equipment specially designed to facilitate operations in confined areas and ground equipment, developed specially for "aircraft" controlled by ML10.a. or ML10.b., or for aero-engines controlled by ML10.d.;
- g. Military crash helmets and protective masks and specially designed components therefor, pressurised breathing equipment and partial pressure suits for use in "aircraft", anti-g suits, liquid oxygen converters used for "aircraft" or missiles, and catapults and cartridge actuated devices for emergency escape of personnel from "aircraft";
- h. Parachutes and related equipment, used for combat personnel, cargo dropping or "aircraft" deceleration, as follows, and specially designed components therefor:
  - 1. Parachutes for:
    - a. Pin point dropping of rangers;
    - b. Dropping of paratroopers;
  - 2. Cargo parachutes;
  - 3. Paragliders, drag parachutes, drogue parachutes for stabilisation and attitude control of dropping bodies, (e.g. recovery capsules, ejection seats, bombs);
  - 4. Drogue parachutes for use with ejection seat systems for deployment and inflation sequence regulation of emergency parachutes;
  - 5. Recovery parachutes for guided missiles, drones or space vehicles;
  - 6. Approach parachutes and landing deceleration parachutes;
  - 7. Other military parachutes;
  - 8. Equipment specially designed for high altitude parachutists (e.g., suits, special helmets, breathing systems, navigation equipment);
- i. Automatic piloting systems for parachuted loads; equipment specially designed or modified for military use for controlled opening jumps at any height, including oxygen equipment.

Note 1 *ML10.b. does not control "aircraft" or variants of those "aircraft" specially designed for military use which:*

- a. *Are not configured for military use and are not fitted with equipment or attachments specially designed or modified for military use; and*
- b. *Have been certified for civil use by the civil aviation authority in a participating state\*.*

Note 2 *ML10.d. does not control:*

- a. *Aero-engines designed or modified for military use which have been certified by civil aviation authorities in a participating state\* for use in "civil aircraft", or specially designed components therefor;*
- b. *Reciprocating engines or specially designed components therefor, except those specially designed for unmanned airborne vehicles.*

Note 3 *The control in ML10.b. and ML10.d. on specially designed components and related equipment for non-military "aircraft" or aero-engines modified for military use applies only to those military components and to military related equipment required for the modification to military use.*

ML10. continued

*\*N.B. In June 2006, the Participating States of the Wassenaar Arrangement are:  
Argentina, Australia, Austria, Belgium, Bulgaria, Canada, Croatia, Czech Republic,  
Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy,  
Japan, Latvia, Lithuania, Luxembourg, Malta, Netherlands, New Zealand, Norway,  
Poland, Portugal, Republic of Korea, Romania, Russian Federation, Slovakia,  
Slovenia, South Africa, Spain, Sweden, Switzerland, Turkey, Ukraine, United  
Kingdom and United States.*



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ML11. Electronic equipment, not controlled elsewhere on the Munitions List as follows, and specially designed components therefor:

a. Electronic equipment specially designed for military use.

Note *ML11.a. includes:*

1. *Electronic countermeasure and electronic counter-countermeasure equipment (i.e., equipment designed to introduce extraneous or erroneous signals into radar or radio communication receivers or otherwise hinder the reception, operation or effectiveness of adversary electronic receivers including their countermeasure equipment), including jamming and counter-jamming equipment;*
2. *Frequency agile tubes;*
3. *Electronic systems or equipment designed either for surveillance and monitoring of the electro-magnetic spectrum for military intelligence or security purposes or for counteracting such surveillance and monitoring;*
4. *Underwater countermeasures, including acoustic and magnetic jamming and decoy, equipment designed to introduce extraneous or erroneous signals into sonar receivers;*
5. *Data processing security equipment, data security equipment and transmission and signalling line security equipment, using ciphering processes;*
6. *Identification, authentication and keyloader equipment and key management, manufacturing and distribution equipment;*
7. *Guidance and navigation equipment.*

b. Global Navigation Satellite Systems (GNSS) jamming equipment.

ML12. High velocity kinetic energy weapon systems and related equipment, as follows, and specially designed components therefor:

- a. Kinetic energy weapon systems specially designed for destruction or effecting mission-abort of a target;
- b. Specially designed test and evaluation facilities and test models, including diagnostic instrumentation and targets, for dynamic testing of kinetic energy projectiles and systems.

*N.B. For weapon systems using sub-calibre ammunition or employing solely chemical propulsion, and ammunition therefor, see ML1. to ML4.*

*Note 1 ML12. includes the following when specially designed for kinetic energy weapon systems:*

- a. *Launch propulsion systems capable of accelerating masses larger than 0.1 g to velocities in excess of 1.6 km/s, in single or rapid fire modes;*
- b. *Prime power generation, electric armour, energy storage, thermal management, conditioning, switching or fuel-handling equipment; and electrical interfaces between power supply, gun and other turret electric drive functions;*
- c. *Target acquisition, tracking, fire control or damage assessment systems;*
- d. *Homing seeker, guidance or divert propulsion (lateral acceleration) systems for projectiles.*

*Note 2 ML12. controls weapon systems using any of the following methods of propulsion:*

- a. *Electromagnetic;*
- b. *Electrothermal;*
- c. *Plasma;*
- d. *Light gas; or*
- e. *Chemical (when used in combination with any of the above).*

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ML13. Armoured or protective equipment and constructions and components, as follows:

- a. Armoured plate as follows:
  1. Manufactured to comply with a military standard or specification; or
  2. Suitable for military use;
- b. Constructions of metallic or non-metallic materials or combinations thereof specially designed to provide ballistic protection for military systems, and specially designed components therefor;
- c. Military helmets;
- d. Body armour and protective garments manufactured according to military standards or specifications, or equivalent, and specially designed components therefor.

*N.B. For "fibrous or filamentary materials" used in the manufacture of body armour, see entry 1C010.*

*Note 1 ML13.b. includes materials specially designed to form explosive reactive armour or to construct military shelters.*

*Note 2 ML13.c. does not control conventional steel helmets, neither modified or designed to accept, nor equipped with any type of accessory device.*

*Note 3 ML13.d. does not control body armour or protective garments when accompanying their user for the user's own personal protection.*

*N.B. See also entry 1A005.*

ML14. Specialised equipment for military training or for simulating military scenarios, simulators specially designed for training in the use of any firearm or weapon controlled by ML1. or ML2., and specially designed components and accessories therefor.

*Technical Note*

*The term 'specialised equipment for military training' includes military types of attack trainers, operational flight trainers, radar target trainers, radar target generators, gunnery training devices, anti-submarine warfare trainers, flight simulators (including human-rated centrifuges for pilot/astronaut training), radar trainers, instrument flight trainers, navigation trainers, missile launch trainers, target equipment, drone "aircraft", armament trainers, pilotless "aircraft" trainers, mobile training units and training equipment for ground military operations.*

*Note 1 ML14. includes image generating and interactive environment systems for simulators when specially designed or modified for military use.*

*Note 2 ML14. does not control equipment specially designed for training in the use of hunting or sporting weapons.*

ML15. Imaging or countermeasure equipment, as follows, specially designed for military use, and specially designed components and accessories therefor:

- a. Recorders and image processing equipment;
- b. Cameras, photographic equipment and film processing equipment;
- c. Image intensifier equipment;
- d. Infrared or thermal imaging equipment;
- e. Imaging radar sensor equipment;
- f. Countermeasure or counter-countermeasure equipment for the equipment controlled by sub-items ML15.a. to ML15.e.

*Note ML15.f. includes equipment designed to degrade the operation or effectiveness of military imaging systems or to minimize such degrading effects.*

*Note 1 The term 'specially designed components' includes the following when specially designed for military use:*

- a. *Infrared image converter tubes;*
- b. *Image intensifier tubes (other than first generation);*
- c. *Microchannel plates;*
- d. *Low-light-level television camera tubes;*
- e. *Detector arrays (including electronic interconnection or read out systems);*
- f. *Pyroelectric television camera tubes;*
- g. *Cooling systems for imaging systems;*
- h. *Electrically triggered shutters of the photochromic or electro-optical type having a shutter speed of less than 100  $\mu$ s, except in the case of shutters which are an essential part of a high speed camera;*
- i. *Fibre optic image inverters;*
- j. *Compound semiconductor photocathodes.*

*Note 2 ML15 does not control "first generation image intensifier tubes" or equipment specially designed to incorporate "first generation image intensifier tubes".*

*N.B. For the status of weapons sights incorporating "first generation image intensifier tubes" see entries ML1.d, ML2.c and ML5.a.*

*N.B. See also entries 6A002.a.2. and 6A002.b.*

ML16. Forgings, castings and other unfinished products the use of which in a controlled product is identifiable by material composition, geometry or function, and which are specially designed for any products controlled by ML1.to ML4., ML6., ML9., ML10., ML12. or ML19.

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- ML17. Miscellaneous equipment, materials and libraries, as follows, and specially designed components therefor:
- a. Self-contained diving and underwater swimming apparatus, as follows:
    1. Closed or semi-closed circuit (rebreathing) apparatus specially designed for military use (i.e. specially designed to be non magnetic);
    2. Specially designed components for use in the conversion of open-circuit apparatus to military use;
    3. Articles designed exclusively for military use with self-contained diving and underwater swimming apparatus;
  - b. Construction equipment specially designed for military use;
  - c. Fittings, coatings and treatments for signature suppression, specially designed for military use;
  - d. Field engineer equipment specially designed for use in a combat zone;
  - e. "Robots", "robot" controllers and "robot" "end-effectors", having any of the following characteristics:
    1. Specially designed for military use;
    2. Incorporating means of protecting hydraulic lines against externally induced punctures caused by ballistic fragments (e.g., incorporating self-sealing lines) and designed to use hydraulic fluids with flash points higher than 839 K (566°C); or
    3. Specially designed or rated for operating in an electro-magnetic pulse (EMP) environment;
  - f. Libraries (parametric technical databases) specially designed for military use with equipment controlled by the Munitions List;
  - g. Nuclear power generating equipment or propulsion equipment, including "nuclear reactors", specially designed for military use and components therefor specially designed or modified for military use;
  - h. Equipment and material, coated or treated for signature suppression, specially designed for military use, other than those controlled elsewhere in the Munitions List;
  - i. Simulators specially designed for military "nuclear reactors";
  - j. Mobile repair shops specially designed or modified to service military equipment;
  - k. Field generators specially designed or modified for military use;
  - l. Containers specially designed or modified for military use;
  - m. Ferries, other than those controlled elsewhere in the Munitions List, bridges and pontoons, specially designed for military use;
  - n. Test models specially designed for the "development" of items controlled by ML4., ML6., ML9. or ML10.;
  - o. Laser protection equipment (e.g., eye and sensor protection) specially designed for military use.

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ML17. continued

Technical Notes

1. For the purpose of ML17, the term 'library' (parametric technical database) means a collection of technical information of a military nature, reference to which may enhance the performance of military equipment or systems.
2. For the purpose of ML17, 'modified' means any structural, electrical, mechanical, or other change that provides a non-military item with military capabilities equivalent to an item which is specially designed for military use.

ML18. Equipment for the production of products referred to in the Munitions List, as follows:

- a. Specially designed or modified production equipment for the production of products controlled by the Munitions List, and specially designed components therefor;
- b. Specially designed environmental test facilities and specially designed equipment therefor, for the certification, qualification or testing of products controlled by the Munitions List.

Technical Note

For the purposes of ML18., the term 'production' includes design, examination, manufacture, testing and checking.

Note 1

ML18.a. and ML18.b. include the following equipment:

- a. Continuous nitrators;
- b. Centrifugal testing apparatus or equipment having any of the following characteristics:
  1. Driven by a motor or motors having a total rated horsepower of more than 298 kW (400 hp);
  2. Capable of carrying a payload of 113 kg or more; or
  3. Capable of exerting a centrifugal acceleration of 8 g or more on a payload of 91 kg or more;
- c. Dehydration presses;
- d. Screw extruders specially designed or modified for military explosive extrusion;
- e. Cutting machines for the sizing of extruded propellants;
- f. Sweetie barrels (tumblers) 1.85 m or more in diameter and having over 227 kg product capacity;
- g. Continuous mixers for solid propellants;
- h. Fluid energy mills for grinding or milling the ingredients of military explosives;
- i. Equipment to achieve both sphericity and uniform particle size in metal powder listed in ML8.c.8.;
- j. Convection current converters for the conversion of materials listed in ML8.c.3.

ML18. continued

- Note 2
- a. *The term 'products referred to in the Munitions List' includes:*
1. *Products not controlled if inferior to specified concentrations as follows:*
    - a. *Hydrazine (see ML8.c.4.);*
    - b. *"Explosives" (see ML8.);*
  2. *Products not controlled if inferior to technical limits, (i.e., "superconductive" materials not controlled by IC005.; "superconductive" electromagnets not controlled by 3A001.e.3.; "superconductive" electrical equipment excluded from control under ML20.b.);*
  3. *Metal fuels and oxidants deposited in laminar form from the vapour phase (see ML8.c.5.);*
- b. *The term 'products referred to in the Munitions List' does not include:*
1. *Signal pistols (see ML2.b.);*
  2. *The substances excluded from control under Note 3 to ML7.;*
  3. *Personal radiation monitoring dosimeters (see ML7.g.) and masks for protection against specific industrial hazards, see also Part 2 of the Defence and Strategic Goods List;*
  4. *Difluoroamine and potassium nitrate powder (see Note 6 to ML8.);*
  5. *Aero-engines excluded from control under ML10.;*
  6. *Conventional steel helmets not equipped with, or modified or designed to accept, any type of accessory device (see Note 2 to ML13.);*
  7. *Equipment fitted with industrial machinery, which is not controlled such as coating machinery not elsewhere specified and equipment for the casting of plastics;*
  8. *Muskets, rifles and carbines dated earlier than 1938, reproductions of muskets, rifles and carbines dated earlier than 1890, revolvers, pistols and machine guns dated earlier than 1890, and their reproductions.*
- Note 3 *Note 2.b.8. of ML18. does not release from controls production equipment for non-antique small arms, even if used to produce reproductions of antique small arms.*

ML19. Directed energy weapon systems (DEW), related or countermeasure equipment and test models, as follows, and specially designed components therefor:

- a. "Laser" systems specially designed for destruction or effecting mission-abort of a target;
- b. Particle beam systems capable of destruction or effecting mission-abort of a target;
- c. High power radio-frequency (RF) systems capable of destruction or effecting mission-abort of a target;

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ML19. continued

- d. Equipment specially designed for the detection or identification of, or defence against, systems controlled by ML19.a. to ML19.c.;
- e. Physical test models and related test results for the systems, equipment and components controlled by this Item.
- f. Continuous wave or pulsed "laser" systems specially designed to cause permanent blindness to unenhanced vision, i.e., to the naked eye or to the eye with corrective eyesight devices.

Note 1 *Directed energy weapon systems controlled by ML19. include systems whose capability is derived from the controlled application of:*

- a. *"Lasers" of sufficient continuous wave or pulsed power to effect destruction similar to the manner of conventional ammunition;*
- b. *Particle accelerators which project a charged or neutral particle beam with destructive power;*
- c. *High pulsed power or high average power radio frequency beam transmitters which produce fields sufficiently intense to disable electronic circuitry at a distant target.*

Note 2 *ML19. includes the following when specially designed for directed energy weapon systems:*

- a. *Prime power generation, energy storage, switching, power conditioning or fuel-handling equipment;*
- b. *Target acquisition or tracking systems;*
- c. *Systems capable of assessing target damage, destruction or mission-abort;*
- d. *Beam-handling, propagation or pointing equipment;*
- e. *Equipment with rapid beam slew capability for rapid multiple target operations;*
- f. *Adaptive optics and phase conjugators;*
- g. *Current injectors for negative hydrogen ion beams;*
- h. *"Space qualified" accelerator components;*
- i. *Negative ion beam funnelling equipment;*
- j. *Equipment for controlling and slewing a high energy ion beam;*
- k. *"Space qualified" foils for neutralising negative hydrogen isotope beams.*

ML20. Cryogenic and "superconductive" equipment, as follows, and specially designed components and accessories therefor:

- a. Equipment specially designed or configured to be installed in a vehicle for military ground, marine, airborne or space applications, capable of operating while in motion and of producing or maintaining temperatures below 103 K (- 170°C);  
Note *ML20.a. includes mobile systems incorporating or employing accessories or components manufactured from non-metallic or non-electrical conductive materials, such as plastics or epoxy-impregnated materials.*



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ML20. continued

- b. "Superconductive" electrical equipment (rotating machinery and transformers) specially designed or configured to be installed in a vehicle for military ground, marine, airborne or space applications, capable of operating while in motion.

*Note ML20.b. does not control direct-current hybrid homopolar generators that have single-pole normal metal armatures which rotate in a magnetic field produced by superconducting windings, provided those windings are the only superconducting component in the generator.*

ML21. "Software", as follows:

- a. "Software" specially designed or modified for the "development", "production" or "use" of equipment or materials controlled by the Munitions List;
- b. Specific "software", as follows:
  1. "Software" specially designed for:
    - a. Modelling, simulation or evaluation of military weapon systems;
    - b. "Development", monitoring, maintenance or up-dating of "software" embedded in military weapon systems;
    - c. Modelling or simulating military operation scenarios, not controlled by ML14.;
    - d. Command, Communications, Control and Intelligence (C<sup>3</sup>I) or Command, Communications, Control, Computer and Intelligence (C<sup>4</sup>I) applications;
  2. "Software" for determining the effects of conventional, nuclear, chemical or biological warfare weapons.
  3. "Software", not controlled by ML21.a., b.1. or b.2., specially designed or modified to enable equipment not controlled by the Munitions List to perform the military functions of equipment controlled by ML5., ML7.g., ML9.c., ML9.e., ML10.e., ML11., ML14., ML15., ML17.i., or ML18.

ML22. "Technology" as follows:

- a. "Technology", other than specified in ML22.b, which is "required" for the "development", "production" or "use" of items controlled in the Munitions List.
- b. "Technology" as follows:
  1. "Technology" "required" for the design of, the assembly of components into, and the operation, maintenance and repair of complete production installations for items controlled in the Munitions List, even if the components of such production installations are not controlled;
  2. "Technology" "required" for the "development" and "production" of small arms even if used to produce reproductions of antique small arms;
  3. "Technology" "required" for the "development", "production" or "use" of toxicological agents, related equipment or components controlled by ML7.a. to ML7.g.;
  4. "Technology" "required" for the "development", "production" or "use" of "biopolymers" or cultures of specific cells controlled by ML7.h.;
  5. "Technology" "required" exclusively for the incorporation of "biocatalysts", controlled by ML7.i.1., into military carrier substances or military material.

*Note 1* "Technology" "required" for the "development", "production" or "use" of items controlled in the Munitions List remains under control even when applicable to any uncontrolled item.

*Note 2* ML22 does not control "technology" as follows:

- a. Which is the minimum necessary for the installation, operation, maintenance (checking) and repair of those items which are not controlled or whose export has been authorised;

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ML22. continued

- b. Which is "in the public domain", "basic scientific research" or the minimum necessary information for patent applications;
- c. For magnetic induction for continuous propulsion of civil transport devices.

ML901. Weapons, as follows, and specially designed components therefor:

- a. rifles, carbines, muskets, pistols, revolvers, shotguns, machine guns and smooth-bore weapons, not controlled in Item ML1; and
- b. air weapons.

ML902. Ammunition, projectiles, and specially designed components therefor, for the weapons specified in Item ML901.

ML903. Deleted.

ML904. Accessories, including telescopic sights, for the weapons specified in Item ML901.

ML908. "Energetic materials" other than "energetic materials" specified in Item ML8, but excluding those specially formulated for toys, novelty goods and fireworks.

ML909. Apparatus or devices, other than specified in Item ML4, for the initiation of detonators or "energetic materials" specified in Item ML908.

*Note: Items ML901 to ML909 do not include nailing or stapling guns, explosive powered fixing tools, starting pistols, flare guns or other signalling devices designed for emergency or life-saving purposes, line throwers, tranquilliser guns, guns that operate a captive bolt for the slaughter of animals, devices for the casting of weighted nets, underwater powerheads, fire extinguisher cartridges, paintball markers, air bag and life raft inflation gas generators, thermal welding charges and associated ignition tapes, oil well perforator charges, oil well gas flare igniters, bird-fright cartridges, bomb disposal disruptor cartridges or any other cartridges or "explosive"/"pyrotechnic" charges specially designed for use with the items listed in this Note.*

Technical Note:

*Specially designed components for the products controlled by ML901 and ML902 include forgings, castings and other unfinished products the use of which in a controlled product is identifiable by material composition, geometry or function.*

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<p><b>PART 2 – DUAL-USE LIST</b></p>
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*Note 1* Terms in "quotations" are defined terms. Refer to the 'Definitions of Terms' section.

*Note 2* Chemicals are listed by name and CAS number. Chemicals of the same structural formula (including hydrates) are controlled regardless of name or CAS number. CAS numbers are shown to assist in identifying whether a particular chemical or mixture is controlled, irrespective of nomenclature. CAS numbers cannot be used as unique identifiers because some forms of the listed chemical have different CAS numbers, and mixtures containing a listed chemical may also have different CAS numbers.

**NUCLEAR TECHNOLOGY NOTE (NTN)**

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

1. The "technology" directly associated with any goods controlled in Category 0 is controlled according to the provisions of Category 0.
2. "Technology" for the "development", "production" or "use" of goods under control remains under control even when applicable to non-controlled goods.
3. 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.
4. 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 0 to 9.)

1. The export of "technology" which is "required" for the "development", "production" or "use" of goods controlled in Categories 0 to 9, is controlled according to the provisions of Categories 0 to 9.
2. "Technology" "required" for the "development", "production" or "use" of goods under control remains under control even when applicable to non-controlled goods.
3. 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.*

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4. 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:

1. Generally available to the public by being:
  - a. Sold from stock at retail selling points, without restriction, by means of:
    1. Over-the-counter transactions;
    2. Mail order transactions;
    3. Electronic transactions; or
    4. Telephone order transactions; and
  - b. 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").*

2. "In the public domain".

**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  $3.18 \times 10^6$  m and a "specific tensile strength" greater than  $76.2 \times 10^3$  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';

0B001 b. continued

7. Magnetic suspension bearings consisting of an annular magnet suspended within a housing made of or protected by "materials resistant to corrosion by UF<sub>6</sub>" containing a damping medium and having the magnet coupling with a pole piece or second magnet fitted to the top cap of the rotor;
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/recipient 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<sub>6</sub>";
12. Scoops consisting of tubes of up to 12 mm internal diameter for the extraction of UF<sub>6</sub> gas from within a centrifuge rotor tube by a Pitot tube action, made of or protected by "materials resistant to corrosion by UF<sub>6</sub>";
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<sub>6</sub>" 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<sub>6</sub>";



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0B001 c. continued

3. Compressors (positive displacement, centrifugal and axial flow types) or gas blowers with a suction volume capacity of 1 m<sup>3</sup>/min or more of UF<sub>6</sub>, and discharge pressure up to 666.7 kPa, made of or protected by "materials resistant to corrosion by UF<sub>6</sub>";
  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<sup>3</sup>/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<sub>6</sub>", with a diameter of 40 mm to 1,500 mm;
- 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<sub>6</sub>, 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<sub>6</sub>" 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<sup>3</sup>/min or more, made of or protected by "materials resistant to corrosion by UF<sub>6</sub>", and rotary shaft seals therefor;
  4. Heat exchangers made of or protected by "materials resistant to corrosion by UF<sub>6</sub>";
  5. Aerodynamic separation element housings, made of or protected by "materials resistant to corrosion by UF<sub>6</sub>" to contain vortex tubes or separation nozzles;
  6. Bellows valves made of or protected by "materials resistant to corrosion by UF<sub>6</sub>", with a diameter of 40 to 1,500 mm;

0B001 d. continued

7. Process systems for separating UF<sub>6</sub> from carrier gas (hydrogen or helium) to 1 ppm UF<sub>6</sub> 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<sub>6</sub> from carrier gas;
  - d. UF<sub>6</sub> 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;
  4. Electrochemical reduction cells feed equipment to take U<sup>+4</sup> 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<sup>+6</sup> or U<sup>+4</sup> to U<sup>+3</sup>;
  6. Uranium oxidation systems for oxidation of U<sup>+3</sup> to U<sup>+4</sup>;

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0B001 continued

- 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;
  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.**

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0B001 continued

- 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<sub>6</sub> and carrier gas to 150 K (-123°C) or less and made from "materials resistant to corrosion by UF<sub>6</sub>";
  2. Uranium pentafluoride (UF<sub>5</sub>) product collectors consisting of filter, impact, or cyclone-type collectors or combinations thereof, and made of "materials resistant to corrosion by UF<sub>5</sub>/UF<sub>6</sub>";
  3. Compressors made of or protected by "materials resistant to corrosion by UF<sub>6</sub>", and rotary shaft seals therefor;
  4. Equipment for fluorinating UF<sub>5</sub> (solid) to UF<sub>6</sub> (gas);
  5. Process systems for separating UF<sub>6</sub> 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<sub>6</sub> 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.**

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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<sub>6</sub>":
- a.    Feed autoclaves, ovens or systems used for passing UF<sub>6</sub> to the enrichment process;
  - b.    Desublimers or cold traps, used to remove UF<sub>6</sub> from the enrichment process for subsequent transfer upon heating;
  - c.    Product and tails stations for transferring UF<sub>6</sub> into containers;
  - d.    Liquefaction or solidification stations used to remove UF<sub>6</sub> from the enrichment process by compressing, cooling and converting UF<sub>6</sub> to a liquid or solid form;
  - e.    Piping systems and header systems specially designed for handling UF<sub>6</sub> within gaseous diffusion, centrifuge or aerodynamic cascades;
  - f.
    1.    Vacuum manifolds or vacuum headers having a suction capacity of 5 m<sup>3</sup>/minute or more; or
    2.    Vacuum pumps specially designed for use in UF<sub>6</sub> bearing atmospheres;
  - g.    UF<sub>6</sub> mass spectrometers/ion sources specially designed or prepared for taking on-line samples of feed, product or tails from UF<sub>6</sub> 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.

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- 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;
  - 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%;

0B004 b. continued

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";*



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0B006 continued

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**

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<sup>3</sup>.

**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<sub>Z</sub> for impurities (excluding BE<sub>carbon</sub> since carbon is not considered an impurity) including boron, where:*

*BE<sub>Z</sub> (ppm) = CF x concentration of element Z in ppm;*

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

*and  $\sigma_B$  and  $\sigma_Z$  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<sub>6</sub> (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.

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**0E**      **Technology**

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

<b>CATEGORY 1 - MATERIALS, CHEMICALS, "MICROORGANISMS" &amp; "TOXINS"</b>
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**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 vinyl ether group as a constitutional unit, specially designed for "aircraft", aerospace or 'missile' use.

Note: In 1A001.c., 'missile' means complete rocket systems and unmanned aerial 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  $10.15 \times 10^6$  m; and
    - b. A "specific tensile strength" exceeding  $17.7 \times 10^4$  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  $1 \text{ m}^2$ .

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, not controlled in ML7, 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 ML13.

*N.B.:* For "fibrous or filamentary materials" used in the manufacture of body armour, see 1C010.

*Note 1:* 1A005 does not control body armour or protective garments when accompanying their user for the user's 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 pyrolyzed carbon-carbon components designed for space launch vehicles specified in 9A004 or sounding rockets specified in 9A104.
- 1A202 Composite structures, not controlled 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<sup>2</sup>;
  - b. A density greater than 3 g/cm<sup>3</sup>; 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";

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1B001 continued

- 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 aerial 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;  
*Technical Note:*  
*For the purposes of 1B001.c. the technique of interlacing includes knitting.*  
Note: *1B001.c. does not control textile machinery not modified for the above end-uses.*
- d. Equipment specially designed or adapted for the production of reinforcement fibres, as follows:
1. Equipment for converting polymeric fibres (such as polyacrylonitrile, rayon, pitch or polycarbosilane) into carbon fibres or silicon carbide fibres, including special equipment to strain the fibre during heating;
  2. Equipment for the chemical vapour deposition of elements or compounds on heated filamentary substrates to manufacture silicon carbide fibres;
  3. Equipment for the wet-spinning of refractory ceramics (such as aluminium oxide);
  4. Equipment for converting aluminium containing precursor fibres into alumina fibres by heat treatment;
- 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 Equipment for producing metal alloys, metal alloy powder or alloyed materials, specially designed to avoid contamination and specially designed for use in one of the processes specified in 1C002.c.2.  
**N.B.: SEE ALSO 1B102.**

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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;
- 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, and components as follows:

**N.B.: SEE ALSO 1B115.b.**

- a. Metal powder "production equipment" 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 ML8.a.
- b. Specially designed components for "production equipment" specified in 1B002 or 1B102.a.

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. Electrobust 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 ML8;
- b. "Production equipment" for the "production", handling, mixing, curing, casting, pressing, machining, extruding or acceptance testing of solid propellants or propellant constituents specified in 1C011.a., 1C011.b., 1C111 or in ML8.

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 Munitions List.

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

1B116 Specially designed nozzles for producing 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.

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- 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, and specially designed components therefor:
- 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 a temperature control capability of the mixing chamber having any of the following, and specially designed components therefor:
- a. Two or more mixing/kneading shafts; or
  - b. A single rotating shaft which oscillates and having kneading teeth/pins on the shaft as well as inside the casing of the mixing chamber.
- 1B119 Fluid energy mills usable for grinding or milling substances specified in 1C011.a., 1C011.b., 1C111 or in the Munitions List, and specially designed components therefor.
- 1B201 Filament winding machines, not controlled 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.

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- 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<sub>2</sub>-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<sub>2</sub>/NH<sub>3</sub>), having all of the following characteristics:
- a. Airtight (i.e., hermetically sealed);
  - b. A capacity greater than 8.5 m<sup>3</sup>/h; and

1B230 continued

- 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  $2 \times 10^8$  Hz but less than  $3 \times 10^{12}$  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  $\pm 15\%$  of the centre frequency of the incident energy, and not capable of withstanding temperatures exceeding 450 K (177°C); or*

1C001 a. continued

- b. Ceramic materials providing more than 20% echo compared with metal over a bandwidth exceeding  $\pm 15\%$  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  $7 \times 10^6 \text{ N/m}^2$ ; and
3. Compressive strength less than  $14 \times 10^6 \text{ N/m}^2$ ;
- 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  $1.5 \times 10^{14}$  Hz but less than  $3.7 \times 10^{14}$  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.

Technical Notes:

1. The metal alloys in 1C002 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.

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1C002 continued

3. *Low cycle fatigue life should be measured in accordance with ASTM Standard E-606 'Recommended Practice for Constant-Amplitude Low-Cycle Fatigue Testing' or national equivalents. Testing should be axial with an average stress ratio equal to 1 and a stress-concentration factor ( $K_t$ ) equal to 1. The average stress is defined as maximum stress minus minimum stress divided by maximum stress.*
  - a. Aluminides, as follows:
    1. Nickel aluminides containing a minimum of 15 weight percent aluminium, a maximum of 38 weight percent aluminium and at least one additional alloying element;
    2. Titanium aluminides containing 10 weight percent or more aluminium and at least one additional alloying element;
  - b. Metal alloys, as follows, made from material specified in 1C002.c.:
    1. Nickel alloys with:
      - a. A stress-rupture life of 10,000 hours or longer at 923 K (650°C) at a stress of 676 MPa; or
      - b. A low cycle fatigue life of 10,000 cycles or more at 823 K (550°C) at a maximum stress of 1,095 MPa;
    2. Niobium alloys with:
      - a. A stress-rupture life of 10,000 hours or longer at 1,073 K (800°C) at a stress of 400 MPa; or
      - b. A low cycle fatigue life of 10,000 cycles or more at 973 K (700°C) at a maximum stress of 700 MPa;
    3. Titanium alloys with:
      - a. A stress-rupture life of 10,000 hours or longer at 723 K (450°C) at a stress of 200 MPa; or
      - b. A low cycle fatigue life of 10,000 cycles or more at 723 K (450°C) at a maximum stress of 400 MPa;
    4. Aluminium alloys with a tensile strength of:
      - a. 240 MPa or more at 473 K (200°C); or
      - b. 415 MPa or more at 298 K (25°C);
    5. Magnesium alloys with:
      - a. A tensile strength of 345 MPa or more; and
      - b. A corrosion rate of less than 1 mm/year in 3% sodium chloride aqueous solution measured in accordance with ASTM standard G-31 or national equivalents;

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1C002 continued

- c. Metal alloy powder or particulate material for material, having all of the following characteristics:
1. Made from any of the following composition systems:  
  
*Technical Note:*  
*X in the following equals one or more alloying elements.*
    - a. Nickel alloys (Ni-Al-X, Ni-X-Al) qualified for turbine engine parts or components, i.e. with less than 3 non-metallic particles (introduced during the manufacturing process) larger than 100 µm in 10<sup>9</sup> alloy particles;
    - b. Niobium alloys (Nb-Al-X or Nb-X-Al, Nb-Si-X or Nb-X-Si, Nb-Ti-X or Nb-X-Ti);
    - c. Titanium alloys (Ti-Al-X or Ti-X-Al);
    - d. Aluminium alloys (Al-Mg-X or Al-X-Mg, Al-Zn-X or Al-X-Zn, Al-Fe-X or Al-X-Fe); or
    - e. Magnesium alloys (Mg-Al-X or Mg-X-Al);
  2. Made in a controlled environment by any of the following processes:
    - a. "Vacuum atomisation";
    - b. "Gas atomisation";
    - c. "Rotary atomisation";
    - d. "Splat quenching";
    - e. "Melt spinning" and "comminution";
    - f. "Melt extraction" and "comminution"; or
    - g. "Mechanical alloying"; and
  3. Capable of forming materials specified in 1C002.a. or 1C002.b.
- d. Alloyed materials having all of the following characteristics:
1. Made from any of the composition systems specified in 1C002.c.1.;
  2. In the form of uncomminuted flakes, ribbons or thin rods; and
  3. Produced in a controlled environment by any of the following:
    - a. "Splat quenching";
    - b. "Melt spinning"; or
    - c. Melt extraction".



- 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  $5 \times 10^{-4}$ ; or
    2. A magnetomechanical coupling factor (k) of more than 0.8; or
  - c. Amorphous or 'nanocrystalline' alloy strips, having all of the following characteristics:
    1. A composition having a minimum of 75 weight percent of iron, cobalt or nickel;
    2. A saturation magnetic induction ( $B_S$ ) of 1.6 T or more; and
    3. Any of the following:
      - a. A strip thickness of 0.02 mm or less; or
      - b. An electrical resistivity of  $2 \times 10^{-4}$  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  $17.5 \text{ g/cm}^3$ ;
  - 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  $0.28 \times 10^{-4} \text{ mm}^2$  (6  $\mu\text{m}$  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  $0.28 \times 10^{-4} \text{ mm}^2$ ; and

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1C005 b. continued

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<sup>2</sup>/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;

1C006 continued

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

Technical Note:

*For the purpose of 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  $644 \pm 6$  K ( $371 \pm 6$ °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  $10 \text{ mg/mm}^2$  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;

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1C007 continued

- 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 having all of the following:
1. Made from any of the following materials:
    - a. Si-N;
    - b. Si-C;
    - c. Si-Al-O-N; or
    - d. Si-O-N; and
  2. Having a specific tensile strength exceeding  $12.7 \times 10^3$  m;
- d. Ceramic-ceramic "composite" materials, with or without a continuous metallic phase, incorporating particles, whiskers or fibres, where carbides or nitrides of silicon, zirconium or boron form the "matrix";
- e. Precursor materials (i.e., special purpose polymeric or metallo-organic materials) for producing any phase or phases of the materials specified 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.

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1C008 continued

- b. Thermoplastic liquid crystal copolymers having a heat distortion temperature exceeding 523 K (250°C) measured according to ISO 75-3 (2004), or national equivalents, with a load of 1.82 N/mm<sup>2</sup> 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. Deleted;
  2. Polyether ketone ketone (PEKK);
  3. Polyether ketone (PEK);
  4. Polyether ketone ether ketone ketone (PEKEKK);
- d. Polyarylene ketones;
- e. Polyarylene sulphides, where the arylene group is biphenylene, triphenylene or combinations thereof;
- f. Polybiphenylenethersulphone having a glass transition temperature ( $T_g$ ) exceeding 513 K (240°C).

Technical Note:

*The glass transition temperature ( $T_g$ ) for 1C008 materials is determined using the method described in ISO 11357-2 (1999) or national equivalents.*

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  $12.7 \times 10^6$  m; and
  2. A "specific tensile strength" exceeding  $23.5 \times 10^4$  m;
- Note:* 1C010.a. does not control polyethylene.
- b. Carbon "fibrous or filamentary materials", having all of the following:
1. A "specific modulus" exceeding  $12.7 \times 10^6$  m; and
  2. A "specific tensile strength" exceeding  $23.5 \times 10^4$  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.
- c. Inorganic "fibrous or filamentary materials", having all of the following:
1. A "specific modulus" exceeding  $2.54 \times 10^6$  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  $10 \times 10^6$  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.;

1C010 continued

- 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  $17.7 \times 10^4$  m;
    - b. With a "specific modulus" exceeding  $10.15 \times 10^6$  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 ML8.a.1., ML8.a.2 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.

1C011 continued

- 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 grams" 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, not controlled in 1C001, usable in 'missiles', "missile" subsystems or unmanned aerial vehicles specified in 9A012.

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, infrared or ultra violet regions of the electromagnetic spectrum.*

Note 2: *1C101 does not include coatings when specially used for the thermal control of satellites.*

Technical Note:

*In 1C101 'missile' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.*

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



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- 1C107 Graphite and ceramic materials, not controlled in 1C007, as follows:
- a. Fine grain graphites with a bulk density of 1.72 g/cm<sup>3</sup> or greater, measured at 288 K (15°C), and having a grain size of 100 µm or less, usable for rocket nozzles and re-entry vehicle nose tips, which can be machined to any of the following products:
    1. Cylinders having a diameter of 120 mm or greater and a length of 50 mm or greater;
    2. Tubes having an inner diameter of 65 mm or greater and a wall thickness of 25 mm or greater and a length of 50 mm or greater; or
    3. Blocks having a size of 120 mm x 120 mm x 50 mm or greater;*N.B.: See also 0C004*
  - b. Pyrolytic or fibrous reinforced graphites, usable for "missile" nozzles and re-entry vehicle nose tips;  
*N.B.: See also 0C004*
  - c. Ceramic composite materials (dielectric constant less than 6 at any frequency from 100 MHz to 100 GHz) usable for "missile" radomes;
  - d. Bulk machinable silicon-carbide reinforced unfired ceramic, usable for "missile" nose tips.
- 1C111 Propellants and constituent chemicals for propellants, not controlled in 1C011, as follows:
- a. Propulsive substances:
    1. Spherical aluminium powder, other than that specified in ML8.a., 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 ML8.a., 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.*

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1C111 continued

3. Liquid oxidiser substances as follows:
  - a. Dinitrogen trioxide;
  - b. Nitrogen dioxide/dinitrogen tetroxide;
  - c. Dinitrogen pentoxide;
  - d. Mixed Oxides of Nitrogen (MON);  
*Technical Note:*  
*Mixed Oxides of Nitrogen (MON) are solutions of Nitric Oxide (NO) in Dinitrogen Tetroxide/Nitrogen Dioxide (N<sub>2</sub>O<sub>4</sub>/NO<sub>2</sub>) that can be used in missile systems. There are a range of compositions that can be denoted as MON<sub>i</sub> or MON<sub>ij</sub>, where i and j are integers representing the percentage of Nitric Oxide in the mixture (e.g., MON<sub>3</sub> contains 3% Nitric Oxide, MON<sub>25</sub> 25% Nitric Oxide. An upper limit is MON<sub>40</sub>, 40% by weight).*
  - e. **SEE ML8.d.10. FOR Inhibited Red Fuming Nitric Acid (IRFNA);**
  - f. **SEE ML8.d.3. AND 1C238 FOR Compounds composed of fluorine and one or more of other halogens, oxygen or nitrogen;**
4. Hydrazine derivatives usable as rocket fuel substances, not controlled in ML8;
- b. Polymeric substances:
  1. Carboxy-terminated polybutadiene (CTPB);
  2. Hydroxy-terminated polybutadiene (HTPB), other than that specified in ML8.e.22.;
  3. Polybutadiene-acrylic acid (PBAA);
  4. Polybutadiene-acrylic acid-acrylonitrile (PBAN);
- c. Other propellant additives and agents:
  1. **SEE ML8.c.3. FOR Carboranes, decaboranes, pentaboranes and derivatives thereof;**
  2. Triethylene glycol dinitrate (TEGDN);
  3. 2-Nitrodiphenylamine;
  4. Trimethylolethane trinitrate (TMETN);
  5. Diethylene glycol dinitrate (DEGDN);
  6. Ferrocene derivatives as follows:
    - a. **See ML8.f.4.b. for catocene;**
    - b. Ethyl ferrocene;
    - c. Propyl ferrocene;
    - d. **See ML8.f.4.d. for n-butyl ferrocene;**
    - e. Pentyl ferrocene;
    - f. Dicyclopentyl ferrocene;
    - g. Dicyclohexyl ferrocene;
    - h. Diethyl ferrocene;
    - i. Dipropyl ferrocene;
    - j. Dibutyl ferrocene;
    - k. Dihexyl ferrocene;
    - l. Acetyl ferrocenes;

1C111 c. 6. continued

**m. See ML8.f.4.c. for ferrocene Carboxylic acids;**

**n. See ML8.f.4.a. for butacene;**

**o. Other ferrocene derivatives usable as rocket propellant burning rate modifiers, not controlled in ML8.f.4.e.**

*Note:* For propellants and constituent chemicals for propellants not specified in 1C111, see ML8.

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, not controlled in 1C002.b.3. or .b.4., 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;

1C202 continued

- 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, not controlled 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  $12.7 \times 10^6$  m or greater; or
  2. A "specific tensile strength" of  $235 \times 10^3$  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  $3.18 \times 10^6$  m or greater; and
  2. A "specific tensile strength" of  $76.2 \times 10^3$  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.*

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1C225 Boron enriched in the boron-10 ( $^{10}\text{B}$ ) 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;

1C230 continued

- 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 ( $^3\text{He}$ ), 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 ( $^6\text{Li}$ ) 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  $1.48 \times 10^3$  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;

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1C236 continued

- 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 (<sup>226</sup>Ra), radium-226 alloys, radium-226 compounds, mixtures containing radium-226, manufactures thereof, 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<sub>3</sub>).

1C239 High explosives, not controlled in ML8, or substances or mixtures containing more than 2% by weight thereof, with a crystal density greater than 1.8 g/cm<sup>3</sup> and having a detonation velocity greater than 8,000 m/s.

1C240 Nickel powder and porous nickel metal, not controlled 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<sup>2</sup> 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.

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1C350 Chemicals, which may be used as precursors for toxic chemical agents, as follows, and "chemical mixtures" containing one or more thereof:

**N.B.: SEE ALSO ML7 AND 1C450.**

1. Thiodiglycol (111-48-8);
2. Phosphorus oxychloride (10025-87-3);
3. Dimethyl methylphosphonate (756-79-6);
4. **SEE ML7.b.1. FOR Methyl phosphonyl difluoride (676-99-3);**
5. Methyl phosphonyl dichloride (676-97-1);
6. Dimethyl phosphite (DMP) (868-85-9);
7. Phosphorus trichloride (7719-12-2);
8. Trimethyl phosphite (TMP) (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 ML7.b.1. 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 ML7.b.2. FOR O-Ethyl-2-diisopropylaminoethyl methyl phosphonite (QL) (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 or ammonium bifluoride (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);



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1C350 continued

47. Phosphorus pentasulphide (1314-80-3);
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);
55. Methylphosphonic acid (993-13-5);
56. Diethyl methylphosphonate (683-08-9);
57. N,N-Dimethylaminophosphoryl dichloride or  
N,N-dimethyl phosphoramidic dichloride (677-43-0);
58. Triisopropyl phosphite (116-17-6);
59. Ethyldiethanolamine (139-87-7);
60. O,O-Diethyl phosphorothioate (2465-65-8);
61. O,O-Diethyl phosphorodithioate (298-06-6);
62. Sodium hexafluorosilicate (16893-85-9);
63. Methylphosphonothioic dichloride (676-98-2);
64. Thiophosphoryl chloride (3982-91-0);
65. Oxalyl chloride (79-37-8).

Note 1: *For exports to "States not Party to the Chemical Weapons Convention", 1C350 does not control "chemical mixtures" containing one or more of the chemicals specified in entries 1C350.1, .3, .5, .11, .12, .13, .17, .18, .21, .22, .26, .27, .28, .31, .32, .33, .34, .35, .36, .54, .55, .56, .57 and .63 in which no individually specified chemical constitutes more than 10% by the weight of the mixture.*

Note 2: *For exports to "States Party to the Chemical Weapons Convention", 1C350 does not control "chemical mixtures" containing one or more of the chemicals specified in entries 1C350.1, .3, .5, .11, .12, .13, .17, .18, .21, .22, .26, .27, .28, .31, .32, .33, .34, .35, .36, .54, .55, .56, .57 and .63 in which no individually specified chemical constitutes more than 30% by the weight of the mixture.*

Note 3: *1C350 does not control "chemical mixtures" containing one or more of the chemicals specified in entries 1C350 .2, .6, .7, .8, .9, .10, .14, .15, .16, .19, .20, .24, .25, .30, .37, .38, .39, .40, .41, .42, .43, .44, .45, .46, .47, .48, .49, .50, .51, .52, .53, .58, .59, .60, .61, .62, .64 and .65 in which no individually specified chemical constitutes more than 30% by the weight of the mixture.*

Note 4: *1C350 does not control products identified as consumer goods packaged for retail sale for personal use or packaged for individual use.*

*N.B.: This exemption does not apply to chemicals 1C350.4, .23 and .29 (see Note 5 of ML7).*

- 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;
    - 21. Kyasanur Forest virus;
    - 22. Louping ill virus;
    - 23. Murray Valley encephalitis virus;
    - 24. Omsk haemorrhagic fever virus;
    - 25. Oropouche virus;
    - 26. Powassan virus;
    - 27. Rocio virus;
    - 28. St Louis encephalitis virus;
    - 29. Hendra virus (Equine morbillivirus);
    - 30. South American haemorrhagic fever (Sabia, Flexal, Guanarito);
    - 31. Pulmonary & renal syndrome-haemorrhagic fever viruses (Seoul, Dobrava, Puumala, Sin Nombre);
    - 32. Nipah 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;

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1C351 continued

- c. Bacteria, whether natural, enhanced or modified, either in the form of "isolated live cultures" or as material including living material which has been deliberately inoculated or contaminated with such cultures, as follows:
1. Bacillus anthracis;
  2. Brucella abortus;
  3. Brucella melitensis;
  4. Brucella suis;
  5. Chlamydia psittaci;
  6. Clostridium botulinum;
  7. Francisella tularensis;
  8. Burkholderia mallei (Pseudomonas mallei);
  9. Burkholderia pseudomallei (Pseudomonas pseudomallei);
  10. Salmonella typhi;
  11. Shigella dysenteriae;
  12. Vibrio cholerae;
  13. Yersinia pestis;
  14. Clostridium perfringens epsilon toxin producing types;
  15. Enterohaemorrhagic Escherichia coli, serotype O157 and other verotoxin producing serotypes.
- d. "Toxins", as follows, and "sub-unit of toxins" thereof:
1. Botulinum toxins;
  2. Clostridium perfringens toxins;
  3. Conotoxin;
  4. Ricin;
  5. Saxitoxin;
  6. Shiga toxin;
  7. Staphylococcus aureus toxins;
  8. Tetrodotoxin;
  9. Verotoxin;
  10. Microcystin (Cyanginosin);
  11. Aflatoxins;
  12. Abrin;
  13. Cholera toxin;
  14. Diacetoxyscirpenol toxin;
  15. T-2 toxin;
  16. HT-2 toxin;
  17. Modeccin;
  18. Volkensin;
  19. Viscum album Lectin 1 (Viscumin).

Note: 1C351.d. does not control botulinum toxins or conotoxins 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.

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;
  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;
  16. Lumpy skin disease virus;
  17. African horse sickness 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 Genetic elements and genetically modified organisms, as follows:

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

1C353 continuedTechnical Notes:

1. *Genetic elements include, inter alia, chromosomes, genomes, plasmids, transposons and vectors whether genetically modified or unmodified.*
2. *Nucleic acid sequences associated with the pathogenicity of any of the micro-organisms specified in 1C351.a. to c. or 1C352 or 1C354 means any sequence specific to the specified micro-organism that:*
  - a. *In itself or through its transcribed or translated products represents a significant hazard to human, animal or plant health; or*
  - b. *Is known to enhance the ability of a specified micro-organism, or any other organism into which it may be inserted or otherwise integrated, to cause serious harm to humans, animals or plant health.*

Note: *1C353 does not apply to nucleic acid sequences associated with the pathogenicity of enterohaemorrhagic Escherichia coli, serotype O157 and other verotoxin producing strains, other than those coding for the verotoxin, or for its sub-units.*

## 1C354 Plant pathogens, as follows:

- a. Viruses, 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. Potato Andean latent tymovirus;
  2. Potato spindle tuber viroid;
- b. 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;
  3. Xanthomonas oryzae pv. Oryzae (Pseudomonas campestris pv. Oryzae);
  4. Clavibacter michiganensis subsp. Sepedonicus (Corynebacterium michiganensis subsp. Sepedonicum or Corynebacterium Sepedonicum);
  5. Ralstonia solanacearum Races 2 and 3 (Pseudomonas solanacearum Races 2 and 3 or Burkholderia solanacearum Races 2 and 3);
- c. 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, and "chemical mixtures" containing one or more thereof:

**N.B.: SEE ALSO ENTRY 1C350, 1C351.d. AND ML7.**

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 ML7.a.3. 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);

*Note 1: For exports to "States not Party to the Chemical Weapons Convention", 1C450 does not control "chemical mixtures" containing one or more of the chemicals specified in entries 1C450.a.1. and .a.2. in which no individually specified chemical constitutes more than 1% by the weight of the mixture.*

*Note 2: For exports to "States Party to the Chemical Weapons Convention", 1C450 does not control "chemical mixtures" containing one or more of the chemicals specified in entries 1C450.a.1. and .a.2. in which no individually specified chemical constitutes more than 30% by the weight of the mixture.*

*Note 3: 1C450 does not control "chemical mixtures" containing one or more of the chemicals specified in entries 1C450.a.4., .a.5., .a.6. and .a.7. in which no individually specified chemical constitutes more than 30% by the weight of the mixture.*

b. Toxic chemical precursors, as follows:

1. Chemicals, not controlled in the Munitions List 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, including:
  - a. diphenyl methylphosphonate (7526-26-3);
  - b. phosphonic acid, methyl-, methyl 3-(trimethoxysilyl)- propyl ester (67812-17-3);
  - c. phosphonic acid, methyl-, monoammonium salt (34255-87-3);
  - d. phosphonic acid, methyl-, monomethyl ester, monosodium salt (73750-69-3);
  - e. phosphonothioic dichloride, ethyl- (993-43-1);
  - f. phosphonic acid, methyl-, bis(3-(trimethoxysilyl)propyl) ester (67812-18-4);
  - g. phosphonic acid, methyl-, compd. with (aminoiminomethyl) urea (1:1) (84402-58-4);

1C450 b. 1. continued

- h. phosphonic acid, methyl-,  
(5-ethyl-2-methyl-1,3,2-dioxaphosphorinan-5-yl) methyl methyl ester, P-oxide)  
(41203-81-0);
- i. phosphonic acid, methyl-,  
bis((5-ethyl-2-methyl-1,3,2-dioxaphosphorinan-5-yl) methyl ester, P,P'-dioxide) (42595-45-9).

*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, other than N,N-dimethyl phosphoramidic dichloride (677-43-0) which is specified in 1C350;
  - 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 (2404-03-7) 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 (96-79-7) or N,N-Diisopropyl-(beta)-aminoethyl chloride hydrochloride (4261-68-1) 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 (5842-07-9) which is specified in 1C350;
  - 7. See 1C350 for ethyldiethanolamine (139-87-7);
  - 8. Methyldiethanolamine (105-59-9).

*Note 1:* For exports to "States not Party to the Chemical Weapons Convention", 1C450 does not control "chemical mixtures" containing one or more of the chemicals specified in entries 1C450.b.1., .b.2., .b.3., .b.4., .b.5. and .b.6. in which no individually specified chemical constitutes more than 10% by the weight of the mixture.

1C450 continued

Note 2: *For exports to "States Party to the Chemical Weapons Convention", 1C450 does not control "chemical mixtures" containing one or more of the chemicals specified in entries 1C450.b.1., .b.2., .b.3., .b.4., .b.5. and .b.6. in which no individually specified chemical constitutes more than 30% by the weight of the mixture.*

Note 3: *1C450 does not control "chemical mixtures" containing the chemical specified in entry 1C450.b.8. in which the specified chemical constitutes no more than 30% by the weight of the mixture.*

Note 4: *1C450 does not control products identified as consumer goods packaged for retail sale for personal use or packaged for individual use.*



**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 vinyl ether monomer;
  - c. "Technology" for the design or "production" of the following base materials or non-"composite" ceramic materials:
    1. Base materials having all of the following characteristics:
      - a. Any of the following compositions:
        1. Single or complex oxides of zirconium and complex oxides of silicon or aluminium;
        2. Single nitrides of boron (cubic crystalline forms);
        3. Single or complex carbides of silicon or boron; or
        4. Single or complex nitrides of silicon;
      - b. Total metallic impurities, excluding intentional additions, of less than:
        1. 1,000 ppm for single oxides or carbides; or

1E002 c. continued

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, 1B102, 1B115 to 1B119, 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".

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- 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.b.3. or b.4., 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 ML9.g.*

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 all tolerances specified by the manufacturer in accordance with ISO 492 Tolerance Class 4 (or ANSI/ABMA Std 20 Tolerance Class ABEC-7 or RBEC-7, or other national equivalents), or better, and having both rings and rolling elements (ISO 5593) made from monel or beryllium;

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

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

Note: 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<sup>3</sup> and 8,000 cm<sup>3</sup>; 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<sub>2</sub>);
  - b. Calcium zirconate (metazirconate) (CaZrO<sub>3</sub>);
  - c. Cerium sulphide (Ce<sub>2</sub>S<sub>3</sub>);
  - d. Erbium oxide (erbia) (Er<sub>2</sub>O<sub>3</sub>);
  - e. Hafnium oxide (hafnia) (HfO<sub>2</sub>);
  - f. Magnesium oxide (MgO);
  - g. Nitrided niobium-titanium-tungsten alloy (approximately 50% Nb, 30% Ti, 20% W);
  - h. Yttrium oxide (yttria) (Y<sub>2</sub>O<sub>3</sub>); or
  - i. Zirconium oxide (zirconia) (ZrO<sub>2</sub>);

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2A225 a. continued

- b. Crucibles having both of the following characteristics:
  - 1. A volume of between 50 cm<sup>3</sup> and 2,000 cm<sup>3</sup>; and
  - 2. Made of or lined with tantalum, having a purity of 99.9% or greater by weight;
- c. Crucibles having all of the following characteristics:
  - 1. A volume of between 50 cm<sup>3</sup> and 2,000 cm<sup>3</sup>;
  - 2. Made of or lined with tantalum, having a purity of 98% or greater by weight; and
  - 3. Coated with tantalum carbide, nitride, boride, or any combination thereof.

## 2A226 Valves having all of the following characteristics:

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

Technical Note:

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

**2B Test, Inspection and Production Equipment**Technical Notes:

- 1. *Secondary parallel contouring axes, (e.g., the w-axis on horizontal boring mills or a secondary rotary axis the centre line of which is parallel to the primary rotary axis) are not counted in the total number of contouring axes. Rotary axes need not rotate over 360°. A rotary axis can be driven by a linear device (e.g. a screw or a rack-and-pinion).*
- 2. *For the purposes of 2B, the number of axes which can be co-ordinated simultaneously for "contouring control" is the number of axes along or around which, during processing of the workpiece, simultaneous and interrelated motions are performed between the workpiece and a tool. This does not include any additional axes along or around which other relative movements within the machine are performed such as:
  - a. *Wheel-dressing systems in grinding machines;*
  - b. *Parallel rotary axes designed for mounting of separate workpieces;*
  - c. *Co-linear rotary axes designed for manipulating the same workpiece by holding it in a chuck from different ends.**
- 3. *Axis nomenclature shall be in accordance with International Standard ISO 841, 'Numerical Control Machines - Axis and Motion Nomenclature'.*
- 4. *For the purposes of 2B001 to 2B009 a "tilting spindle" is counted as a rotary axis.*

2B continued

5. *Stated positioning accuracy levels derived from measurements made according to ISO 230/2 (1988)<sup>1</sup> 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)<sup>2</sup>;*
- 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  $\hat{A}$  becomes the stated value of each axis for the model ( $\hat{A}_x \hat{A}_y \dots$ );*
- 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  $\hat{A}$  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 and any combination thereof, for removing (or cutting) metals, ceramics or "composites", which, according to the manufacturer's technical specification, can be equipped with electronic devices for "numerical control", and specially designed components as follows:

**N.B.: SEE ALSO 2B201.**

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

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

- a. *Crankshafts or cam shafts;*
- b. *Tools or cutters;*
- c. *Extruder worms;*
- d. *Engraved or faceted jewellery parts.*

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

- 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  $\mu\text{m}$  according to ISO 230/2 (1988)<sup>3</sup> or national equivalents along any linear axis; and

<sup>1</sup> 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.

<sup>2</sup> 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 a. continued

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. Having all of the following:
    - a. Positioning accuracy with "all compensations available" equal to or less (better) than 6 µm according to ISO 230/2 (1988)<sup>4</sup> or national equivalents along any linear axis; and
    - b. Three linear axes plus one rotary axis which can be coordinated simultaneously for "contouring control";
  2. Five or more axes which can be coordinated simultaneously for "contouring control";
  3. A positioning accuracy for jig boring machines, with "all compensations available", equal to or less (better) than 4 µm according to ISO 230/2 (1988)<sup>5</sup> or national equivalents along any linear axis; or
  4. Fly cutting machines, having all of the following characteristics:
    - a. Spindle "run-out" and "camming" less (better) than 0.0004 mm TIR; and
    - b. Angular deviation of slide movement (yaw, pitch and roll) less (better) than 2 seconds of arc, TIR over 300 mm of travel.
- c. Machine tools for grinding, having any of the following characteristics:
1. Having all of the following:
    - a. Positioning accuracy with "all compensations available" equal to or less (better) than 4 µm according to ISO 230/2 (1988)<sup>6</sup> 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.*

<sup>3</sup> 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

<sup>4</sup> 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

<sup>5</sup> 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

<sup>6</sup> 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

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2B001 c. continued

2. *Machines designed specifically as jig grinders that do not have a z-axis or a w-axis, with a positioning accuracy with "all compensations available" less (better) than 4 µm according to ISO 230/2 (1988)<sup>7</sup> or national equivalents.*
  3. *Surface grinders.*
- d. Electrical discharge machines (EDM) of the non-wire type which have two or more rotary axes which can be coordinated simultaneously for "contouring control";
  - e. Machine tools for removing metals, ceramics or "composites" having all of the following characteristics:
    1. Removing material by means of any of the following:
      - a. Water or other liquid jets, including those employing abrasive additives;
      - b. Electron beam; or
      - c. "Laser" beam; and
    2. Having two or more rotary axes which:
      - a. Can be coordinated simultaneously for "contouring control"; and
      - b. Have a positioning accuracy of less (better) than 0.003°;
  - f. Deep-hole-drilling machines and turning machines modified for deep-hole-drilling, having a maximum depth-of-bore capability exceeding 5,000 mm and specially designed components therefor.

- 2B002 Numerically controlled machine tools using a magnetorheological finishing (MRF) process equipped to produce non-spherical surfaces and having any of the following characteristics:
- a. Finishing the form to less (better) than 1.0 µm; or
  - b. Finishing to a roughness less (better) than 100 nm rms.

Technical Note:

For the purposes of 2B002, MRF is a material removal process using an abrasive magnetic fluid whose viscosity is controlled by a magnetic field.

- 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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<sup>7</sup> 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



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- 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 Munitions List.*

- 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. 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. Ion implantation production equipment having beam currents of 5 mA or more;
  - c. Electron beam physical vapour deposition (EB-PVD) production equipment incorporating power systems rated for over 80 kW, having any of the following:
    1. A liquid pool level "laser" control system which regulates precisely the ingots feed rate; or

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2B005 c. continued

2. A computer controlled rate monitor operating on the principle of photo-luminescence of the ionised atoms in the evaporant stream to control the deposition rate of a coating containing two or more elements;
- d. Plasma spraying production equipment having any of the following 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. Sputter deposition production equipment capable of current densities of  $0.1 \text{ mA/mm}^2$  or higher at a deposition rate of 15  $\mu\text{m/h}$  or more;
- f. Cathodic arc deposition production equipment incorporating a grid of electromagnets for steering control of the arc spot on the cathode;
- g. Ion plating production equipment 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, equipment and "electronic assemblies", as follows:

- a. Computer controlled or "numerically controlled" co-ordinate measuring machines (CMM), having a three dimensional (volumetric) maximum permissible error of indication ( $MPE_E$ ) at any point within the operating range of the machine (i.e., within the length of axes) equal to or less (better) than  $(1.7 + L/1,000) \mu\text{m}$  (L is the measured length in mm) tested according to ISO 10360-2 (2001);

**N.B.:** SEE ALSO 2B206.

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

1. Linear displacement measuring instruments having any of the following:

Technical Note:

*For the purpose of 2B006.b.1. 'linear displacement' means the change of distance between the measuring probe and the measured object.*

2B006 b. continued

- a. Non-contact type measuring systems with a "resolution" equal to or less (better) than 0.2  $\mu\text{m}$  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  $\pm 1$  K;
- c. Measuring systems having all of the following:
  1. Containing a "laser"; and
  2. Maintaining, for at least 12 hours, over a temperature range of  $\pm 1$  K around a standard temperature and at a standard pressure, all of the following:
    - a. A "resolution" over their full scale of 0.1  $\mu\text{m}$  or less (better); and
    - b. A "measurement uncertainty" equal to or less (better) than  $(0.2 + L/2,000)$   $\mu\text{m}$  (L is the measured length in mm); or
- d. "Electronic assemblies" specially designed to provide feedback capability in systems specified in 2B006.b.1.c.;

Note: 2B006.b.1. does not control measuring interferometer systems, with an automatic control system that is designed to use no feedback techniques, containing a "laser" to measure slide movement errors of machine-tools, dimensional inspection machines or similar equipment.

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

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

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

Note: 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.

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- 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 "programs" or to generate or modify numerical program 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  $5 \times 10^3$  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 or units, specially designed for machine tools, or dimensional inspection or measuring systems and equipment, as follows:
- a. Linear position feedback units (e.g., inductive type devices, graduated scales, infrared systems or "laser" systems) having an overall "accuracy" less (better) than  $(800 + (600 \times L \times 10^{-3}))$  nm (L equals the effective length in mm);  
*N.B.: For "laser" systems see also Note to 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  $0.00025^\circ$ ;  
*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

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2B009 continued

- 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", not controlled in 2B004, having all of the following:

**N.B.: SEE ALSO 2B204.**

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

2B105 Chemical vapour deposition (CVD) furnaces, not controlled in 2B005.a., designed or modified for the densification of carbon-carbon composites.

2B109 Flow-forming machines, not controlled 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 an acceleration equal to or greater than 10 g rms between 20 Hz and 2 kHz and imparting forces equal to or greater than 50 kN, measured 'bare table';

2B116 continued

- 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 equal to or greater than 50 kN, measured 'bare table', and usable in vibration test systems specified in 2B116.a.;
- d. Test piece support structures and electronic units designed to combine multiple shaker units in a system capable of providing an effective combined force 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, not controlled 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

2B120 continued

- 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), not controlled 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 and any combination thereof, not controlled 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)<sup>8</sup> 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.

<sup>8</sup> 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

2B201 continued

- 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)<sup>9</sup> 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 a maximum workpiece capacity of 150 mm or length; and
    2. Axes limited to x, z and c;
  - b. Jig grinders that do not have a z-axis or a w-axis with an overall positioning accuracy less (better) than 4 µm according to ISO 230/2 (1988)<sup>10</sup> or national equivalents.

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

- a. Gears;
- b. Crankshafts or camshafts;
- c. Tools or cutters;
- d. Extruder worms.

*Note 2:* A machine tool having at least two of the three turning, milling or grinding capabilities (e.g., a turning machine with milling capability), must be evaluated against each applicable entry 2B001.a. or 2B201.a. or b.

2B204 "Isostatic presses", not controlled 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.

<sup>9</sup> 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

<sup>10</sup> 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



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2B204 continued*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, not controlled in 2B006, as follows:

- a. Computer controlled or numerically 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  $(1.25 + L/1000)$   $\mu\text{m}$  tested with a probe of an "accuracy" of less (better) than  $0.2 \mu\text{m}$  (L is the measured length in millimetres) (Ref.:VDI/VDE 2617 Parts 1 and 2);
- b. Systems for simultaneous linear-angular inspection of hemishells, having both of the following characteristics:
  1. "Measurement uncertainty" along any linear axis equal to or less (better) than  $3.5 \mu\text{m}$  per 5 mm; and
  2. "Angular position deviation" equal to or less than  $0.02^\circ$ .

*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.*

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- 2B207 "Robots", "end-effectors" and control units, not controlled in 2B007, as follows:
- a. "Robots" or "end-effectors" specially designed to comply with national safety standards applicable to handling high explosives (for example, meeting electrical code ratings for high explosives);
  - b. Control units specially designed for any of the "robots" or "end-effectors" specified in 2B207.a.
- 2B209 Flow forming machines, spin forming machines capable of flow forming functions, not controlled 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

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2B225 continued

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

Technical Note:

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

2B226 Controlled atmosphere (vacuum or inert gas) induction furnaces, 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<sup>3</sup> and 20,000 cm<sup>3</sup>, 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  $\pm 1\%$  of full-scale; or
    2. A full scale of 13 kPa or greater and an 'accuracy' of better than  $\pm 130$  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<sup>3</sup>/s; and
  - c. Capable of producing an ultimate vacuum better than 13 mPa.

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2B231 continued*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, equipment and components, as follows:

- a. Reaction vessels or reactors, with or without agitators, with total internal (geometric) volume greater than 0.1 m<sup>3</sup> (100 litres) and less than 20 m<sup>3</sup> (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 specified in 2B350.a.; and impellers, blades or shafts designed for such agitators, where all surfaces of the agitator that come in direct contact with the chemical(s) being processed or contained are made from any of the following materials:
  1. Alloys with more than 25% nickel and 20% chromium by weight;
  2. Fluoropolymers;
  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<sup>3</sup> (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;

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2B350 continued

- d. Heat exchangers or condensers with a heat transfer surface area greater than 0.15 m<sup>2</sup>, and less than 20 m<sup>2</sup>; and tubes, plates, coils or blocks (cores) designed for such heat exchangers or condensers, where all surfaces that come in direct contact with the chemical(s) being processed are made from any of the following materials:
1. Alloys with more than 25% nickel and 20% chromium by weight;
  2. Fluoropolymers;
  3. Glass (including vitrified or enamelled coatings or glass lining);
  4. Graphite or 'carbon graphite';
  5. Nickel or alloys with more than 40% nickel by weight;
  6. Tantalum or tantalum alloys;
  7. Titanium or titanium alloys;
  8. Zirconium or zirconium alloys;
  9. Silicon carbide; or
  10. Titanium carbide;
- e. Distillation or absorption columns of internal diameter greater than 0.1 m; and liquid distributors, vapour distributors or liquid collectors designed for such distillation or absorption columns, where all surfaces that come in direct contact with the chemical(s) being processed are made from any of the following materials:
1. Alloys with more than 25% nickel and 20% chromium by weight;
  2. Fluoropolymers;
  3. Glass (including vitrified or enamelled coatings or glass lining);
  4. Graphite or 'carbon graphite';
  5. Nickel or alloys with more than 40% nickel by weight;
  6. Tantalum or tantalum alloys;
  7. Titanium or titanium alloys; or
  8. Zirconium or zirconium alloys;
- f. Remotely operated filling equipment in which all surfaces that come in direct contact with the chemical(s) being processed are made from any of the following materials:
1. Alloys with more than 25% nickel and 20% chromium by weight; or
  2. Nickel or alloys with more than 40% nickel by weight;
- g. Valves with nominal sizes greater than 10 mm and casings (valve bodies) or preformed casing liners designed for such 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;

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2B350 continued

- 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 or 'carbon 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 and seal-less pumps, with manufacturer's specified maximum flow-rate greater than 0.6 m<sup>3</sup>/hour, or vacuum pumps with manufacturer's specified maximum flow-rate greater than 5 m<sup>3</sup>/hour (under standard temperature (273 K (0°C)) and pressure (101.3 kPa) conditions); and casings (pump bodies), preformed casing liners, impellers, rotors or jet pump nozzles designed for such pumps, in which all surfaces that come in direct contact with the chemical(s) being processed are made from any of the following materials:
1. Alloys with more than 25% nickel and 20% chromium by weight;
  2. Ceramics;
  3. Ferrosilicon;
  4. Fluoropolymers;
  5. Glass (including vitrified or enamelled coatings or glass lining);
  6. Graphite or 'carbon graphite';
  7. Nickel or alloys with more than 40% nickel by weight;
  8. Tantalum or tantalum alloys;
  9. Titanium or titanium alloys; 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.

Technical Note:

'Carbon graphite' is a composition consisting of amorphous carbon and graphite, in which the graphite content is eight percent or more by weight.

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- 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<sup>3</sup>; 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 (2<sup>nd</sup> edition, Geneva 1993).*
  - 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 20 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. One or more sealing joints within the steam containment area; and
    4. Capable of in-situ steam sterilisation in a closed state;*Technical Note:*  
*Centrifugal separators include decanters.*
  - d. Cross (tangential) flow filtration equipment and components as follows:
    1. Cross (tangential) flow filtration equipment capable of separation of pathogenic micro-organisms, viruses, toxins or cell cultures, without the propagation of aerosols, having both of the following characteristics:
      - a. A total filtration area equal to or greater than 1 m<sup>2</sup>; and
      - b. Capable of being sterilised or disinfected in-situ;*Technical Note:*  
*In 2B352.d.1.b. sterilised denotes the elimination of all viable microbes from the equipment through the use of either physical (e.g. steam) or chemical agents. Disinfected denotes the destruction of potential microbial infectivity in the equipment through the use of chemical agents with a germicidal effect. Disinfection and sterilisation are distinct from sanitisation, the latter referring to cleaning procedures designed to lower the microbial content of equipment without necessarily achieving elimination of all microbial infectivity or viability.*



2B352 d. continued

2. Cross (tangential) flow filtration components (e.g. modules, elements, cassettes, cartridges, units or plates) with filtration area equal to or greater than 0.2 m<sup>2</sup> for each component and designed for use in cross (tangential) flow filtration equipment specified in 2B352.d.;

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

- e. Steam sterilisable freeze drying equipment with a condenser capacity exceeding 10 kg of ice in 24 hours and less than 1,000 kg of ice in 24 hours;
- f. Protective and containment equipment, as follows:
1. Protective full or half suits, or hoods dependent upon a tethered external air supply and operating under positive pressure;  
*Note:* 2B352.f.1. does not control suits designed to be worn with self-contained breathing apparatus.
  2. 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 (closed with vertical flow).
- g. Chambers designed for aerosol challenge testing with "microorganisms", viruses or "toxins" and having a capacity of 1 m<sup>3</sup> 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 2A001 or 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 co-ordinating simultaneously more than four axes for "contouring control".

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

2D002 continued

Note 2: 2D002 does not control "software" for items specified in 2B002. See 2D001 for control of "software" for items specified in 2B002.2D101 "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 programs;
- 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;

2E003 2. continued

- b. "Diffusion bonding" of "superalloys" or titanium alloys:
  1. Surface preparation;
  2. Temperature;
  3. Pressure;
- c. "Direct-acting hydraulic pressing" of aluminium alloys or titanium alloys:
  1. Pressure;
  2. Cycle time;
- d. "Hot isostatic densification" of titanium alloys, aluminium alloys or "superalloys":
  1. Temperature;
  2. Pressure;
  3. Cycle time;
- c. "Technology" for the "development" or "production" of hydraulic stretch-forming machines and dies therefor, for the manufacture of airframe structures;
- d. "Technology" for the "development" of generators of machine tool instructions (e.g., part programs) 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, 2B119 to 2B122 or 2D101.
- 2E201 "Technology" according to the General Technology Note for the "use" of equipment or "software" specified in 2A225, 2A226, 2B001, 2B006, 2B007.b., 2B007.c., 2B008, 2B009, 2B201, 2B204, 2B206, 2B207, 2B209, 2B225 to 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. <u>Coating Process</u> (1) *	2. <u>Substrate</u>	3. <u>Resultant Coating</u>
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)

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

TABLE - DEPOSITION TECHNIQUES

1. <u>Coating Process</u> (1)	2. <u>Substrate</u>	3. <u>Resultant Coating</u>
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. <u>Coating Process</u> (1)	2. <u>Substrate</u>	3. <u>Resultant Coating</u>
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. <u>Coating Process</u> (1)	2. <u>Substrate</u>	3. <u>Resultant Coating</u>
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. <u>Coating Process</u> (1)	2. <u>Substrate</u>	3. <u>Resultant Coating</u>
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) Dielectric layers (15) Diamond-like carbon (17)



TABLE - DEPOSITION TECHNIQUES

1. <u>Coating Process</u> (1)	2. <u>Substrate</u>	3. <u>Resultant Coating</u>
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

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TABLE - DEPOSITION TECHNIQUES

1. <u>Coating Process</u> (1)	2. <u>Substrate</u>	3. <u>Resultant Coating</u>
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

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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 to 1.1 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.
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  $1 \times 10^{-7} \text{ K}^{-1}$  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, equipment for the manufacture of disposables, valves for faucets, acoustic diaphragms for speakers, engine parts for automobiles, cutting tools, punching-pressing dies, office automation equipment, microphones or medical devices or moulds, for casting or moulding of plastics, manufactured from alloys containing less than 5% beryllium.
18. 'Silicon carbide' does not include cutting and forming tool materials.
19. Ceramic substrates, as used in this entry, does not include ceramic materials containing 5% by weight, or greater, clay or cement content, either as separate constituents or in combination.

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TABLE - DEPOSITION TECHNIQUES - TECHNICAL NOTE

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

- a. Chemical Vapour Deposition (CVD) is an overlay coating or surface modification coating process wherein a metal, alloy, "composite", dielectric or ceramic is deposited upon a heated substrate. Gaseous reactants are decomposed or combined in the vicinity of a substrate resulting in the deposition of the desired elemental, alloy or compound material on the substrate. Energy for this decomposition or chemical reaction process may be provided by the heat of the substrate, a glow discharge plasma, or "laser" irradiation.

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

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

N.B.3 The gaseous reactants used in the out-of-pack process are produced using the same basic reactions and parameters as the pack cementation process, except that the substrate to be coated is not in contact with the powder mixture.

- b. Thermal Evaporation-Physical Vapour Deposition (TE-PVD) is an overlay coating process conducted in a vacuum with a pressure less than 0.1 Pa wherein a source of thermal energy is used to vaporize the coating material. This process results in the condensation, or deposition, of the evaporated species onto appropriately positioned substrates.

The addition of gases to the vacuum chamber during the coating process to synthesize compound coatings is an ordinary modification of the process.

The use of ion or electron beams, or plasma, to activate or assist the coating's deposition is also a common modification in this technique. The use of monitors to provide in-process measurement of optical characteristics and thickness of coatings can be a feature of these processes.

Specific TE-PVD processes are as follows:

1. Electron Beam PVD uses an electron beam to heat and evaporate the material which forms the coating;
2. Ion Assisted Resistive Heating PVD employs electrically resistive heating sources in combination with impinging ion beam(s) to produce a controlled and uniform flux of evaporated coating species;
3. "Laser" Vaporization uses either pulsed or continuous wave "laser" beams to vaporize the material which forms the coating;

4. Cathodic Arc Deposition employs a consumable cathode of the material which forms the coating and has an arc discharge established on the surface by a momentary contact of a ground trigger. Controlled motion of arcing erodes the cathode surface creating a highly ionized plasma. The anode can be either a cone attached to the periphery of the cathode, through an insulator, or the chamber. Substrate biasing is used for non line-of-sight deposition.  
N.B. This definition does not include random cathodic arc deposition with non-biased substrates.
5. Ion Plating is a special modification of a general TE-PVD process in which a plasma or an ion source is used to ionize the species to be deposited, and a negative bias is applied to the substrate in order to facilitate the extraction of the species from the plasma. The introduction of reactive species, evaporation of solids within the process chamber, and the use of monitors to provide in-process measurement of optical characteristics and thicknesses of coatings are ordinary modifications of the process.
- c. Pack Cementation is a surface modification coating or overlay coating process wherein a substrate is immersed in a powder mixture (a pack), that consists of:
1. The metallic powders that are to be deposited (usually aluminium, chromium, silicon or combinations thereof);
  2. An activator (normally a halide salt); and
  3. An inert powder, most frequently alumina.
- The substrate and powder mixture is contained within a retort which is heated to between 1,030 K (757°C) and 1,375 K (1,102°C) for sufficient time to deposit the coating.
- d. Plasma Spraying is an overlay coating process wherein a gun (spray torch) which produces and controls a plasma accepts powder or wire coating materials, melts them and propels them towards a substrate, whereon an integrally bonded coating is formed. Plasma spraying constitutes either low pressure plasma spraying or high velocity plasma spraying.
- N.B.1 Low pressure means less than ambient atmospheric pressure.  
N.B.2 High velocity refers to nozzle-exit gas velocity exceeding 750 m/s calculated at 293 K (20°C) at 0.1 MPa.
- e. Slurry Deposition is a surface modification coating or overlay coating process wherein a metallic or ceramic powder with an organic binder is suspended in a liquid and is applied to a substrate by either spraying, dipping or painting, subsequent air or oven drying, and heat treatment to obtain the desired coating.
- f. Sputter Deposition is an overlay coating process based on a momentum transfer phenomenon, wherein positive ions are accelerated by an electric field towards the surface of a target (coating material). The kinetic energy of the impacting ions is sufficient to cause target surface atoms to be released and deposited on an appropriately positioned substrate.

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- 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  $5 \times 10^3$  Gy (silicon) or higher;
- b. A dose rate upset of  $5 \times 10^6$  Gy (silicon)/s or higher; or
- c. A fluence (integrated flux) of neutrons (1 MeV equivalent) of  $5 \times 10^{13}$  n/cm<sup>2</sup> or higher on silicon, or its equivalent for other materials;



3A001 a. 1. continued

Note: 3A001.a.1.c. does not apply to Metal Insulator Semiconductors (MIS).

2. "Microprocessor microcircuits", "microcomputer microcircuits", microcontroller microcircuits, storage integrated circuits manufactured from a compound semiconductor, analogue-to-digital converters, digital-to-analogue converters, electro-optical or "optical integrated circuits" designed for "signal processing", field programmable logic devices, neural network integrated circuits, custom integrated circuits for which either the function is unknown or the control status of the equipment in which the integrated circuit will be used is unknown, 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, manufactured from a compound semiconductor and operating at a clock frequency exceeding 40 MHz;
 

Note: 3A001.a.3. includes digital signal processors, digital array processors and digital coprocessors.

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 10 bit, with an output rate greater than 500 million words per second;
    2. A resolution of 10 bit or more, but less than 12 bit, with an output rate greater than 200 million words per second;
    3. A resolution of 12 bit with an output rate greater than 50 million words per second;
    4. A resolution of more than 12 bit, but equal to or less than 14 bit, with an output rate greater than 5 million words per second; or
    5. A resolution of more than 14 bit with an output rate greater than 1 million words per second;

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3A001 a. 5. continued

- 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  $n$  bit corresponds to a quantisation of  $2^n$  levels.
  2. The number of bits in the output word is equal to the resolution of the analogue-to-digital converter.
  3. The output rate is the maximum output rate of the converter, regardless of the architecture or oversampling. Vendors may also refer to the output rate as sampling rate, conversion rate or throughput rate. It is often specified in megahertz (MHz) or mega samples per second (MSPS).
  4. For the purpose of measuring output rate, one output word per second is equivalent to one Hertz or one sample per second.
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 0.1 ns;
  - or
  - c. A toggle frequency exceeding 133 MHz;

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. Deleted;
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 1,000 terminals;
  - b. A typical "basic gate propagation delay time" of less than 0.1 ns;
  - or
  - c. An operating frequency exceeding 3 GHz;

3A001 a. continued

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 a rated execution time for an N-point complex FFT of less than  $(N \log_2 N) / 20,480$  ms, where N is the number of points;

Technical Note:

*When N is equal to 1,024 points, the formula in 3A001.a.12. gives an execution time of 500  $\mu$ s.*

## b. Microwave or millimetre wave components, as follows:

1. Electronic vacuum tubes and cathodes, as follows:

Note 1: *3A001.b.1. does not control tubes designed or rated for operation in any frequency band which meets all of the following characteristics:*

- a. *Does not exceed 31.8 GHz; and*
- b. *Is "allocated by the ITU" for radio-communications services, but not for radio-determination.*

Note 2: *3A001.b.1. does not control non-"space-qualified" tubes which meet all of the following characteristics:*

- a. *An average output power equal to or less than 50 W; and*
- b. *Designed or rated for operation in any frequency band which meets all of the following characteristics:*
  1. *Exceeds 31.8 GHz but does not exceed 43.5 GHz; and*
  2. *Is "allocated by the ITU" for radio-communications services, but not for radio-determination.*

- a. Travelling wave tubes, pulsed or continuous wave, as follows:
  1. Operating at frequencies exceeding 31.8 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 a "fractional bandwidth" of more than 7% or a peak power exceeding 2.5 kW;
  4. Helix tubes, or derivatives thereof, with any of the following characteristics:
    - a. An "instantaneous bandwidth" of more than one octave, and average power (expressed in kW) times frequency (expressed in GHz) of more than 0.5;
    - b. An "instantaneous bandwidth" of one octave or less, and average power (expressed in kW) times frequency (expressed in GHz) of more than 1; or
    - c. Being "space qualified";

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3A001 b. 1. continued

- 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  $5 \text{ A/cm}^2$ ;
2. Microwave monolithic integrated circuits (MMIC) power amplifiers having any of the following:
- a. Rated for operation at frequencies exceeding 3.2 GHz up to and including 6 GHz and with an average output power greater than 4W (36 dBm) with a "fractional bandwidth" greater than 15%;
  - b. Rated for operation at frequencies exceeding 6 GHz up to and including 16 GHz and with an average output power greater than 1W (30 dBm) with a "fractional bandwidth" greater than 10%;
  - c. Rated for operation at frequencies exceeding 16 GHz up to and including 31.8 GHz and with an average output power greater than 0.8W (29 dBm) with a "fractional bandwidth" greater than 10%;
  - d. Rated for operation at frequencies exceeding 31.8 GHz up to and including 37.5 GHz;
  - e. Rated for operation at frequencies exceeding 37.5 GHz up to and including 43.5 GHz and with an average output power greater than 0.25W (24 dBm) with a "fractional bandwidth" greater than 10%; or
  - f. Rated for operation at frequencies exceeding 43.5 GHz.
- Note 1: 3A001.b.2. does not control broadcast satellite equipment designed or rated to operate in the frequency range of 40.5 GHz to 42.5 GHz.
- Note 2: The control status of the MMIC whose rated operating frequency includes frequencies listed in more than one frequency range, as defined by 3A001.b.2.a. to 3A001.b.2.f., is determined by the lowest average output power control threshold.
- Note 3: Notes 1 and 2 in the chapeau to Category 3 mean that 3A001.b.2. does not control MMICs if they are specially designed for other applications, e.g., telecommunications, radar, automobiles.
3. Discrete microwave transistors having any of the following:
- a. Rated for operation at frequencies exceeding 3.2 GHz up to and including 6 GHz and having an average output power greater than 60W (47.8 dBm);
  - b. Rated for operation at frequencies exceeding 6 GHz up to and including 31.8 GHz and having an average output power greater than 20W (43 dBm);
  - c. Rated for operation at frequencies exceeding 31.8 GHz up to and including 37.5 GHz and having an average output power greater than 0.5W (27 dBm);

3A001 b. 3. continued

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

Note: *The control status of a transistor whose rated operating frequency includes frequencies listed in more than one frequency range, as defined by 3A001.b.3.a. to 3A001b.3.e., is determined by the lowest average output power control threshold.*

- 4. Microwave solid state amplifiers and microwave assemblies/modules containing microwave amplifiers, having any of the following:
  - a. Rated for operation at frequencies exceeding 3.2 GHz up to and including 6 GHz and with an average output power greater than 60W (47.8 dBm) with a "fractional bandwidth" greater than 15%;
  - b. Rated for operation at frequencies exceeding 6 GHz up to and including 31.8 GHz and with an average output power greater than 15W (42 dBm) with a "fractional bandwidth" greater than 10%;
  - c. Rated for operation at frequencies exceeding 31.8 GHz up to and including 37.5 GHz;
  - d. Rated for operation at frequencies exceeding 37.5 GHz up to and including 43.5 GHz and with an average output power greater than 1W (30 dBm) with a "fractional bandwidth" greater than 10%;
  - e. Rated for operation at frequencies exceeding 43.5 GHz; or
  - f. Rated for operation at frequencies above 3.2 GHz and having all of the following:
    - 1. An average output power (in watts), P, greater than 150 divided by the maximum operating frequency (in GHz) squared [ $P > 150 \text{ W} \cdot \text{GHz}^2 / f_{\text{GHz}}^2$ ];
    - 2. A fractional bandwidth of 5% or greater; and
    - 3. Any two sides perpendicular to one another with length d (in cm) equal to or less than 15 divided by the lowest operating frequency in GHz [ $d \leq 15 \text{ cm} \cdot \text{GHz} / f_{\text{GHz}}$ ].

Technical Note:

*3.2 GHz should be used as the lowest operating frequency ( $f_{\text{GHz}}$ ) in the formula in 3A001.b.4.f.3., for amplifiers that have a rated operating range extending downward to 3.2 GHz and below [ $d \leq 15 \text{ cm} \cdot \text{GHz} / 3.2 \text{ GHz}$ ].*

N.B.: *MMIC power amplifiers should be evaluated against the criteria in 3A001.b.2.*

Note 1: *3A001.b.4. does not control broadcast satellite equipment designed or rated to operate in the frequency range of 40.5 to 42.5 GHz.*

Note 2: *The control status of an item whose rated operating frequency includes frequencies listed in more than one frequency range, as defined by 3A001.b.4.a. to 3A001.b.4.e., is determined by the lowest average output power control threshold.*

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3A001 b. continued

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  $\mu\text{s}$  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. Deleted;
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  $\text{cm}^3$ ;

*Note: 3A001.b.8. does not control equipment designed or rated for operation in any frequency band which is "allocated by the ITU" for radio-communications services, but not for radio-determination.*
- 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  $\mu\text{s}$  and bandwidth in MHz) of more than 100;
      3. A bandwidth greater than 250 MHz; or
      4. A dispersive delay of more than 10  $\mu\text{s}$ ; 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  $\mu\text{s}$  and bandwidth in MHz) of more than 100;
      2. A dispersive delay of more than 10  $\mu\text{s}$ ; 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;

3A001 c. continued

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  $27 \text{ cm}^3$  (e.g., standard C-cells or R14 batteries).

    - a. Primary cells and batteries having an 'energy density' exceeding 480 Wh/kg and rated for operation in the temperature range from below 243 K (-30°C) to above 343 K (70°C);
    - b. Rechargeable cells and batteries having an 'energy density' exceeding 150 Wh/kg after 75 charge/discharge cycles at a discharge current equal to C/5 hours (C being the nominal capacity in ampere hours) when operating in the temperature range from below 253 K (-20°C) to above 333 K (60°C);

*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  $160 \text{ W/m}^2$  at an operating temperature of 301 K (28°C) under a tungsten illumination of  $1 \text{ kW/m}^2$  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 than 25 kJ;
    - b. Capacitors with a repetition rate of 10 Hz or more (repetition rated capacitors) having all of the following:
      1. A voltage rating equal to or more than 5 kV;
      2. An energy density equal to or more than 50 J/kg;

3A001 e. 2. continued

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<sup>2</sup>;
- 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 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, the ETSI or the IEEE for civil television applications.*



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3A002 a. continued

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 rate equal to or more than 200 million samples per second and a resolution of 10 bit 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.*
6. Digital instrumentation data recorders, using magnetic disk storage technique, having all of the following:
  - a. Digitising rate equal to or more than 100 million samples per second and a resolution of 8 bit or more; and
  - b. A continuous throughput of 1 Gbit/s or more;
- b. "Frequency synthesiser" "electronic assemblies" having a "frequency switching time" from one selected frequency to another of less than 1 ms;
- c. Radio frequency "signal analysers", as follows:
  1. "Signal analysers" capable of analysing frequencies exceeding 31.8 GHz but not exceeding 37.5 GHz and having a 3 dB resolution bandwidth (RBW) exceeding 10 MHz;
  2. "Signal analysers" capable of analysing frequencies exceeding 43.5 GHz;
  3. "Dynamic signal analysers" having a "real-time bandwidth" exceeding 500 kHz;

*Note:* 3A002.c.3. 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 31.8 GHz but not exceeding 43.5 GHz and rated to generate a pulse duration of less than 100 ns;
  2. A maximum synthesised frequency exceeding 43.5 GHz;
  3. A "frequency switching time" from one selected frequency to another of less than 1 ms; or
  4. 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;

Technical Note:

*For the purposes of 3A002.d.1., 'pulse duration' is defined as the time interval between the leading edge of the pulse achieving 90% of the peak and the trailing edge of the pulse achieving 10% of the peak.*

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 43.5 GHz;
- f. Microwave test receivers having all of the following:
1. A maximum operating frequency exceeding 43.5 GHz; and
  2. Being capable of measuring amplitude and phase simultaneously;
- g. Atomic frequency standards having any of the following:
1. Long-term stability (aging) less (better) than  $1 \times 10^{-11}$  /month; or
  2. Being "space qualified".

Note: *3A002.g.1. does not control non-"space qualified" rubidium standards.*

3A003 Spray cooling thermal management systems employing closed loop fluid handling and reconditioning equipment in a sealed enclosure where a dielectric fluid is sprayed onto electronic components using specially designed spray nozzles that are designed to maintain electronic components within their operating temperature range, and specially designed components therefor.

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- 3A101 Electronic equipment, devices and components, not controlled in 3A001, as follows:
- a. Analogue-to-digital converters, usable in "missiles", designed to meet military specifications for ruggedized equipment;
  - b. Accelerators capable of delivering electromagnetic radiation produced by bremsstrahlung from accelerated electrons of 2 MeV or greater, and systems containing those accelerators.  
*Note: 3A101.b. above does not specify equipment specially designed for medical purposes.*
- 3A201 Electronic components, not controlled 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  $\mu$ F; and  
d. Series inductance less than 50 nH; or
    2. a. Voltage rating greater than 750 V;  
b. Capacitance greater than 0.25  $\mu$ F; and  
c. Series inductance less than 10 nH;
  - 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.
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3A201 c. continued

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  $\mu$ s, then  $Q$  is the total accelerated charge in Coulombs. If the accelerator beam pulse duration is greater than 1  $\mu$ s, then  $Q$  is the maximum accelerated charge in 1  $\mu$ s.

$Q$  equals the integral of  $i$  with respect to  $t$ , over the lesser of 1  $\mu$ s 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  $\mu$ s 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, not controlled 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, not controlled 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.

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- 3A227 High-voltage direct current power supplies, not controlled 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  $\mu$ s or less;

*Note:* 3A228 includes gas krytron tubes and vacuum sphytron tubes.
  - b. Triggered spark-gaps having both of the following characteristics:
    1. An anode delay time of 15  $\mu$ s 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  $\mu$ s or less.

- 3A229 Firing sets and equivalent high-current pulse generators as follows:  
**N.B.: SEE ALSO ML4.b.**
- 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  $\mu$ s;
    4. Having an output greater than 100 A;
    5. Having a 'rise time' of less than 10  $\mu$ s 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 ML4.b.**
- a. Electrically driven explosive detonators, as follows:
    1. Exploding bridge (EB);
    2. Exploding bridge wire (EBW);
    3. Slapper;
    4. Exploding foil initiators (EFI);

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3A232 continued

- b. Arrangements using single or multiple detonators designed to nearly simultaneously initiate an explosive surface over greater than 5,000 mm<sup>2</sup> from a single firing signal with an initiation timing spread over the surface of less than 2.5 µs.

*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, not controlled 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<sub>6</sub>;
- 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<sub>6</sub>;
- f. Mass spectrometers equipped with a microfluorination ion source designed for actinides or actinide fluorides.

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**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. Equipment designed for epitaxial growth, as follows:
    1. Equipment capable of producing a layer of any material other than silicon with a thickness uniform to less than  $\pm 2.5\%$  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;
  - b. 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. A beam energy of 65 keV or more and a beam current of 45 mA or more for high energy oxygen implant into a heated semiconductor material "substrate";
  - c. Anisotropic plasma dry etching equipment, as follows:
    1. Equipment with cassette-to-cassette operation and load-locks, and having any of the following:
      - a. Designed or optimised to produce critical dimensions of 180 nm or less with  $\pm 5\%$  3 sigma precision; or
      - b. Designed for generating less than 0.04 particles/cm<sup>2</sup> with a measurable particle size greater than 0.1  $\mu\text{m}$  in diameter;
    2. Equipment specially designed for equipment specified in 3B001.e. and having any of the following:
      - a. Designed or optimised to produce critical dimensions of 180 nm or less with  $\pm 5\%$  3 sigma precision; or
      - b. Designed for generating less than 0.04 particles/cm<sup>2</sup> with a measurable particle size greater than 0.1  $\mu\text{m}$  in diameter;
  - d. Plasma enhanced CVD equipment, as follows:
    1. Equipment with cassette-to-cassette operation and load-locks, and designed according to the manufacturer's specifications or optimised for use in the production of semiconductor devices with critical dimensions of 180 nm or less;
    2. Equipment specially designed for equipment controlled by 3B001.e. designed according to the manufacturer's specifications or optimised for use in the production of semiconductor devices with critical dimensions of 180 nm or less;



3B001 continued

- e. Automatic loading multi-chamber central wafer handling systems, having all of the following:
1. Interfaces for wafer input and output, to which more than two 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. 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 245 nm; or
- b. Capable of producing a pattern with a 'minimum resolvable feature' size of 180 nm or less;

Technical Note:

*The 'minimum resolvable feature' size is calculated by the following formula:*

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

*where the K factor = 0.45*

*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.

Note: *3B001.h. does not control multi-layer masks with a phase shift layer designed for the fabrication of memory devices not controlled by 3A001.*

- 3B002      Test equipment, specially designed for testing finished or unfinished semiconductor devices, as follows, and specially designed components and accessories therefor:
- a.    For testing S-parameters of transistor devices at frequencies exceeding 31.8 GHz;
  - b.    Deleted;
  - c.    For testing microwave integrated circuits specified in 3A001.b.2.

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**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;
- c. Silicon carbide; or
- d. 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 Mendeleev'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  $\mu\text{coulomb}/\text{mm}^2$  or better;
- c. All resists designed for use with X-rays, with a sensitivity of 2.5  $\text{mJ}/\text{mm}^2$  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.*

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**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 any of the following:
- a. Equipment specified in 3B001.a. to f.; or
  - b. Equipment specified in 3B002.
- 3D003 'Physics-based' simulation "software" specially designed for the "development" of lithographic, etching or deposition processes for translating masking patterns into specific topographical patterns in conductors, dielectrics or semiconductor materials.

*Technical Note:*

*'Physics-based' in 3D003 means using computations to determine a sequence of physical cause and effect events based on physical properties (e.g., temperature, pressure, diffusion constants and semiconductor materials properties).*

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

- 3D004 "Software" specially designed for the "development" of the equipment specified in 3A003.
- 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 1: 3E001 does not control "technology" for the "production" of equipment or components controlled by 3A003.*

*Note 2: 3E001 does not control "technology" for the "development" or "production" of integrated circuits specified in 3A001.a.3. to 3A001.a.12., having all of the following:*

- 1. Using "technology" of 0.5  $\mu\text{m}$  or more, and*
- 2. Not incorporating 'multi-layer structures'.*

3E001 continuedTechnical Note:

*The term 'multi-layer structures' does not include devices incorporating a maximum of three metal layers and three polysilicon layers.*

3E002 "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: *Decontrol note 2 to 3E001 also applies to 3E002.*

3E003 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;  
Note: *3E003.b. does not control technology for high electron mobility transistors (HEMT) operating at frequencies lower than 31.8 GHz and hetero-junction bipolar transistors (HBT) operating at frequencies lower than 31.8 GHz.*
- c. "Superconductive" electronic devices;
- d. Substrates of films of diamond for electronic components;
- e. Substrates of silicon-on-insulator (SOI) for integrated circuits in which the insulator is silicon dioxide;
- f. Substrates of silicon carbide for electronic components;
- g. Electronic vacuum tubes operating at frequencies of 31.8 GHz or higher.

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  $5 \times 10^3$  Gy (silicon);
    - b. Dose Rate Upset  $5 \times 10^6$  Gy (silicon)/s; or
    - c. Single Event Upset  $1 \times 10^{-7}$  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.*

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

4A003 a. continued

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

- b. "Digital computers" having an "Adjusted Peak Performance" ("APP") exceeding 0.75 Weighted TeraFLOPS (WT);
- c. "Electronic assemblies" specially designed or modified for enhancing performance by aggregation of processors so that the "APP" of the aggregation exceeds the limit 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.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. Deleted;
- e. Equipment performing analogue-to-digital conversions exceeding the limits in 3A001.a.5.;
- f. Deleted;
- g. Equipment specially designed to provide external interconnection of "digital computers" or associated equipment which allows communications at data rates exceeding 1.25 Gbyte/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, not controlled 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 a. "Software" specially designed or modified for the "development", "production" or "use" of equipment or "software" specified in 4A001 to 4A004, or 4D.

- b. "Software", other than that specified in 4D001.a., specially designed or modified for the "development" or "production" of:
1. "Digital computers" having an "Adjusted Peak Performance" ("APP") exceeding 0.04 Weighted TeraFLOPS (WT); or
  2. "Electronic assemblies" specially designed or modified for enhancing performance by aggregation of processors so that the "APP" of the aggregation exceeds the limit in 4D001.b.1.;

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. Deleted;
  - 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.*

**4E Technology**

- 4E001
- a. "Technology" according to the General Technology Note, for the "development", "production" or "use" of equipment or "software" specified in 4A or 4D.
  - b. "Technology", other than that specified in 4E001.a., specially designed or modified for the "development" or "production" of:
    1. "Digital computers" having an "Adjusted Peak Performance" ("APP") exceeding 0.04 Weighted TeraFLOPS (WT); or
    2. "Electronic assemblies" specially designed or modified for enhancing performance by aggregation of processors so that the "APP" of the aggregation exceeds the limit in 4E001.b.1.;

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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: <u>Note</u> Every "CE" must be evaluated independently.	Effective calculating Rate, R
XP only  (R <sub>xp</sub> )	$\frac{1}{3 * (t_{xp \text{ add}})}$ <p>if no add is implemented use:</p> $\frac{1}{(t_{xp \text{ mult}})}$ <p>If neither add nor multiply is implemented use the fastest available arithmetic operation as follows:</p> $\frac{1}{3 * t_{xp}}$ <p>See Notes X &amp; Z</p>
FP only (R <sub>fp</sub> )	$\max \frac{1}{t_{fp \text{ add}}}, \frac{1}{t_{fp \text{ mult}}}$ <p>See Notes X &amp; Y</p>
Both FP and XP (R)	Calculate both R <sub>xp</sub> , R <sub>fp</sub>
For simple logic processors not implementing any of the specified arithmetic operations.	$\frac{1}{3 * t_{log}}$ <p>Where t<sub>log</sub> is the execute time of the XOR, or for logic hardware not implementing the XOR, the fastest simple logic operation. See Notes X &amp; Z</p>
For special logic processors not using any of the specified arithmetic or logic operations.	$R = R' * WL/64$ <p>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.</p>

---

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.

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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.

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TECHNICAL NOTE ON "CTP"

Step 3: "CTP" for aggregations of "CEs", including CPUs

For a CPU with a single "CE",

$$\text{"CTP"} = \text{TP}$$

(for "CEs" performing both fixed and floating point operations

$$\text{TP} = \max(\text{TP}_{\text{fp}}, \text{TP}_{\text{xp}})$$

"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.

$$\text{"CTP"} = \text{TP}_1 + C_2 * \text{TP}_2 + \dots + C_n * \text{TP}_n,$$

where the TPs are ordered by value, with TP<sub>1</sub> being the highest, TP<sub>2</sub> being the second highest, ..., and TP<sub>n</sub> being the lowest. C<sub>i</sub> is a coefficient determined by the strength of the interconnection between "CEs", as follows:

For multiple "CEs" operating simultaneously and sharing memory:

$$C_2 = C_3 = C_4 = \dots = C_n = 0.75$$

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  $C_i$ :

$$C_i = \frac{0.75}{\sqrt{m}} \quad (i = 2, \dots, n)$$

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:

$$\begin{aligned} C_i &= 0.75 * k_i & (i = 2, \dots, 32) \text{ (see Note below)} \\ &= 0.60 * k_i & (i = 33, \dots, 64) \\ &= 0.45 * k_i & (i = 65, \dots, 256) \\ &= 0.30 * k_i & (i > 256) \end{aligned}$$

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  $i^{\text{th}}$  "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"<sub>64</sub>, "CE"<sub>65</sub> and "CE"<sub>66</sub>. 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.:

$$TP_1 \geq TP_2 \geq \dots \geq TP_n, \text{ and}$$

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.



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

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

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

Abbreviations used in this Technical Note

n	number of processors in the "digital computer"
i	processor number (i,...n)
$t_i$	processor cycle time ( $t_i = 1/F_i$ )
$F_i$	processor frequency
$R_i$	peak floating point calculating rate
$W_i$	architecture adjustment factor

Outline of "APP " calculation method

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

Note In determining FPO, include only 64-bit or larger floating point additions and/or multiplications. All floating point operations must be expressed in operations per processor cycle; operations requiring multiple cycles may be expressed in fractional results per cycle. For processors not capable of performing calculations on floating point operands of 64-bits or more, the effective calculating rate R is zero.

2. Calculate the floating point rate R for each processor  $R_i = FPO_i/t_i$ .
3. Calculate "APP" as "APP" =  $W_1 \times R_1 + W_2 \times R_2 + \dots + W_n \times R_n$ .
4. For "vector processors",  $W_i = 0.9$ . For non-"vector processors",  $W_i = 0.3$ .

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

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

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

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

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

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

Note 6 "APP" values must be calculated for:

1. Processor combinations containing processors specially designed to enhance performance by aggregation, operating simultaneously and sharing memory; or
2. Multiple memory/processor combinations operating simultaneously utilizing specially designed hardware.

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

**CATEGORY 5 - 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;

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5A001 b. continued

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
  - 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 frequency range of 1.5 MHz or more but less than 30 MHz, or 250 W or more in the frequency range of 30 MHz or more but not exceeding 87.5 MHz, over an "instantaneous bandwidth" of one octave or more and with an output harmonic and distortion content of better than -80 dB;
3. Being radio equipment employing "spread spectrum" techniques, including "frequency hopping" techniques, not controlled in 5A001.b.4., 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 radio equipment employing ultra-wideband modulation techniques, having user programmable channelising codes, scrambling codes or network identification codes, having any of the following characteristics:
  - a. A bandwidth exceeding 500 MHz; or
  - b. A "fractional bandwidth" of 20% or more;
5. Being digitally controlled radio receivers having all of the following:
  - a. More than 1,000 channels;
  - b. A "frequency switching time" of less than 1 ms;
  - c. Automatic searching or scanning of a part of the electromagnetic spectrum; and
  - d. Identification of the received signals or the type of transmitter; or*Note: 5A001.b.5. does not control radio equipment specially designed for use with civil cellular radio-communications systems.*

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5A001 b. continued

6. Employing functions of digital "signal processing" to provide 'voice coding' output at rates of less than 2,400 bit/s.
- Technical Notes:*
1. For variable rate voice coding, 5A001.b.6. applies to the voice coding output of continuous speech.
  2. For the purposes of 5A001.b.6., 'voice coding' is defined as the technique to take samples of human voice and then convert these samples into a digital signal, taking into account specific characteristics of human speech.
- c. Optical 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  $2 \times 10^9$  N/m<sup>2</sup> 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.*
  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 31.8 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).
- e. Radio direction finding equipment operating at frequencies above 30 MHz and having all of the following characteristics, and specially designed components therefor:
1. "Instantaneous bandwidth" of 10 MHz or more; and
  2. Capable of finding a line of bearing (LOB) to non-cooperating radio transmitters with a signal duration of less than 1 ms.

5A001 continued

- f. Jamming equipment specially designed or modified to intentionally and selectively interfere with, deny, inhibit, degrade or seduce cellular mobile telecommunications services, having any of the following characteristics, and specially designed components therefor:
1. Simulating the functions of Radio Access Network (RAN) equipment;
  - or
  2. Detecting and exploiting specific characteristics of the mobile telecommunications protocol employed (e.g., GSM).

*N.B. For GNSS jamming equipment see ML11.b.*

5A101 Telemetering and telecontrol equipment, including ground equipment, designed or modified for 'missiles'.

Technical Note:

*In 5A101 'missile' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.*

Note: 5A101 does not control:

- a. Equipment designed or modified for manned aircraft or satellites;
- b. Ground based equipment designed or modified for terrestrial or marine applications;
- c. Equipment designed for commercial, civil or 'Safety of Life' (e.g. data integrity, flight safety) GNSS services;

**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.

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

1. Equipment employing digital techniques designed to operate at a "total digital transfer rate" exceeding 15 Gbit/s;

Technical Note:

*For switching equipment the "total digital transfer rate" is measured at the highest speed port or line.*

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";

4. Radio equipment employing quadrature-amplitude-modulation (QAM) techniques above level 256; or

5B001 b. continued

5.    Equipment employing "common channel signalling" operating in non-associated mode of operation.



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**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" specially designed or modified to provide characteristics, functions or features of equipment specified in 5A001 or 5B001;
  - d. "Software" specially designed or modified for the "development" of any of the following telecommunication transmission or switching equipment:
    1. Equipment employing digital techniques, including "Asynchronous Transfer Mode" ("ATM"), designed to operate at a "total digital transfer rate" exceeding 15 Gbit/s;  
*Technical Note:*  
*For switching equipment the "total digital transfer rate" is measured at the highest speed port or line.*
    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.
    3. Equipment employing "optical switching"; or
    4. Radio equipment employing quadrature-amplitude-modulation (QAM) techniques above level 256.
- 5D101 "Software" specially designed or modified for the "use" of equipment specified in 5A101.

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**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 base station receiving equipment whose reception capabilities that allow multi-band, multi-channel, multi-mode, multi-coding algorithm or multi-protocol operation can be modified by changes in "software";
    4. "Technology" for the "development" of "spread spectrum" techniques, including "frequency hopping" techniques.
  - c. "Technology" according to the General Technology Note for the "development" or "production" of any of the following telecommunication transmission or switching equipment, functions or features:
    1. Equipment employing digital techniques designed to operate at a "total digital transfer rate" exceeding 15 Gbit/s;  
*Technical Note:*  
*For switching equipment the "total digital transfer rate" is measured at the highest speed port or line.*
    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);
      - 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.

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5B001 b. continued

3. Equipment employing "optical switching";
4. Radio equipment having any of the following:
  - a. Quadrature-amplitude-modulation (QAM) techniques above level 256; or
  - b. Operating at input or output frequencies exceeding 31.8 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 frequency band which is "allocated by the ITU" for radio-communications services, but not for radio-determination.*
5. Equipment employing "common channel signalling" operating in non-associated mode of operation.

5E101 "Technology" according to the General Technology Note for the "development", "production" or "use" of equipment specified in 5A101.

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**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; 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.*

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.*

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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. Deleted;
4. Specially designed or modified to reduce the compromising emanations of information-bearing signals beyond what is necessary for health, safety or electromagnetic interference standards;
5. Designed or modified to use cryptographic techniques to generate the spreading code for "spread spectrum" systems, not controlled in 5A002.a.6., including the hopping code for "frequency hopping" systems;
6. Designed or modified to use cryptographic techniques to generate channelising codes, scrambling codes or network identification codes, for systems using ultra-wideband modulation techniques, having any of the following characteristics:
  - a. A bandwidth exceeding 500 MHz; or

5A002 a. 6. continued

- b. A "fractional bandwidth" of 20% or more.
- 7. Deleted;
- 8. Communications cable systems designed or modified using mechanical, electrical or electronic means to detect surreptitious intrusion;
- 9. Designed or modified to use "quantum cryptography".  
*Technical Note:*  
*"Quantum cryptography" is also known as quantum key distribution (QKD).*

Note: 5A002 does not control:

- a. *"Personalised smart cards":*
  - 1. *Where the cryptographic capability is restricted for use in equipment or systems excluded from control under entries b. to f. of this Note; or*
  - 2. *For general public-use applications where the cryptographic capability is not user-accessible and it is specially designed and limited to allow protection of personal data stored within.*

*N.B. 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 contents stored on 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;*
  - 3. *Copying control of copyright protected audio/video data; or*
  - 4. *Encryption and/or decryption for protection of libraries, design attributes, or associated data for the design of semiconductor devices or integrated circuits;*

5A002 a. continued

- 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 base station) 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;
- 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.

5D002 continued

- Note:*    *5D002 does not control:*
- a.    *"Software" required for the "use" of equipment excluded from control under the Note to 5A002;*
  - b.    *"Software" providing any of the functions of equipment excluded from control under the Note 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  $\pm 20^\circ$ , 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  $20^\circ$  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  $1.9^\circ$ ; 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  $\mu$ Pa 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  $\mu$ Pa at 1 m) for equipment with an operating frequency in the band between 24 kHz and 30 kHz;
  4. Forming beams of less than  $1^\circ$  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

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6A001 a. 1. continued

6. Designed to withstand pressure during normal operation at depths exceeding 1,000 m and having transducers with any of the following:
  - a. Dynamic compensation for pressure; or
  - b. Incorporating other than lead zirconate titanate as the transduction element;
- c. Acoustic projectors, including transducers, incorporating piezoelectric, magnetostrictive, electrostrictive, electrodynamic or hydraulic elements operating individually or in a designed combination, 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  $0.01 \text{ mW/mm}^2/\text{Hz}$  for devices operating at frequencies below 10 kHz;
  2. A continuously radiated 'acoustic power density' exceeding  $0.001 \text{ mW/mm}^2/\text{Hz}$  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.*

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6A001 continued

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

Technical Notes:

1. 'Piezoelectric polymer film' sensing elements consist of polarised polymer film that is stretched over and attached to a supporting frame or spool (mandrel).
2. 'Flexible piezoelectric composite' sensing elements consist of piezoelectric ceramic particles or fibres combined with an electrically insulating, acoustically transparent rubber, polymer or epoxy compound, where the compound is an integral part of the sensing elements.
3. 'Hydrophone sensitivity' is defined as twenty times the logarithm to the base 10 of the ratio of rms output voltage to a 1 V rms reference, when the hydrophone sensor, without a pre-amplifier, is placed in a plane wave acoustic field with an rms pressure of 1  $\mu$ Pa. For example, a hydrophone of -160 dB (reference 1 V per  $\mu$ Pa) 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.

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6A001 2. continued

- b. Towed acoustic hydrophone arrays having any of the following:
1. Hydrophone group spacing of less than 12.5 m or 'able to be modified' to have hydrophone group spacing of less than 12.5 m;
  2. Designed or 'able to be modified' to operate at depths exceeding 35 m;  
*Technical Note:*  
*'Able to be modified' in 6A001.a.2.b.1. and 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 beam forming using Fast Fourier or other transforms or processes;
- d. Heading sensors having all of the following:
1. An accuracy of better than  $\pm 0.5^\circ$ ; 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;

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6A001 2. continued

- 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 beam forming 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.

N.B.: Silicon and other material based microbolometer non "space-qualified" "focal plane arrays" are only specified in 6A002.a.3.f.

- 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;
- 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 12 µm or less; and
    - 3. Any of the following photocathodes:

6A002 a. 2. continued

- a. S-20, S-25 or multialkali photocathodes with a luminous sensitivity exceeding 350  $\mu\text{A}/\text{lm}$ ;
  - b. GaAs or GaInAs photocathodes; or
  - c. Other III-V compound semiconductor photocathodes;  
*Note:* 6A002.a.2.a.3.c. does not apply to 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 12  $\mu\text{m}$  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:

*N.B.:* Silicon and other material based microbolometer non "space-qualified" "focal plane arrays" are only specified in 6A002.a.3.f.

Technical Notes:

- 1. Linear or two-dimensional multi-element detector arrays are referred to as "focal plane arrays";
- 2. For the purposes of 6A002.a.3. 'cross scan direction' is defined as the axis parallel to the linear array of detector elements and the 'scan direction' is defined as the axis perpendicular to the linear array of detector elements.

*Note 1:* 6A002.a.3. includes photoconductive arrays and photovoltaic arrays.

*Note 2:* 6A002.a.3. does not control:

- a. Multi-element (not to exceed 16 elements) encapsulated photoconductive cells using either lead sulphide or lead selenide;
  - b. Pyroelectric detectors using any of the following:
    - 1. Triglycine sulphate and variants;
    - 2. Lead-lanthanum-zirconium titanate and variants;
    - 3. Lithium tantalate;
    - 4. Polyvinylidene fluoride and variants; or
    - 5. Strontium barium niobate and variants.
- a. Non-"space-qualified" "focal plane arrays", having all of the following:

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6A002 a. 2. continued

1. Individual elements with a peak response within the wavelength range exceeding 900 nm but not exceeding 1,050 nm; and
  2. A response "time constant" of less than 0.5 ns;
- b. 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" non-linear (2-dimensional) "focal plane arrays", having individual elements with a peak response in the wavelength range exceeding 1,200 nm but not exceeding 30,000 nm;
- N.B.: *Silicon and other material based microbolometer non "space-qualified" "focal plane arrays" are only specified in 6A.002.a.3.f.*
- d. Non-"space-qualified" linear (1-dimensional) "focal plane arrays", having all of the following:
1. Individual elements with a peak response in the wavelength range exceeding 1,200 nm but not exceeding 2,500 nm; and
  2. Any of the following:
    - a. A ratio of scan direction dimension of the detector element to the cross-scan direction dimension of the detector element of less than 3.8; or
    - b. Signal processing in the element (SPRITE);
- e. Non-"space-qualified" linear (1-dimensional) "focal plane arrays", having individual elements with a peak response in the wavelength range exceeding 2,500 nm but not exceeding 30,000 nm.
- f. Non-"space-qualified" non-linear (2-dimensional) infrared "focal plane arrays" based on 'micro-bolometer' material having individual elements with an unfiltered response in the wavelength range equal to or exceeding 8,000 nm but not exceeding 14,000 nm.

Technical Note:

*For the purposes of 6A002.a.3.f. 'micro-bolometer' is defined as a thermal imaging detector that, as a result of a temperature change in the detector caused by the absorption of infrared radiation, is used to generate any usable signal.*

- 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  $\mu$ rad (microradians); or

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6A002 b. continued

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.
  - 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.

- a. Instrumentation cameras and specially designed components therefor, as follows:

*Note:* Instrumentation cameras, specified in 6A003.a.3. to 6A003.a.5., with modular structures should be evaluated by their maximum capability, using plug-ins available according to the camera manufacturer's specifications.

1. High-speed cinema recording cameras using any film format from 8 mm to 16 mm inclusive, in which the film is continuously advanced throughout the recording period, and that are capable of recording at framing rates exceeding 13,150 frames/s;  
*Note:* 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/ $\mu$ s;
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  $\mu$ s per full frame; and
  - b. A read out time allowing a framing rate of more than 125 full frames per second.
6. Plug-ins, having all of the following characteristics:
  - a. Specially designed for instrumentation cameras which have modular structures and which are specified in 6A003.a.; and
  - b. Enabling these cameras to meet the characteristics specified in 6A003.a.3., 6A003.a.4., or 6A003.a.5., according to the manufacturer's specifications.

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6A003 continued

## 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 a peak response in the wavelength range exceeding 10 nm, but not exceeding 30,000 nm and having all of the following:
  - a. Having any of the following:
    1. More than  $4 \times 10^6$  "active pixels" per solid state array for monochrome (black and white) cameras;
    2. More than  $4 \times 10^6$  "active pixels" per solid state array for colour cameras incorporating three solid state arrays; or
    3. More than  $12 \times 10^6$  "active pixels" for solid state array colour cameras incorporating one solid state array; and
  - b. Having any of the following:
    1. Optical mirrors controlled by 6A004.a.;
    2. Optical control equipment controlled by 6A004.d.; or
    3. The capability for annotating internally generated camera tracking data.

Technical Notes:

1. *For the purpose of this entry, digital video cameras should be evaluated by the maximum number of "active pixels" used for capturing moving images.*
  2. *For the purpose of this entry, camera tracking data is the information necessary to define camera line of sight orientation with respect to the earth. This includes: 1) the horizontal angle the camera line of sight makes with respect to the earth's magnetic field direction and; 2) the vertical angle between the camera line of sight and the earth's horizon.*
2. Scanning cameras and scanning camera systems, having all of the following:
    - a. A peak response in the wavelength range exceeding 10 nm, but not exceeding 30,000 nm;
    - b. Linear detector arrays with more than 8,192 elements per array; and
    - c. Mechanical scanning in one direction;
  3. Imaging cameras incorporating image intensifier tubes specified in 6A002.a.2.a.;
  4. 'Imaging cameras' incorporating "focal plane arrays" having any of the following:
    - a. Incorporating "focal plane arrays" controlled by 6A002.a.3.a. to 6A002.a.3.e.; or

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6A003 b. 4. continued

- b. Incorporating "focal plane arrays" controlled by 6A002.a.3.f.

Note 1: *'Imaging cameras' described in 6A003.b.4 include "focal plane arrays" combined with sufficient signal processing electronics, beyond the read out integrated circuit, to enable as a minimum the output of an analogue or digital signal once power is supplied.*

Note 2: *6A003.b.4.a. 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.*

Note 3: *6A003.b.4.b. does not control imaging cameras having any of the following characteristics:*

- a. A maximum frame rate equal to or less than 9 Hz;*
- b. Having all of the following:*
  - 1. Having a minimum horizontal or vertical Instantaneous-Field-of-View (IFOV) of at least 10 mrad/pixel (milliradians/pixel);*
  - 2. Incorporating a fixed focal-length lens that is not designed to be removed;*
  - 3. Not incorporating a 'direct view' display; and*
  - 4. Having any of the following:*
    - a. No facility to obtain a viewable image of the detected field-of-view, or*
    - b. The camera is designed for a single kind of application and designed not to be user modified; or*
- c. Where the camera is specially designed for installation into a civilian passenger land vehicle of less than three tonnes (gross vehicle weight) and having all of the following:*
  - 1. Is only operable when installed in any of the following:*
    - a. The civilian passenger land vehicle for which it was intended; or*
    - b. A specially designed, authorized maintenance test facility; and*

6A003 b. continued

2. *Incorporates an active mechanism that forces the camera not to function when it is removed from the vehicle for which it was intended.*

Technical Notes:

1. *Instantaneous Field of View (IFOV) specified in 6A003.b.4. Note 3.b. is the lesser figure of the Horizontal IFOV or the Vertical IFOV.  
Horizontal IFOV = horizontal Field of View (FOV) / number of horizontal detector elements  
Vertical IFOV = vertical Field of View (FOV) / number of vertical detector elements.*
2. *'Direct view' in 6A003.b.4. Note 3.b. refers to an imaging camera operating in the infrared spectrum that presents a visual image to a human observer using a near-to-eye micro display incorporating any light-security mechanism.*

## 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  $30 \text{ kg/m}^2$  and a total mass exceeding 10 kg;
  3. Lightweight "composite" or foam mirror structures having an average "equivalent density" of less than  $30 \text{ kg/m}^2$  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  $100 \text{ cm}^3$  in volume; or
  2. Exceeding 80 mm in diameter or length of major axis and 20 mm in thickness (depth).
- c. "Space-qualified" components for optical systems, as follows:
  1. Lightweighted to less than 20% "equivalent density" compared with a solid blank of the same aperture and thickness;

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6A004 c. continued

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  $5 \times 10^{-6}$  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  $\mu$ rad (microradians) or less;
  3. Gimbals having all of the following:
    - a. A maximum slew exceeding  $5^\circ$ ;
    - b. A bandwidth of 100 Hz or more;
    - c. Angular pointing errors of 200  $\mu$ rad (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<sup>2</sup>; or
      2. Exceeding 1 m in diameter or major axis length and capable of angular accelerations exceeding 0.5 rad (radians)/s<sup>2</sup>;
  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  $3 \times 10^{-6}/K$  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. 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 *6A004.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  $2.5 \times 10^{-6}$  /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", not controlled 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 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 output power exceeding 120 W;

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6A005 a. continued

- 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 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 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 output power exceeding 20 W;
  - b. Gold (Au) "lasers" having an average output power exceeding 5 W;
  - c. Sodium (Na) "lasers" having an output power exceeding 5 W;
  - d. Barium (Ba) "lasers" having an average output power exceeding 2 W;
- 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<sub>2</sub>) "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<sub>2</sub>-I) "lasers";
    - 2. Deuterium Fluoride-Carbon dioxide (DF-CO<sub>2</sub>) "lasers";

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6A005 a. continued

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.
- b. Semiconductor "lasers", as follows:
    1. Individual single-transverse mode semiconductor "lasers", having any of the following:
      - a. A wavelength equal to or less than 1,510 nm, and having an average or CW output power exceeding 1.5 W; or
      - b. A wavelength greater than 1,510 nm, and having an average or CW output power exceeding 500 mW;
    2. Individual, multiple-transverse mode semiconductor "lasers", having any of the following:
      - a. A wavelength of less than 1,400 nm, and having an average or CW output power exceeding 10 W;
      - b. A wavelength equal to or greater than 1,400 nm and less than 1,900 nm, and having an average or CW output power exceeding 2.5 W; or
      - c. A wavelength equal to or greater than 1,900 nm and having an average or CW output power exceeding 1 W.
    3. Individual semiconductor "laser" arrays, having any of the following:
      - a. A wavelength of less than 1,400 nm, and having an average or CW output power exceeding 80 W;



6A005 b. 3. continued

- b. A wavelength equal to or greater than 1,400 nm and less than 1,900 nm, and having an average or CW output power exceeding 25 W; or
  - c. A wavelength equal to or greater than 1,900 nm, and having an average or CW output power exceeding 10 W.
4. Array stacks of semiconductor "lasers" containing at least one array that is controlled under 6A005.b.3.

Technical Notes:

- 1. Semiconductor "lasers" are commonly called "laser" diodes.
- 2. An 'array' consists of multiple semiconductor "laser" emitters fabricated as a single chip so that the centres of the emitted light beams are on parallel paths.
- 3. An 'array stack' is fabricated by stacking, or otherwise assembling, 'arrays' so that the centres of the emitted light beams are on parallel paths.

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;

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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

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6A005 c. 3. continued

2. An average power exceeding 2 kW;
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;

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6A005 continued

- d. Dye and other liquid "lasers", having any of the following:
1. A wavelength less than 150 nm and
    - a. An output energy exceeding 50 mJ per pulse and a pulsed "peak power" exceeding 1 W; or
    - b. An average or CW output power exceeding 1 W;
  2. A wavelength of 150 nm or more but not exceeding 800 nm and 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 ML19.a.*
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

6A005 f. 1. continued

- 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  $\mu$ rad;
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  $\mu$ m, whichever is the smaller;
4. Projection telescopes specially designed for use with "SHPL" systems.

6A006 "Magnetometers", "magnetic gradiometers", "intrinsic magnetic gradiometers", underwater electric field sensors and compensation systems, and specially designed components therefor, as follows:

*Note:* 6A006 does not control instruments specially designed for fishery applications or biomagnetic measurements for medical diagnostics.

- a. "Magnetometers" and subsystems as follows:
  1. Using "superconductive" (SQUID) "technology" and having any of the following characteristics:
    - a. SQUID systems designed for stationary operation, without specially designed subsystems designed to reduce in-motion noise, and having a "noise level" (sensitivity) equal to or lower (better) than 50 fT (rms) per square root Hz at a frequency of 1 Hz; or
    - b. SQUID systems having an in-motion-magnetometer "noise level" (sensitivity) lower (better) than 20 pT (rms) per square root Hz at a frequency of 1 Hz and specially designed to reduce in-motion noise;
  2. Using optically pumped or nuclear precession (proton/Overhauser) "technology" having a "noise level" (sensitivity) lower (better) than 20 pT (rms) per square root Hz;
  3. Using fluxgate "technology" having a "noise level" (sensitivity) equal to or lower (better) than 10 pT (rms) per square root Hz at a frequency of 1 Hz;
  4. Induction coil "magnetometers" having a "noise level" (sensitivity) lower (better) than any of the following:
    - a. 0.05 nT (rms) per square root Hz at frequencies of less than 1 Hz;
    - b.  $1 \times 10^{-3}$  nT (rms) per square root Hz at frequencies of 1 Hz or more but not exceeding 10 Hz; or

6A006 a. 4. continued

- c.  $1 \times 10^{-4}$  nT (rms) per square root Hz at frequencies exceeding 10 Hz;
- 5. Fibre optic "magnetometers" having a "noise level" (sensitivity) lower (better) than 1 nT (rms) per square root Hz;
- b. Underwater electric field sensors having a "noise level" (sensitivity) lower (better) than 8 nanovolt per metre per square root Hz when measured at 1 Hz;
- c. "Magnetic gradiometers", as follows:
  - 1. "Magnetic gradiometers" using multiple "magnetometers" specified in 6A006.a.;
  - 2. 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;
  - 3. "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;
- d. Compensation systems for magnetic or underwater electric field sensors resulting in a performance equal to or better than the control parameters of 6A006.a., 6A006.b. or 6A006.c.

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  $\pm 6.25\%$  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;

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;

6A008 i. continued

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', not controlled 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  $5 \times 10^5$  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. This includes devices that sense by one time operation or failure.*



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- 6A107 Gravity meters (gravimeters) and components for gravity meters and gravity gradiometers, as follows:
- a. Gravity meters, not controlled in 6A007.b, designed or modified for airborne or marine use, and having a static or operational accuracy of  $7 \times 10^{-6}$  m/s<sup>2</sup> (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, not controlled 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;  
*Note:* 6A108.a. includes the following:
    - a. Terrain contour mapping equipment;
    - b. Imaging sensor equipment;
    - c. Scene mapping and correlation (both digital and analogue) equipment;
    - d. Doppler navigation radar equipment.
  - 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.*Technical Note:*  
*In 6A108.b. 'missile' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.*
- 6A202 Photomultiplier tubes having both of the following characteristics:
- a. Photocathode area of greater than 20 cm<sup>2</sup>; and
  - b. Anode pulse rise time of less than 1 ns.
- 6A203 Cameras and components, not controlled 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;

6A203 a. continued

*Note:* In 6A203.a. components of such cameras include their synchronizing electronics units and rotor assemblies consisting of turbines, mirrors and bearings.

- 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  $50 \times 10^3$  Gy (silicon) ( $5 \times 10^6$  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, not controlled 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;

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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  $\pm 0.1\%$  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, not controlled 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 (including epitaxial wafers) of any of the following:
  1. Cadmium zinc telluride (CdZnTe), with zinc content of less than 6% by 'mole fraction';
  2. Cadmium telluride (CdTe) of any purity level; or
  3. Mercury cadmium telluride (HgCdTe) of any purity level.

*Technical Note:*

*'Mole fraction' is defined as the ratio of moles of ZnTe to the sum of moles of CdTe and ZnTe present in the crystal.*

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<sup>3</sup>; 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<sub>2</sub>);
  3. Thallium arsenic selenide (Tl<sub>3</sub>AsSe<sub>3</sub>, also known as TAS);
- c. Non-linear optical materials, having all of the following:
  1. Third order susceptibility ( $\chi_3$ ) of  $10^{-6} \text{ m}^2/\text{V}^2$  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;

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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  $5 \times 10^{-6}$ ;
- f. Synthetically produced diamond material with an absorption of less than  $10^{-5} \text{ cm}^{-1}$  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 and electric field compensation systems for magnetic and electric field sensors designed to operate on mobile platforms;
- 2. "Software" specially designed for magnetic and electric field 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 "programs" 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'.

Technical Note:

*In 6D103 'missile' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.*

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**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  $5 \times 10^{-3}$ ;  
*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  $0.5 \text{ m}^2$ ;
  - 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;
- 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.:* For automatic pilots for underwater vehicles, see Category 8.  
For radar, see Category 6.

7A001 Linear 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. For angular or rotational accelerometers, see 7A002.

- 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, and angular or rotational accelerometers, 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 one month 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 12 g; or
  2. Less (better) than 0.5° per hour when specified to function at linear acceleration levels from 12 g to 100 g inclusive; or

- b. An angle random walk of less (better) than or equal to 0.0035° per square root hour; or

*Note:* 7A002.b. does not control spinning mass gyros (spinning mass gyros are gyros which use a continually rotating mass to sense angular motion).

*Technical Note:*

For the purposes of 7A002.b., 'angle random walk' is the angular error buildup with time that is due to white noise in angular rate. (IEEE STD 528-2001)

- c. Specified to function at linear acceleration levels exceeding 100 g.



7A003 Inertial Systems and specially designed components, as follows:

**N.B.: SEE ALSO 7A103.**

- a. Inertial navigation systems (INS) (gimballed or strapdown) and inertial equipment designed for "aircraft", land vehicle, vessels (surface or underwater) or "spacecraft" for attitude, guidance or control, having any of the following characteristics, and specially designed components therefor:
  1. Navigation error (free inertial) subsequent to normal alignment of 0.8 nautical mile per hour (nm/hr) 'Circular Error Probable' (CEP) or less (better); or
  2. Specified to function at linear acceleration levels exceeding 10 g;
- b. Hybrid Inertial Navigation Systems embedded with Global Navigation Satellite System(s) (GNSS) or with "Data-Based Referenced Navigation" ("DBRN") System(s) for attitude, guidance or control, subsequent to normal alignment, having an INS navigation position accuracy, after loss of GNSS or "DBRN" for a period of up to four minutes, of less (better) than 10 metres 'Circular Error Probable' (CEP).
- c. Inertial Equipment for Azimuth, Heading, or North Pointing having any of the following characteristics, and specially designed components therefor:
  1. Designed to have an Azimuth, Heading, or North Pointing accuracy equal to, or less (better) than 6 arc minutes RMS at 45 degrees latitude; or
  2. Designed to have a non-operating shock level of 900 g or greater at a duration of 1 msec, or greater.

Note 1: *The parameters of 7A003.a. and 7A003.b. 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:*
  - a. *A constant power spectral density (PSD) value of 0.04 g<sup>2</sup>/Hz over a frequency interval of 15 to 1,000 Hz; and*
  - b. *The PSD attenuates with frequency from 0.04 g<sup>2</sup>/Hz to 0.01 g<sup>2</sup>/Hz over a frequency interval from 1,000 to 2,000 Hz;*
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".*

Note 3: *7A003.c.1. does not control theodolite systems incorporating inertial equipment specially designed for civil surveying purposes.*

7A003 continued

Technical Notes:

1. *7A003.b. refers to systems in which an INS and other independent navigation aids are built into a single unit (embedded) in order to achieve improved performance.*
2. *'Circular Error Probable' (CEP) – In a circular normal distribution, the radius of the circle containing 50 percent of the individual measurements being made, or the radius of the circle within which there is a 50 percent probability of being located.*

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, not controlled in 7A001, as follows, and specially designed components therefor:

- a. Linear accelerometers, designed for use in inertial navigation systems or in guidance systems of all types, usable in 'missiles', having all the following characteristics, and specially designed components therefor;
  1. A "bias" 'repeatability' of less (better) than 1250 micro g; and

7A101 a. continued

2. A "scale factor" 'repeatability' of less (better) than 1250 ppm;

Note: 7A101.a. does not specify accelerometers which are specially designed and developed as MWD (Measurement While Drilling) Sensors for use in downhole well service operations.

Technical Notes:

1. In 7A101.a. 'missile' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km;
2. In 7A101.a. the measurement of "bias" and "scale factor" refers to a one sigma standard deviation with respect to a fixed calibration over a period of one year;
3. In 7A101.a. 'repeatability' is defined according to IEEE standard 528-2001 as the closeness of agreement among repeated measurements of the same variable under the same operating conditions when changes in conditions or non-operating periods occur between measurements.

b. Continuous output accelerometers specified to function at acceleration levels exceeding 100g.

7A102 All types of gyros, not controlled 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.

Technical Note:

In 7A102 'missile' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.

7A103 Instrumentation, navigation equipment and systems, not controlled in 7A003, as follows; and specially designed components therefor:

a. Inertial or other equipment using accelerometers specified in 7A001 or 7A101 or gyros specified in 7A002 or 7A102 and systems incorporating such equipment;

Note: 7A103.a. does not specify equipment containing accelerometers specified in 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, unmanned aerial vehicles specified in 9A012 or sounding rockets specified in 9A104;

c. 'Integrated navigation systems', designed or modified for 'missiles' and capable of providing a navigational accuracy of 200m Circle of Equal Probability (CEP) or less.

Technical Notes:

1. An 'integrated navigation system' typically incorporates the following components:

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7A103 c. continued

- a. *An inertial measurement device (e.g., an attitude and heading reference system, inertial reference unit, or inertial navigation system);*
  - b. *One or more external sensors used to update the position and/or velocity, either periodically or continuously throughout the flight (e.g., satellite navigation receiver, radar altimeter, and/or Doppler radar); and*
  - c. *Integration hardware and software;*
2. *In 7A103.c. 'missile' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.*

7A104 Gyro-astro compasses and other devices, not controlled in 7A004, which derive position or orientation by means of automatically tracking celestial bodies or satellites and specially designed components therefor.

7A105 Receiving equipment for Global Navigation Satellite Systems (GNSS; e.g. GPS, GLONASS, or Galileo), having any of the following characteristics, and specially designed components therefor:

- a. Designed or modified for use in space launch vehicles specified in 9A004, unmanned aerial vehicles specified in 9A012 or sounding rockets specified in 9A104; or
- b. Designed or modified for airborne applications and having any of the following:
  1. Capable of providing navigation information at speeds in excess of 600 m/s (1,165 nautical miles/hour);
  2. Employing decryption, designed or modified for military or governmental services, to gain access to GNSS secured signal/data; or
  3. Being specially designed to employ anti-jam features (e.g. null steering antenna or electronically steerable antenna) to function in an environment of active or passive countermeasures.

Note: *7A105.b.2. and 7A105.b.3. do not control equipment designed for commercial, civil or 'Safety of Life' (e.g., data integrity, flight safety) GNSS services.*

7A106 Altimeters, not controlled 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 and servo valves, 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;
- c. Flight control servo valves designed or modified for the systems specified in 7A116.a. or 7A116.b., and designed or modified to operate in a vibration environment greater than 10 g rms between 20 Hz and 2 kHz.

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.*

7B001 continued

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 "Production facilities" and "production equipment" as follows:

- a. "Production facilities" specially designed for equipment specified in 7A117;
- b. Production equipment, and other test, calibration and alignment equipment, other than that specified in 7B001 to 7B003, designed or modified to be used with equipment specified in 7A.

**7C Materials**

None.

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**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:
  1. Doppler radar velocity data;
  2. Global navigation satellite systems (i.e., GPS or GLONASS) reference data; or
  3. Data from "Data-Based Referenced Navigation" ("DBRN") systems;
- c. "Source code" for integrated avionics or mission systems which combine sensor data and employ "expert systems";
- d. "Source code" for the "development" of any of the following:
  1. Digital flight management systems for "total control of flight";
  2. Integrated propulsion and flight control systems;
  3. Fly-by-wire or fly-by-light control systems;
  4. Fault-tolerant or self-reconfiguring "active flight control systems";
  5. Airborne automatic direction finding equipment;
  6. Air data systems based on surface static data; or
  7. Raster-type head-up displays or three dimensional displays;

7D003 continued

- 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.;
- c. Integration "software" designed or modified for the equipment specified in 7A103.c.

Note: *A common form of integration "software" employs Kalman filtering.*

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.



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- 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.

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<b>CATEGORY 8 - MARINE</b>
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**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

8A001 d. continued

3. Having a fibre optic data or command link exceeding 1,000 m;
- e. Ocean salvage systems with a lifting capacity exceeding 5 MN for salvaging objects from depths exceeding 250 m and having 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  $2 \times (\text{displaced volume at the operational design draught})^{2/3}$ .*

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;

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8A002 a. continued

3. Umbilical cables, and connectors therefor, using optical fibre and having synthetic strength members;
- b. Systems specially designed or modified for the automated control of the motion of 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;

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8A002 continued

- f. Electronic imaging systems, specially designed or modified for underwater use, capable of storing digitally more than 50 exposed images;  
*Note:* 8A002.f. does not control digital cameras specially designed for consumer purposes, other than those employing electronic image multiplication techniques.
- 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;
- h. "Robots" specially designed for underwater use, controlled by using a dedicated 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 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 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

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8A002 j. continued

- d. Systems specially designed:
  1. To pressurise the products of reaction or for fuel reformation;
  2. To store the products of the reaction; and
  3. To discharge the products of the reaction against a pressure of 100 kPa or more;
2. Diesel cycle engine air independent systems, having all of the following:
  - a. Chemical scrubber or absorber systems specially designed to remove carbon dioxide, carbon monoxide and particulates from recirculated engine exhaust;
  - b. Systems specially designed to use a monoatomic gas;
  - c. Devices or enclosures specially designed for underwater noise reduction in frequencies below 10 kHz or special mounting devices for shock mitigation; and
  - d. Specially designed exhaust systems that do not exhaust continuously the products of combustion;
3. Fuel cell air independent power systems with an output exceeding 2 kW having 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.;

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8A002 continued

- 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;
  - 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;



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8A002 o. continued

- 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  $\mu$ Pa, 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<sup>3</sup>.

*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.

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<b>CATEGORY 9 - PROPULSION SYSTEMS, SPACE VEHICLES AND RELATED EQUIPMENT</b>
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**9A Systems, Equipment and Components**

*N.B.:* For propulsion systems designed or rated against neutron or transient ionizing radiation, see ML12.

9A001 Aero gas turbine engines having any of the following:

**N.B.:** SEE ALSO 9A101.

- a. Incorporating any of the "technologies" specified in 9E003.a.; or  
*Note:* 9A001.a. does not control aero gas turbine engines which meet all of the following:
- a. Certified by the civil aviation authority in a "participating state"; and
  - b. Intended to power non-military manned aircraft for which one of the following has been issued by a "participating state" for the aircraft with this specific engine type:
    1. A civil Type Certificate; or
    2. An equivalent document recognized by the International Civil Aviation Organisation (ICAO).
- b. Designed to power an aircraft to cruise at Mach 1 or higher 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, 9A108 and 9A120.

- 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  $1.14 \times 10^{-3} \text{ cm}^2$  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  $1.4 \text{ g/cm}^3$  and tensile strengths exceeding 48 MPa.

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- 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  $\pm 5^\circ$ ;
    2. Angular vector rotations of  $20^\circ/\text{s}$  or more; or
    3. Angular vector accelerations of  $40^\circ/\text{s}^2$  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.**
- 9A012 "Unmanned aerial vehicles" ("UAVs"), associated systems, equipment and components as follows:
- a. "UAVs" having any of the following:
    1. An autonomous flight control and navigation capability (e.g., an autopilot with an Inertial Navigation System); or
    2. Capability of controlled-flight out of the direct vision range involving a human operator (e.g., televisual remote control).
  - b. Associated systems, equipment and components as follows:
    1. Equipment specially designed for remotely controlling the "UAVs" specified in 9A012.a.;
    2. Guidance or control systems, not controlled in 7A, specially designed for integration into "UAVs" specified in 9A012.a.;
    3. Equipment and components specially designed to convert a manned "aircraft" to a "UAV" specified in 9A012.a.

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- 9A101 Lightweight turbojet and turbofan engines (including turbocompound engines), not controlled in 9A001, as follows:
- a. Engines having both of the following characteristics:
    1. Maximum thrust value greater than 400 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 0.15 kg/N/hr or less (at maximum continuous power at sea level static and standard conditions);
  - 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", not controlled in 9A005, having a total impulse capacity equal to or greater than 1.1 MNs;
  - b. Liquid propellant rocket engines, usable in complete rocket systems or unmanned aerial vehicles, capable of a range of 300 km, not controlled in 9A005 or 9A105.a., having a total impulse capacity equal to or greater than of 0.841 MNs.
- 9A106 Systems or components, not controlled 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 greater than 10 g rms between 20 Hz and 2 kHz.

Note: *The only servo valves and pumps specified in 9A106.d., are the following:*

- a. *Servo valves designed for flow rates equal to or greater than 24 litres per minute, at an absolute pressure equal to or greater than 7 MPa, 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 aerial vehicles, capable of a range of 300 km, not controlled in 9A007, having total impulse capacity equal to or greater than 0.841 MNs.

**N.B.: SEE ALSO 9A119.**

9A108 Components, not controlled in 9A008, usable in "missiles", as follows, specially designed for solid rocket propulsion systems:

- a. Rocket motor cases and "insulation" components 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', not controlled in 9A009, and specially designed components therefor.

**N.B.: SEE ALSO 9A119.**

Technical Note:

*In 9A109 'missile' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.*



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- 9A110 Composite structures, laminates and manufactures thereof, not controlled 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 as follows:
- a. Apparatus and devices for handling, control, activation or launching, designed or modified for space launch vehicles specified in 9A004, unmanned aerial vehicles specified in 9A012 or sounding rockets specified in 9A104;
  - b. Vehicles for transport, handling, control, activation or launching, designed or modified for space launch vehicles specified in 9A004 or sounding rockets specified in 9A104.
- 9A116 Reentry vehicles, usable in "missiles", and equipment designed or modified therefor, as follows:
- a. Reentry vehicles;
  - c. 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 aerial vehicles, capable of a range of 300 km, not controlled in 9A005, 9A007, 9A009, 9A105, 9A107 and 9A109.

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9A120 Liquid propellant tanks, not controlled in 9A006, specially designed for propellants specified in 1C111 or 'other liquid propellants', used in rocket systems capable of delivering at least a 500 kg payload to a range of at least 300 km.

*Note:* In 9A120 'other liquid propellants' includes, but is not limited to, propellants specified in ML8.b.

9A350 Spraying or fogging systems, specially designed or modified for fitting to aircraft, "lighter-than-air vehicles" or unmanned aerial vehicles, and specially designed components therefor, as follows:

- a. Complete spraying or fogging systems capable of delivering, from a liquid suspension, an initial droplet 'VMD' of less than 50 µm at a flow rate of greater than two litres per minute;
- b. Spray booms or arrays of aerosol generating units capable of delivering, from a liquid suspension, an initial droplet 'VMD' of less than 50 µm at a flow rate of greater than two litres per minute;
- c. Aerosol generating units specially designed for fitting to systems specified in 9A350.a. and b.

*Note:* Aerosol generating units are devices specially designed or modified for fitting to aircraft such as nozzles, rotary drum atomizers and similar devices.

*Note:* 9A350 does not control spraying of fogging systems and components that are demonstrated not to be capable of delivering biological agents in the form of infectious aerosols.

*Technical Notes:*

1. Droplet size for spray equipment or nozzles specially designed for use on aircraft, "lighter-than-air vehicles" or unmanned aerial vehicles should be measured using either of the following:
  - a. Doppler laser method;
  - b. Forward laser diffraction method.
2. In 9A350 'VMD' means Volume Median Diameter and for water-based systems this equates to Mass Median Diameter (MMD).

**9B Test, Inspection and Production Equipment**

9B001 Specially designed equipment, tooling and fixtures, as follows, for manufacturing gas turbine blades, vanes or tip shroud castings:

- a. Directional solidification or single crystal casting equipment;
- b. Ceramic cores or shells;

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- 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  $25 \times 10^6$ .
- 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.

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- 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.
- 9B010 Equipment specially designed for the production of "UAVs" and associated systems, equipment and components specified in 9A012.
- 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 equal to or greater than 10 g rms, measured 'bare table', between 20 Hz and 2 kHz imparting forces equal to or greater than 5 kN; and
    2. Altitude equal to or greater than 15 km; or
    3. Temperature range of at least 223 K (-50°C) to 398 K (+ 125°C);

*Technical Notes:*

    1. *9B106.a. describes systems that are capable of generating a vibration environment with a single wave (e.g., a sine wave) and systems capable of generating a broad band random vibration (i.e., power spectrum);*
    2. *In 9B106.a.1. 'bare table' means a flat table, or surface with no fixture or fittings.*
  - b. Environmental 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 total rated acoustic power output of 4 kW or greater; and
    2. Altitude equal to or greater than 15 km; 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

- 9C108 "Insulation" material in bulk form and "interior lining", not controlled in 9A008, for rocket motor cases usable in "missiles" or specially designed for 'missiles'.

*Technical Note:*

*In 9C108 'missile' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.*

- 9C110 Resin impregnated fibre preregs 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  $7.62 \times 10^4$  m and a "specific modulus" greater than  $3.18 \times 10^6$  m.

**N.B.: SEE ALSO 1C010 and 1C210.**

*Note: The only resin impregnated fibre preregs 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 9A001 to 9A119, 9B or 9E003.
- 9D002 "Software" specially designed or modified for the "production" of equipment specified in 9A001 to 9A119 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.*
  - e. "Software" specially designed or modified for the "use" of "UAVs" and associated systems, equipment and components specified by 9A012.
- 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 9A012, 9A350, 9B or 9D.

9E002 "Technology" according to the General Technology Note for the "production" of equipment specified in 9A001.c., 9A004 to 9A011, 9A350 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;

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9E003 continued

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 specified in 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. Hollow fan blades.
- 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°;



9E003 c. continuedTechnical 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 the "development" or "production" of helicopter power transfer systems or tilt rotor or tilt wing "aircraft" power transfer systems;
- e. "Technology" for the "development" or "production" of reciprocating diesel engine ground vehicle propulsion systems having all of the following:
  1. A 'box volume' of 1.2 m<sup>3</sup> or less;
  2. An overall power output of more than 750 kW based on 80/1269/EEC, ISO 2534 or national equivalents; and
  3. A power density of more than 700 kW/m<sup>3</sup> of 'box volume';

Technical Note:

*'Box volume' in 9E003.e. 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.*

- f. "Technology" "required" for the "production" of specially designed components, as follows, for high output diesel engines:
  1. "Technology" "required" for the "production" of engine systems having all of the following components employing ceramics materials specified in 1C007:
    - a. Cylinder liners;
    - b. Pistons;
    - c. Cylinder heads; and
    - d. One or more other components (including exhaust ports, turbochargers, valve guides, valve assemblies or insulated fuel injectors);
  2. "Technology" "required" for the "production" of turbocharger systems, with single-stage compressors having all of the following:
    - a. Operating at pressure ratios of 4:1 or higher;
    - b. A mass flow in the range from 30 to 130 kg per minute; and

9E003 f. continued

- c. Variable flow area capability within the compressor or turbine sections;
- 3. "Technology" "required" for the "production" of fuel injection systems with a specially designed multifuel (e.g., diesel or jet fuel) capability covering a viscosity range from diesel fuel (2.5 cSt at 310.8 K (37.8°C)) down to gasoline fuel (0.5 cSt at 310.8 K (37.8°C)), having both of the following:
  - a. Injection amount in excess of 230 mm<sup>3</sup> per injection per cylinder; and
  - b. 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;
- g. "Technology" "required" for the "development" or "production" of high output diesel engines for solid, gas phase or liquid film (or combinations thereof) cylinder wall lubrication, 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.

<b>SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES</b>
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*Note* This List contains a sub-set of the Items controlled in Categories 1 to 9 of the Part 2 List of Dual-Use Goods and Technologies. The items in this List are considered to be sensitive, requiring additional care in their transfer. General Export Licences are generally not available for the export of the following sensitive goods.

*N.B.* Where abbreviated entries are used, see Part 2 for full details. Text that differs from that in Part 2 is in **bold type**.

Category 1

1A002	"Composite" structures or laminates...
1C001	Materials specially designed for use as absorbers of electromagnetic waves, or intrinsically conductive polymers. NB : SEE ALSO 1C101
1C007.c. & 1C007.d. 1C010.c. & 1C010.d. 1C012	Ceramic-ceramic "composite" materials... Fibrous or filamentary materials... Materials as follows...
1C101	Materials or devices for reduced observables such as radar reflectivity, ultraviolet/infrared signatures and acoustic signatures; not controlled in 1C001, usable in 'missiles', "missile" subsystems or "unmanned aerial vehicles" specified in 9A012.
1C239	High explosives, not controlled in the Munitions List, or substances or mixtures containing more than 2% thereof, with a crystal density greater than 1.8 gm per cm <sup>3</sup> and having a detonation velocity greater than 8000 m/s.
1D002	"Software" for the "development" of organic "matrix", metal "matrix" or carbon "matrix" laminates or "composites" <b>listed in this List.</b>
1D103	"Software" specially designed for analysis of reduced observables such as radar reflectivity, ultraviolet/infrared signatures and acoustic signatures.
1E001	"Technology" according to the General Technology Note for the "development" or "production" of equipment and materials in <b>1A002 or 1C of this List.</b>
1E002.e. & 1E002.f. 1E101	Other "technology"... "Technology" according to the GTN for the "use" of goods specified in 1C101 or 1D103.

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1E102 "Technology" according to the GTN for the "development" of "software" specified in 1D103.

1E201 "Technology" according to the General Technology Note for the "use" of goods specified in 1C239.

Category 2

2B001.a. Deleted

2B001.b. Deleted

2B001.d. Deleted

2B001.f. Deleted

2B003 Deleted

2D001 **"Software", other than that controlled by 2D002, specially designed for the "development" or "production" of the following equipment:**

- a. Machine tools for turning, having all of the following characteristics:
  1. Positioning accuracy with "all compensations available" equal to or less (better) than **3.6 µm** according to ISO 230/2 (1997) or national equivalents along any linear axis; and
  2. Two or more axes which can be coordinated simultaneously for "contouring control".
- 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 **3.6 µm** according to ISO 230/2 (1997) or national equivalents along any linear axis; and
  - b. Three linear axes plus one rotary axis which can be coordinated simultaneously for "contouring control";
  2. Five or more axes which can be coordinated simultaneously for "contouring control" **and have a positioning accuracy with "all compensations available" equal to or less (better) than 3.6 µm according to ISO 230/2 (1997) or national equivalents along any linear axis; or**
  3. A positioning accuracy for jig boring machines, with "all compensations available", equal to or less (better) than 3 µm according to ISO 230/2 (1997) or national equivalents along any linear axis;
- c. Electrical discharge machines (EDM)....
- d. Deep-hole-drilling machines....
- e. "Numerically controlled" or manual machine tools...

2E001

**"Technology" according to the General Technology Note for the "development" of equipment or "software" in 2D of this List or for the "development" of the following equipment:**

- a. Machine tools for turning, having all of the following characteristics:
  1. Positioning accuracy with "all compensations available" equal to or less (better) than **3.6 µm** according to ISO 230/2 (1997) or national equivalents along any linear axis; and
  2. Two or more axes which can be coordinated simultaneously for "contouring control".
- 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 **3.6 µm** according to ISO 230/2 (1997) or national equivalents along any linear axis; and
  - b. Three linear axes plus one rotary axis which can be coordinated simultaneously for "contouring control";
  2. Five or more axes which can be coordinated simultaneously for "contouring control" **and have a positioning accuracy with "all compensations available" equal to or less (better) than 3.6 µm according to ISO 230/2 (1997) or national equivalents along any linear axis; or**
  3. A positioning accuracy for jig boring machines, with "all compensations available", equal to or less (better) than 3 µm according to ISO 230/2 (1997) or national equivalents along any linear axis;
- c. Electrical discharge machines (EDM)....
- d. Deep-hole-drilling machines....
- e. "Numerically controlled" or manual machine tools...

2E002

**"Technology" according to the General Technology Note for the "production" of the following equipment:**

- a. Machine tools for turning, having all of the following characteristics:
  1. Positioning accuracy with "all compensations available" equal to or less (better) than **3.6 µm** according to ISO 230/2 (1997) or national equivalents along any linear axis; and
  2. Two or more axes which can be coordinated simultaneously for "contouring control".
- 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 **3.6 µm** according to ISO 230/2 (1997) or national equivalents along any linear axis; and
  - b. Three linear axes plus one rotary axis which can be coordinated simultaneously for "contouring control";
  2. Five or more axes which can be coordinated simultaneously for "contouring control" **and have a positioning accuracy with "all compensations available" equal to or less (better) than 3.6 µm according to ISO 230/2 (1997) or national equivalents along any linear axis; or**
  3. A positioning accuracy for jig boring machines, with "all compensations available", equal to or less (better) than 3 µm according to ISO 230/2 (1997) or national equivalents along any linear axis;
- c. Electrical discharge machines (EDM)....
- d. Deep-hole-drilling machines....
- e. "Numerically controlled" or manual machine tools...

Category 3

- 3A002.g.2. Atomic frequency standards....
- 3A229 Firing sets and equivalent high-current pulse generators, as follows...  
NB : SEE ALSO ML4.a.,b., ML909
- 3A232 Detonators and multipoint initiation systems, as follows...  
NB : SEE ALSO ML4.a.
- 3B001.a.2. Metal organic chemical vapour deposition reactors....
- 3D001 "Software" specially designed for the "development" or "production" of equipment in **3A002.g. or 3B of this List.**

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- 3E001 "Technology" according to the General Technology Note for the "development" or "production" of equipment in **3A or 3B of this List.**
- 3E201 "Technology" according to the General Technology Note for the "use" of equipment specified in 3A229 or 3A232.

Category 4

- 4A001.a.2. Electronic computers.....radiation hardened;
- 4A003.b. Deleted
- 4A003.c. Deleted
- 4D001 **"Software" specially designed for the "development" or "production" of equipment in 4A of this List or for the "development" or "production" of "digital computers" having an "Adjusted Peak Performance" ("APP") exceeding 0.1 Weighted TeraFLOPS (WT).**
- 4E001 **"Technology" according to the General Technology Note for the "development" or "production" of the following equipment or "software":**
- **Equipment in 4A of this List;**
  - **"Digital computers" having an "Adjusted Peak Performance" ("APP") exceeding 0.1 Weighted TeraFLOPS (WT); or**
  - **"Software" in 4D of this List.**

Category 5 - Part 1

- 5A001.b.3. Being radio equipment .....
- 5A001.b.5. Being digitally controlled radio receivers...
- 5B001.a. Equipment and specially designed components or accessories therefor, specially designed for the "development", "production" or "use" of equipment, functions or features in Category 5 - Part 1 **of this List.**
- 5D001.a. **"Software" specially designed for the "development" or "production" of equipment, functions or features in Category 5 - Part 1 of this List.**
- 5D001.b. "Software" specially designed or modified to support "technology" listed under 5E001 **of this List.**
- 5E001.a. **"Technology" according to the General Technology Note for the "development" or "production" of equipment, functions, features or "software" in Category 5 - Part 1 of this List.**

Category 5 - Part 2

- 5A002.a.2. Equipment designed or modified to perform cryptanalytic functions.
- 5D002.c.1. Only software having the characteristics, or performing or simulating the functions, of equipment specified in 5A002.a.2.
- 5E002 Only "technology" for the "development", "production" or "use" of the goods specified in 5A002.a.2. or 5D002.c.1. above.

Category 6

- 6A001.a.1.b. Object detection or location systems having any of the following:  
 1. A transmitting frequency below **5 kHz**;  
 6. Designed to withstand...;
- 6A001.a.2.a.2. Hydrophones...Incorporating...
- 6A001.a.2.a.3. Hydrophones...Having any...
- 6A001.a.2.a.6. Hydrophones...Designed for...
- 6A001.a.2.b. Towed acoustic hydrophone arrays...
- 6A001.a.2.c. Processing equipment, specially designed for **real time application with** 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.d. Heading sensors....
- 6A001.a.2.e. Bottom or bay cable systems having any of the following:  
 1. Incorporating hydrophones... or  
 2. Incorporating multiplexed hydrophone group signal modules...;
- 6A001.a.2.f. Processing equipment, specially designed for **real time application with** 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;
- 6A002.a.1.a.,b., and c. "Space-qualified" solid-state detectors.....
- 6A002.a.2.a. Image intensifier tubes ...  
 1. A peak response...  
 2. A microchannel plate...  
 3. Photocathodes, as follows:  
 a. **S-20, S-25 or multialkali photocathodes with a luminous sensitivity exceeding 700 µA/lm**;  
 b. GaAs or GaInAs photocathodes;  
 c. Other III-V compound semiconductor photocathodes.



6A002.a.3. Non-space qualified "focal plane arrays" ...;

**Note 3**

*In 6A002.a.3. the following "focal plane arrays" are not included in this List:*

- a. Platinum Silicide (PtSi) "focal plane arrays" having less than 10,000 elements;*
- b. Iridium Silicide (IrSi) "focal plane arrays".*

**Note 4**

*In 6A002.a.3. the following "focal plane arrays" are not included in this List:*

- a. Indium Antimonide (InSb) or Lead Selenide (PbSe) "focal plane arrays" having less than 256 elements;*
- b. Indium Arsenide (InAs) "focal plane arrays";*
- c. Lead Sulphide (PbS) "focal plane arrays";*
- d. Indium Gallium Arsenide (InGaAs) "focal plane arrays".*

**Note 5**

*In 6A002.a.3. Mercury Cadmium Telluride (HgCdTe) "focal plane arrays" as follows are not included in this List:*

- a. Scanning Arrays having any of the following:
  - 1. 30 elements or less; or*
  - 2. incorporating time delay-and-integration within the element and having 2 elements or less;**
- b. Staring Arrays having less than 256 elements.*

**Technical Notes**

- 1. 'Scanning Arrays' are defined as "focal plane arrays" designed for use with a scanning optical system that images a scene in a sequential manner to produce an image;*
- 2. 'Staring Arrays' are defined as "focal plane arrays" designed for use with a non-scanning optical system that images a scene.*

**Note 6**

*In 6A002.a.3. the following "focal plane arrays" are not included in this List:*

- a. Gallium Arsenide (GaAs) or Gallium Aluminium Arsenide (GaAlAs) quantum well "focal plane arrays" having less than 256 elements;*
- b. Microbolometer "focal plane arrays" having less than 8,000 elements.*

6A002.b. "Monospectral imaging sensors" and "multispectral imaging sensors"....

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- 6A002.c. Direct view imaging equipment operating in the visible or infrared spectrum, incorporating any of the following:
1. Image intensifier tubes having the characteristics listed in **6A002.a.2.a. of this List**; or
  2. "Focal plane arrays" having the characteristics listed in **6A002.a.3. of this List**;
- 6A002.e. "Space-qualified" "focal plane arrays"....
- 6A003.b.3 Imaging cameras incorporating image intensifier tubes having the characteristics listed in **6A002.a.2.a. of this List**;
- 6A003.b.4 Imaging cameras incorporating "focal plane arrays" having any of the following:
- a. Incorporating "focal plane arrays" listed in **6A002.a.3.a. to 6A002.a.3.e. of this List**; or
  - b. Incorporating "focal plane arrays" listed in **6A002.a.3.f. of this List**
- Note 1* 'Imaging cameras' described in 6A003.b.4 include "focal plane arrays" combined with sufficient signal processing electronics, beyond the read out integrated circuit, to enable as a minimum the output of an analogue or digital signal once power is supplied.
- Note 2* 6A003.b.4.a. 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.
- 6A003.b.4. contd. *Note 3* 6A003.b.4.b. does not control imaging cameras having any of the following characteristics:
- a. A maximum frame rate equal to or less than 9 Hz;
  - b. Having all of the following:
    1. Having a minimum horizontal or vertical Instantaneous-Field-of-View (IFOV) of at least 10 mrad/pixel (milliradians/pixel);
    2. Incorporating a fixed focal-length lens that is not designed to be removed;
    3. Not incorporating a direct view display; and
-

Technical Note:

'Direct view' refers to an imaging camera operating in the infrared spectrum that presents a visual image to a human observer using a near-to-eye micro display incorporating any light-security mechanism.

4. Having any of the following:
- a. No facility to obtain a viewable image of the detected field-of-view; or
  - b. The camera is designed for a single kind of application and designed not to be user modified; or

Technical Note

Instantaneous Field of View (IFOV) specified in Note 3.b. is the lesser figure of the Horizontal FOV or the Vertical FOV.

Horizontal IFOV = horizontal Field of View (FOV)/number of horizontal detector elements

Vertical IFOV= vertical Field of View (FOV)/number of vertical detector elements.

- c. Where the camera is specially designed for installation into a civilian passenger land vehicle of less than three tonnes (gross vehicle weight) and having all of the following:
  1. Is only operable when installed in any of the following:
    - a. The civilian passenger land vehicle for which it was intended; or
    - b. A specially designed, authorized maintenance test facility; and
  2. Incorporates an active mechanism that forces the camera not to function when it is removed from the vehicle for which it was intended.

Note: When necessary, details of the item will be provided, upon request, to the appropriate authority in the exporter's country in order to ascertain compliance with the conditions described in Note 3.b.4. and Note 3.c. above.

6A004.c.	"Space-qualified" components for optical systems....
6A004.d.	Optical control equipment.....
6A006.a.	"Magnetometers" ... using optically pumped or nuclear precession (proton/Overhauser) having a "noise level" (sensitivity) lower (better) than 2 pT rms per square root Hz.
6A006.g.	Magnetic compensation systems... <b><u>Note In 6A006.g. those compensators which provide only absolute values of the earth's magnetic field as output, (i.e., the frequency bandwidth of the output extends from DC to at least 0.8 Hz) are not included in this List.</u></b>

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6A006.h.	"Superconductive" electromagnetic sensors.....
6A008.d.	Radar systems.....Capable of...
6A008.h.	Radar systems...Employing processing
6A008.k.	Radar systems...Having "signal processing"...
6A008.l.3.	Radar systems...Having data processing... Processing for...
6B008	Pulse radar cross-section measurement systems having transmit pulse widths of 100 ns or less and specially designed components therefor. NB: SEE ALSO 6B108
6B108	Systems specially designed for radar cross section measurement usable for "missiles" and their subsystems.
6D001	"Software" specially designed for the "development" or "production" of equipment in <b>6A004, 6A008 or 6B008 of this List.</b>
6D003.a.	"Software", as follows:...
6E001	"Technology" according to...
6E002	<b>"Technology" according to the General Technology Note for the "production" of equipment in 6A or 6B of this List.</b>

#### Category 7

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), <b>except "guidance sets" designed for missiles with a range under 300 km or manned aircraft.</b>
7B001	Test, calibration or alignment equipment specially designed for equipment specified <b>in 7A117 above.</b> <i>Note: 7B001 does not control test, calibration or alignment equipment for Maintenance Level I or Maintenance Level II.</i>
7B003	Equipment specially designed for the "production" of equipment specified <b>in 7A117 above.</b>
7B103	"Production facilities" specially designed for equipment specified <b>in 7A117 above.</b>
7D002	"Source code" for the "use"...
7D003.a.	"Software" specially designed or modified to...
7D003.b.	"Source code" for...
7D003.c.	"Source code" for...
7D003.d.1. to 4. & 7.	"Source code" for the "development" of...
7D101	"Software" specially designed for the "use" of equipment specified in 7B003 or 7B103 <b>above.</b>

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- 7E001 "Technology" according to the General Technology Note for the "development" of equipment or "software" specified in 7A117, 7B003, 7B103 or 7D101 **above**.
- 7E002 "Technology" according to the General Technology Note for the "production" of equipment specified in 7A117, 7B003 and 7B103 **above**.
- 7E101 "Technology" according to the General Technology Note for the "use" of equipment specified in 7A117, 7B003, 7B103 and 7D101 **above**.

#### Category 8

- 8A001.b. Manned, untethered submersible vehicles...
- 8A001.c. Unmanned, tethered submersible vehicles.....
- 8A001.d. Unmanned, untethered submersible vehicles...
- 8A002.b. Systems specially designed or modified for the automated control of the motion of submersible vehicles **in 8A001 of this List** using navigation data and having closed loop servo-controls:
1. Enabling...;
  2. Maintaining...; or
  3. Maintaining...;
- 8A002.h. "Robots" specially designed for underwater use.....
- 8A002.j. Air independent power systems.....
- 8A002.o.3. Noise reduction systems designed for use on vessels of 1000 tonnes displacement...
- 8A002.p. Pumpjet propulsion systems....
- 8D001 **"Software" specially designed for the "development" or "production" of equipment in 8A of this List.**
- 8D002 Specific "software".....
- 8E001 "Technology" according to the General Technology Note for the "development" or "production" of equipment in **8A of this List**.
- 8E002.a. "Technology" for the "development", "production", repair, overhaul or refurbishing (re-machining) of propellers specially designed for underwater noise reduction.

#### Category 9

- 9A004 Space launch vehicles **capable of delivering at least a 500 kg payload to a range of at least 300 km.**  
 N.B.: SEE ALSO 9A104.  
*Note 1: 9A004 does not control payloads.*

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- 9A005 Liquid rocket propulsion systems containing any of the systems or components specified in 9A006 **usable for space launch vehicles specified in 9A004 above or sounding rockets specified in 9A104 below**.  
N.B.: SEE ALSO 9A105 and 9A119.
- 9A007.a. Solid rocket propulsion systems, **usable for space launch vehicles specified in 9A004 above or sounding rockets specified in 9A104 below**, with any of the following:  
N.B.: SEE ALSO 9A119.
- a. Total impulse capacity exceeding 1.1 MNs;
- 9A008.d. Components, as follows, specially designed for solid rocket propulsion systems:  
N.B.: SEE ALSO 9A108.c.
- d. Movable nozzle or secondary fluid injection thrust vector control systems, **usable for space launch vehicles specified in 9A004 above or sounding rockets specified in 9A104 below**, capable of any of the following:
1. Omni-axial movement exceeding  $\pm 5^\circ$ ;
  2. Angular vector rotations of  $20^\circ/\text{s}$  or more; or
  3. Angular vector accelerations of  $40^\circ/\text{s}^2$  or more.
- 9A011 Ramjet, scramjet or combined cycle engines...
- 9A104 Sounding rockets, capable of **delivering at least a 500 kg payload to a range of at least 300 km**.  
N.B.: SEE ALSO 9A004.
- 9A105.a. Liquid propellant rocket engines, as follows:  
N.B.: SEE ALSO 9A119.
- a. Liquid propellant rocket engines usable in "missiles", not controlled in 9A005, having a total impulse capacity equal to or greater than 1.1 MNs; **except liquid propellant apogee engines designed or modified for satellite applications and having all of the following:**
1. **nozzle throat diameter of 20 mm or less; and**
  2. **combustion chamber pressure of 15 bar or less.**

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- 9A106.c. Systems or components, not controlled in 9A006, usable in "missiles", as follows, specially designed for liquid rocket propulsion systems:
- c. Thrust vector control sub-systems, **except those designed for rocket systems that are not capable of delivering at least a 500 kg payload to a range of at least 300 km.**
- 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.
- 9A108.c. Components, not controlled in 9A008, usable in "missiles", as follows, specially designed for solid rocket propulsion systems:
- c. Thrust vector control sub-systems, **except those designed for rocket systems that are not capable of delivering at least a 500 kg payload to a range of at least 300 km.**
- 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.
- 9A116 Reentry vehicles, usable in "missiles", and equipment designed or modified therefor, as follows, **except for reentry vehicles designed for non-weapon payloads:**
- 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.
- 9A119 Individual rocket stages, usable in complete rocket systems or "unmanned aerial vehicles", capable of **delivering at least a 500 kg payload to a range of 300 km**, not controlled in 9A005 or 9A007.a. **above**
- 9B001.b. Ceramic cores or shells

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9B115	Specially designed "production equipment" for the systems, sub-systems and components specified in 9A005, 9A007.a., 9A008.d., 9A105.a., 9A106.c., 9A108.c., 9A116 or 9A119 <b>above</b> .
9B116	Specially designed "production facilities" for the space launch vehicles specified in 9A004, or systems, sub-systems, and components specified in 9A005, 9A007.a., 9A008.d., 9A104, 9A105.a., 9A106.c., 9A108.c., 9A116 or 9A119 <b>above</b> .
9D001	<b>"Software" specially designed or modified for the "development" of equipment or "technology" in 9A, 9B or 9E003 of this List.</b>
9D002	<b>"Software" specially designed or modified for the "production" of equipment in 9A or 9B of this List.</b>
9D004.a. 9D004.c.	Other "software"...2D or 3D... Other "software"..."Software" specially...
9D101	"Software" specially designed for the "use" of goods specified in 9B116 <b>above</b> .
9E001	"Technology" according to the General Technology Note.....
9E002	"Technology" according to the General Technology Note...
9E003.a.1. 9E003.a.2. to 5. & 9E003.a.8., 9.E.3.a.9.	Other "technology"...Gas turbine blades... Other "technology"...
9E101	"Technology" according to the General Technology Note for the "development" or "production" of goods specified in 9A104, 9A105.a., 9A106.c., 9A108.c., 9A116 or 9A119 <b>above</b> .
9E102	"Technology" according to the General Technology Note for the "use" of space launch vehicles specified in 9A004, 9A005, 9A007.a., 9A008.d., 9A104, 9A105.a., 9A106.c., 9A108.c., 9A116, 9A119, 9B115, 9B116 or 9D101 <b>above</b> .



<b>VERY SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES</b>
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*Note* This List is a sub-set of the items contained in the Sensitive List. The items in this List are considered to be very sensitive, requiring extreme care in their transfer. General Export Licences are not available for the export of the following very sensitive goods.

*N.B.* Where abbreviated entries are used, see Part 2 for full details. Text that differs from that in Part 2 is in **bold type**.

Category 0 All of Category 0 of Part 2 is included in the Very Sensitive List.

N.B.: For 0C003 and 0C004, only if for use in a "nuclear reactor" (within 0A001.a.).

Category 1  
1A002.a.

**"Composite" structures or laminates having an organic "matrix" and made from materials listed under 1C010.c. or 1C010.d.**

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.

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.

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1B233	Lithium isotope separation facilities or plants, and equipment therefor, as follows: <ul style="list-style-type: none"> <li>a. Facilities or plants for the separation of lithium isotopes;</li> <li>b. Equipment for the separation of lithium isotopes, as follows:                 <ul style="list-style-type: none"> <li>1. Packed liquid-liquid exchange columns specially designed for lithium amalgams;</li> <li>2. Mercury or lithium amalgam pumps;</li> <li>3. Lithium amalgam electrolysis cells;</li> <li>4. Evaporators for concentrated lithium hydroxide solution.</li> </ul> </li> </ul>
1C001	Materials specially designed for use as absorbers of electromagnetic waves...
1C012	Materials as follows...
1C233	Lithium enriched in the lithium-6 ( <sup>6</sup> 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. <u>Note:</u> 1C233 does not control thermoluminescent dosimeters. <u>Technical Note:</u> The natural isotopic abundance of lithium-6 is approximately 6.5 weight per cent (7.5 atom per cent).
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. <u>Note:</u> 1C235 does not control a product or device containing less than $1.48 \times 10^3$ GBq (40 Ci) of tritium.
1C351.d.4.	Ricin
1C351.d.5.	Saxitoxin
1E001	"Technology" according to the General Technology Note for the "development" or "production" of equipment and materials in <b>1A002 or 1C of this List.</b>
1E201	"Technology" according to the General Technology Note for the "use" of goods specified in 1B226, 1B231, 1B233, 1C233 or 1C235.
<u>Category 2</u>	None

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Category 3

- 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  $\mu$ s or less;

*Note: 3A228 includes gas krytron tubes and vacuum sphytron tubes.*
  - b. Triggered spark-gaps having both of the following characteristics:
    1. An anode delay time of 15  $\mu$ s or less; and
    2. Rated for a peak current of 500 A or more;
- 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
- 3E201 "Technology" according to the General Technology Note for the "use" of equipment specified in 3A228.a., 3A228.b. or 3A231.

Category 4

None

Category 5 - Part 1

- 5A001.b.5. Digitally controlled radio receivers...
- 5D001.a. **"Software" specially designed for the "development" or "production" of equipment, functions or features in Category 5, Part 1 of this List.**
- 5E001.a. **"Technology" according to the General Technology Note for the "development" or "production" of equipment, functions, features or "software" in Category 5, Part 1 of this List.**

Category 5 - Part 2

None

Category 6

- 6A001.a.1.b.1. **Object detection or location systems having a sound pressure level exceeding 210 dB (reference 1  $\mu$ Pa at 1 m) and an operating frequency in the band from 30 Hz to 2 kHz.**

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6A001.a.2.a.1.	Hydrophones...Incorporating...
6A001.a.2.a.2.	Hydrophones...Incorporating flexible assemblies...
6A001.a.2.a.3.	Hydrophones...Having any...
6A001.a.2.a.5.	Hydrophones...When designed...
6A001.a.2.a.6.	Hydrophones...Designed for...
6A001.a.2.b.	Towed acoustic hydrophone arrays...
6A001.a.2.c.	Processing equipment, specially designed for <b>real time application with</b> 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.e.	Bottom or bay cable systems having any of the following: <ol style="list-style-type: none"> <li>1. Incorporating hydrophones... <u>or</u></li> <li>2. Incorporating multiplexed hydrophone group signal modules ...;</li> </ol>
6A001.a.2.f.	Processing equipment, specially designed for <b>real time application with</b> 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;
6A002.a.1.c.	"Space-qualified" solid-state detectors...
6A008.1.3.	Radar systems...Having data processing... Processing for...
6A203	Cameras and components, not controlled in 6A003, as follows: <ol style="list-style-type: none"> <li>a. Mechanical rotating mirror cameras, as follows, and specially designed components therefor: <ol style="list-style-type: none"> <li>1. Framing cameras with recording rates greater than 225,000 frames per second;</li> <li>2. Streak cameras with writing speeds greater than 0.5 mm per microsecond;</li> </ol> <p><i>Note: In 6A203.a. components of such cameras include their synchronizing electronics units and rotor assemblies consisting of turbines, mirrors and bearings.</i></p> </li> </ol>
6A225	Velocity interferometers for measuring velocities exceeding 1 km/s during time intervals of less than 10 microseconds. <p><i>Note: 6A225 includes velocity interferometers such as VISARs (Velocity interferometer systems for any reflector) and DLI (Doppler laser interferometers).</i></p>
6A226	Pressure sensors, as follows: <ol style="list-style-type: none"> <li>a. Manganin gauges for pressures greater than 10 GPa;</li> <li>b. Quartz pressure transducers for pressures greater than 10 GPa.</li> </ol>
6B008	Pulse radar cross-section...

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- 6D001 "Software" specially designed for the "development" or "production" of equipment in **6A008, or 6B008 of this List.**
- 6D003.a. "Software", as follows:...
- 6E001 "Technology" according to the General Technology Note for the "development" of **equipment or "software" in 6A, 6B, or 6D of this List.**
- 6E002 "Technology" according to the General Technology Note for the "production" of equipment in **6A or 6B of this List.**

#### Category 7

- 7D003.a. "Software" specially designed or modified to...  
7D003.b. "Source code" for...

#### Category 8

- 8A001.b. Manned, untethered submersible vehicles...  
8A001.d. Unmanned, untethered submersible vehicles...
- 8A002.o.3.b. Active noise reduction or cancellation systems...
- 8D001 **"Software" specially designed for the "development" or "production" of equipment in 8A of this List.**
- 8E001 "Technology" according to the General Technology Note for the "development" or "production" of equipment in **8A of this List.**

#### Category 9

- 9A011 Ramjet, scramjet or combined cycle engines...
- 9D001 **"Software" specially designed or modified for the "development" of equipment or "technology" in 9A or 9E003 of this List.**
- 9D002 **"Software" specially designed or modified for the "production" of equipment in 9A of this List.**
- 9E001 "Technology" according to the General Technology Note for the "development" of equipment or "software" in **9A011 or 9D of this List.**
- 9E002 "Technology" according to the General Technology Note for the "production" of equipment in **9A011 of this List.**
- 9E003.a.1. Other "technology"...Gas turbine blades...

9E003.a.3.a.      "Technology" "required" for ...  
Components manufactured from...  
Organic "composite" materials designed to operate above 588 K  
(315°C).

## INDEX OF CONTROLLED GOODS

1,1,3 Trinitroazetidine (TNAZ) .....	ML8a.28
1,1,3,3,3-Pentafluoro-2-(trifluoromethyl)-1-propene .....	1C450a.6
1,2,3 Tris(1,2 bis(difluoroamino)ethoxy) propane .....	ML8e.43
1,2,4 Butanetriol .....	ML8e.45
1,2,4 Trihydroxybutane .....	ML8e.45
1,2-bis (2-chloroethylthio) ethane .....	ML7a
1,3,5 Trichlorobenzene .....	ML8e.44
1,3,5 Trinitro 1,3,5 triaza cyclohexane .....	ML8a.20
1,3,5,7 Tetraacetyl 1,3,5,7 tetraazacyclooctane (TAT) .....	ML8e.46
1,3,5,7 Tetranitro 1,3,5,7 tetraazacyclooctane .....	ML8a.7
1,3-bis (2-chloroethylthio) -n-propane .....	ML7a
1,4,5,8 Tetraazadecalin .....	ML8e.47
1,4,5,8 Tetranitro 1,4,5,8 tetraazadecalin (TNAD) .....	ML8a.29
1,4-bis (2-chloroethylthio) -n-butane .....	ML7a
1,5-bis (2-chloroethylthio) -n-pentane .....	ML7a
2 (5 Cyanotetrazolato) pentaamminecobalt(III)perchlorate .....	ML8a.22
2,2-Diphenyl-2-hydroxyacetic acid .....	1C350.32
2,4,6 Trinitro 2,4,6 triazacyclohexanone (K 6 or Keto RDX) .....	ML8a.26
2,4,6,8 Tetranitro 2,4,6,8 tetraazabicyclo(3,3,0)octan 3 one .....	ML8a.27
2-Chloroethanol .....	1C350.15
2-Chloroethylchloromethylsulphide .....	ML7a
2-chlorovinylchloroarsine .....	ML7a
2-Nitrodiphenylamine .....	1C111c.4
3 Nitro 1,2,4 triazol 5 one .....	ML8a.17
3-Hydroxy-1-methylpiperidine .....	1C350.10
3-Quinuclidinol .....	1C350.13
3-Quinuclidone .....	1C350.37
3-Quinuclidinyl benzilate (BZ) .....	ML7a
5,7 Diamino 4,6 dinitrobenzofurazane 1 oxide (CL 14) .....	ML8a.25
7 Amino 4,6 dinitrobenzofurazane 1 oxide (ADNBF) .....	ML8a.24

## A

Absolute reflectance measurement equipment .....	6B004a
Absorbers of electromagnetic waves .....	1C001
Absorbers, hair type .....	1C001a
Absorbers, non-planar & planar .....	1C001a
Absorption columns .....	2B350e
Accelerators (electro-magnetic radiation) .....	3A101b
Accelerators or coprocessors, graphics .....	4A003d
Accelerometer axis align stations .....	7B003f
Accelerometers & accelerometer components .....	7A001&101
Acoustic beam forming software .....	6D003a.1
Acoustic hydrophone arrays, towed .....	6A001a.2.b
Acoustic location & object detection systems .....	6A001a.1.b
Acoustic mounts, noise reduction equipment for vessels .....	8A002o.3.a
Acoustic positioning systems .....	6A001a.1.d
Acoustic projectors .....	6A001a.1.c
Acoustic systems, marine .....	6A001a
Acoustic transducers .....	6A001a.2.a
Acoustic underwater communications systems .....	5A001b.1
Acoustic vibration test equipment .....	9B006
Acoustic wave devices .....	3A001c
Acoustic-optic signal processing devices .....	3A001c.3
Active acoustic systems .....	6A001a.1
Active compensating system rotor clearance control software .....	9D004d
Active flight control system software .....	7D003e
Active flight control system technology .....	7E004b
Active magnetic bearing systems .....	2A001c
Actively cooled mirrors .....	6A005e.1
Adaptive control software .....	2D002
ADCs (analogue-to-digital converters) .....	3A001a.5
ADCs (analogue-to-digital converters) .....	3A101a
ADCs (analogue-to-digital converters) .....	4A003e

Additives, precursors & stabilisers .....	ML8e
ADN (ammonium dinitramide).....	ML8a.32
ADNBF (7 Amino 4,6 dinitrobenzofurazane 1 oxide) .....	ML8a.24
Aero engines, military.....	ML10c
Aero gas turbine engine/assemblies/component test software .....	9D004b
Aero gas turbine engines.....	9A001
Aerodynamic isotope separation plant.....	0B001a.3
Aerodynamic separation process systems & components.....	0B001d
Aerosol challenge testing chambers.....	2B352g
Aflatoxin.....	1C351d.11
African swine fever virus (animal pathogens).....	1C352a.1
Agent Orange .....	ML7a
Agitators (chemical manufacturing).....	2B350b
AHRS (Attitude Heading Reference Systems), source code.....	7D002
Aiming devices.....	ML5
Air independent power systems (for underwater use).....	8A002j
Air traffic control software .....	6D003d
Air weapons.....	ML1
Air weapons.....	ML901b
Airborne altimeters.....	7A006
Airborne altimeters.....	7A106
Airborne components, military .....	ML10
Airborne equipment, military.....	ML10e.i
Airborne vehicles, military .....	ML10a,b
Aircraft & aircraft components, military .....	ML10
Aircraft engines, military .....	ML10c
Aircraft equipment, military .....	ML10d.i
Aircraft fuels (military high energy).....	ML8d
Aircraft inertial navigation systems & equipment.....	7A003
Aircraft inertial navigation systems & equipment.....	7A103
Aircraft refuellers, military .....	ML10f
Aircraft simulators, military.....	ML14
Alexandrite .....	6C005b
Alexandrite lasers.....	6A005c.1
Align & expose step & repeat equipment (wafer processing) .....	3B001f
Alkyl Phosphonyl Difluorides .....	ML7b.1
Alkylphenylene ethers or thio-ethers, as lubricating fluids.....	1C006b
All wheel drive utility vehicles .....	ML6
Alloy strips, magnetic .....	1C003c
Alloyed metal materials in powder or particulate form.....	1C002b
Alloyed metal materials in powder or particulate form.....	1C002c
Alloyed metal materials in powder or particulate form.....	1C202
Alloys, aluminium.....	1C002a.1
Alloys, aluminium.....	1C002a.2.d
Alloys, aluminium.....	1C202a
Alloys, magnesium.....	1C002a.2.e
Alloys, metal powder .....	1C002b
Alloys, nickel .....	1C002a.1.a
Alloys, nickel .....	1C002a.2.a
Alloys, niobium.....	1C002a.2.b
Alloys, titanium.....	1C002a.1.b
Alloys, titanium.....	1C202b
Alpha-emitting radionuclides.....	1C236
Altimeters, airborne.....	7A006
Altimeters, radar or laser types .....	7A106
Aluminides, nickel .....	1C002a.1.a
Aluminides, titanium.....	1C002a.1.b
Aluminium alloy powder, made from materials of 1C002a.....	1C002b.1.d
Aluminium alloy powder, made from materials of 1C002a.....	1C002c
Aluminium alloys, aq.....	1C002a.1
Aluminium alloys, aq.....	1C002a.2.d
Aluminium alloys, aq.....	1C002c
Aluminium alloys, aq.....	1C202
Aluminium organo-metallic compounds .....	3C003
Aluminium powder, spherical.....	ML8c.8
Aluminium powder, spherical .....	1C111a.1
Amalgam electrolysis cells, lithium isotope separation .....	1B233
Amalgam pumps, lithium.....	1B233
Amino dinitrobenzo furoxan (ADNBF) .....	ML8a.24
Amiton.....	1C450a.1
AMMO (Azidomethylmethyloxetane) & its polymers .....	ML8e.1



Ammonia crackers .....	0B004b.5
Ammonia distillation towers.....	0B004b
Ammonia hydrogen exchange plant, equipment and components.....	0B004a.2
Ammonia hydrogen exchange plant, equipment and components.....	0B004a.2
Ammonia synthesis converters & units .....	1B227
Ammonium dinitramide (ADN) .....	ML8a.32
Ammonium hydrogen fluoride.....	1C350.42
Ammonium perchlorate .....	ML8a.19
Ammunition & components.....	ML3
Ammunition & components, non-military.....	ML902
Ammunition trailers .....	ML6f
Amorphous alloy strips .....	1C003
Amphibious cargo carriers, military .....	ML6i
Amphibious vehicles .....	ML6g
Amplifiers, microwave solid state .....	3A001b.4
Anaerobic chambers .....	2B352f.2
Analogue computers.....	4A001
Analogue computers.....	4A101
Analogue instrumentation tape recorders .....	3A002a.1
Analogue-to-digital conversion equipment .....	4A003e
Analogue-to-digital converters, integrated circuits .....	3A001a.5
Analogue-to-digital converters, integrated circuits .....	3A101a
Analysers, network.....	3A002e
Analysers, spectrum .....	3A002c.1
Analysis on line of UF6 gas lines .....	0B002g.4
Anechoic chambers .....	9B106b
Angular measuring instruments .....	2B006b.2
Angular measuring instruments .....	2B206
Angular-linear inspection equipment (hemishells).....	2B006c
Angular-linear inspection equipment (hemishells).....	2B206
Animal pathogens .....	1C352
Antennae, phased array .....	5A001d
Antennae, phased array (for radar) .....	6A008e
Anti-g suits.....	ML10g
Anti-vibration mounts, military .....	ML10
Anti-vibration mounts, military .....	ML6
Anti-vibration mounts, military .....	ML9
Anti-vibration mounts (noise reduction), civil vessels.....	8A002o.3.a
Antibodies, defence against CBW agents.....	ML7e
Antimony hydrides.....	3C004
Aramid fibres & filamentary materials.....	1C010a
Aramid fibres & filamentary materials.....	1C210a
Arc remelt & casting furnaces .....	2B227a
Argon ion lasers .....	6A005a.6
Argon ion lasers .....	6A205a
Armed vehicles & related equipment/components.....	ML6b
Armour Body.....	1A005
Armoured plate.....	ML13a
Armoured railway trains & related equipment .....	ML6c
Armoured vehicles & related equipment .....	ML6b
Aromatic polyamide fibres production technology .....	1E002d
Aromatic polyamide-imides.....	1C008a.2
Aromatic polyetherimides.....	1C008a.4
Aromatic polyimides.....	1C008a.3
Array processor microcircuits.....	3A001a.3
Array processors/assemblies .....	4A003
Array processors/assemblies .....	4A004
Arsenic hydrides.....	3C004
Arsenic trichloride.....	1C350.31
Artificial Intelligence software .....	4D003b
Asynchronous transfer mode (ATM) equipment.....	5B001b.1
Asynchronous transfer mode (ATM) development software .....	5D001d.1
Atomic clocks, frequency standards .....	3A002g
Atomic transition solid state lasers .....	6A005c.2
Atomic vapour laser isotope separation plant (ALVIS).....	0B001g
Atomic vapour laser isotope separation process equipment.....	0B001g
Attack alerting/warning systems.....	ML5b
Attitude control equipment .....	7A116
Attitude Heading Reference Systems (AHRS), source software .....	7D002
Aujeszkys disease virus (Porcine herpes virus).....	1C352a.6
Autoclave regulation technology .....	1E103

Autoclaves, gaseous diffusion or centrifuge cascade .....	0B002a
Automated control systems, submersible vehicles .....	8A002b
Avian influenza virus .....	1C352a.2
Avionics EMP/EMI protection technology .....	7E102
Azidomethylmethyloxetane (AMMO) & its polymers .....	ML8e.1

**B**

Bacillus anthracis .....	1C351c.1
Bacteria .....	1C351c
Bacteria .....	1C352b
Bacteria .....	1C353
Bacteria .....	1C354a
Bacteria .....	ML7a,e
Balancing machines, centrifugal multiplane .....	2B119 & 2B229
Ball & solid roller bearings .....	2A001a
Ball & solid roller bearings .....	2A001b
Ballistic protection materials for military systems .....	ML13b
Band-pass filters, tunable .....	3A001b.5
Barium metal vapour lasers .....	6A005a.2.d
Basic copper salicylate .....	ML8e.2
Batch mixers with vacuum & temperature control .....	1B111 & 1B117
Bathymetric survey systems .....	6A001a.1.b
Batteries/cells (high energy), primary .....	3A001e.1.a
Batteries/cells (high energy), rechargeable/secondary .....	3A001e.1.b
Bay cable systems .....	6A001a.2.e
Bay cable systems software .....	6D003a.3
BCMO (Bischloromethyl oxetane) .....	ML8e.8
Beam steering mirrors .....	6A004a.4
Beamforming techniques .....	6A001a.2.c
Bearings, ball & solid roller .....	2A001a
Bearings, ball & solid roller .....	2A001b
Bearings, gas centrifuge .....	0B001b.7
Bearings, gas centrifuge .....	0B001b.8
Bearings, high precision/temperature/special .....	2A001
Bearings, magnetic (active) .....	2A001c
Bearings, magnetic (suspension) .....	0B001b.7
Bearings, silent for marine use .....	ML9g
Bearings, solid roller .....	2A001b
Bellows pumps .....	2B350i
Bellows seal valves .....	0B001c.6
Bellows seal valves .....	0B001d.6
Bellows seal valves .....	2A226
Bellows seal valves Bellows seal valves .....	2B350g
Bellows-forming dies .....	2B228c
Bellows-forming mandrels .....	2B228c
Benzeneacetic acid, alpha-hydroxy-alpha-phenyl- .....	1C350.32
Benzilic acid .....	1C350.32
Benzilic acid .....	1C350.32
Beryllium metal or alloy powder .....	1C111a.2.b
Beryllium metal or alloy powder .....	1C230
Beryllium metal or alloy powder .....	ML8a.2.b
Beryllium/beryllium substrate blanks .....	6C004d
BHEGA (Bis(2 hydroxyethyl)glycolamide) .....	ML8e.5
Binary precursors .....	ML7b
Biocatalyst incorporation in military carriers technology .....	ML7i.3
Biocatalyst production systems .....	ML7h.2
Biocatalysts, military .....	ML7h.1
Biological agents adapted for use in war .....	ML7a
Biological containment facilities, ACDP level 3 or 4 .....	2B352a.1
Biological isolators .....	2B352a.3
Biological manufacturing equipment & facilities .....	2B352
Biological safety cabinets .....	2B352a.3
Biological systems .....	ML7h.2
Biopolymer technology .....	ML7i.2
Biopolymers for chemical warfare agent identification .....	ML7g
Bioreactors (capacity 300 L or more) .....	2B352b
Bis (2-chloroethyl) ethylamine (HN1) .....	ML7a
Bis (2-chloroethyl) methylamine (HN2) .....	ML7a
Bis (2-chloroethylthioethyl) ether .....	ML7a

Bis (2-chloroethylthiomethyl) ether	ML7a
Bis (2-chlorovinyl) chloroarsine	ML7a
Bis (2 fluoro 2,2 dinitroethyl)formal (FEFO)	ML8e.4
Bis (2 hydroxyethyl)glycolamide (BHEGA)	ML8e.5
Bis (2 methyl aziridinyl) 2 (2 hydroxypropanoxy)propylamino phosphine oxide (BOBBA 8)	ML8e.41
Bis (2 methylaziridinyl)methylaminophosphine oxide (Methyl BAPO)	ML8e.6
Bis (2,2 dinitropropyl)acetal	ML8e.3
Bis (2,2 dinitropropyl)formal	ML8e.3
Bis (2-chloroethyl) sulphide	ML7a
Bis (2-chloroethylthio) methane	ML7a
Bisazidomethyloxetane & its polymers	ML8e.7
Bischloromethyloxetane (BCMO)	ML8e.8
Bismaleimides	1C008a.1
Bismuth	1C229
Bladders for aircraft/aerospace/missiles, fuel	1A001a
Bladders for aircraft/aerospace/missiles, fuel	1A001c
Blank ammunition	ML3
Blanks, beryllium/beryllium (Be/Be) deposited material	6C004d
Blanks, Zinc selenide (ZnSe) substrate	6C004a
Blanks, Zinc sulphide (ZnS) substrate	6C004a
Blowers	0B001c.3
Blowers, positive displacement/centrifugal/axial flow, gas	0B001d.3
Bluetongue virus	1C352a.3
BNCP (Cis bis(5 nitrotetrazolato) pentaaminecobalt(III) perchlorate)	ML8a.23
BNO (Butadienenitrileoxide)	ML8e.9
Boats, military	ML9
BOBBA 8 (Bis(2 methyl aziridinyl) 2 (2 hydroxypropanoxy) propylamino phosphine oxide)	ML8e.41
Body armour	1A005
Body armour	ML13d
Bomb activation equipment	ML4b
Bomb control equipment	ML4b
Bomb detection equipment	ML4b
Bomb handling equipment	ML4b
Bomb jamming equipment	ML4b
Bomb laying equipment, military	ML4b
Bomb powering equipment, military one time operation	ML4b
Bomb sweeping equipment, military	ML4b
Bombing computers	ML5a
Bombs	ML4a
Boring machines (CNC)	2B001
Boring machines (CNC)	2B201
Boron & boron compounds	1C225
Boron carbide powder (fuel)	1C011b
Boron carbide powder (fuel)	ML8a.2.d
Boron metal or alloy powder	1C011b
Boron metal or alloy powder	1C111a.2.c
Boron metal powder (fuel)	ML8a.2.d
Bottom cable systems	6A001a.2.e
Bottom cable systems software	6D003a.3
Botulinum toxin	1C351d.1
Boules of electro-optic materials	6C004b
Brayton cycle engine, air independent	8A002j
Bridges, military	ML17m
Bridge laying vehicles	ML6i
Bromobenzyl cyanide (CA)	ML7c.1
Brucella abortus	1C351c.2
Brucella melitensis	1C351c.3
Brucella suis	1C351c.4
BTTN (Butanetrioltrinitrate)	ML8e.10
Bulk acoustic wave devices	3A001c.2
Bulk fluoride glass, low optic absorption	6C004e.2
Bulk refuellers, military	ML6i
Bullet proof materials & clothing	ML13d
Bullet proof tyres	ML6j
Bullet resistant materials & clothing	ML13d
Butacene	ML8.f.4.a & 1C111c.1
Butadienenitrileoxide (BNO)	ML8e.9
Butanetrioltrinitrate (BTTN)	ML8e.10
Butyl 2-chloro-4-fluorophenoxyacetate (LNF)	ML7a
Butylene imine trimesamide isocyanuric	ML8e.32
BZ (3-Quinuclidinyl benzilate)	ML7a

**C**

C <sup>3</sup> I (Command, Communications, Control & Intelligence) software .....	ML21b.1.d
CA (Bromobenzyl cyanide) .....	ML7c.1
Cable - optical fibre & accessories for underwater use, .....	5A001c.2
Cable, underwater communication .....	5A001c.2
Cables with surreptitious intrusion detection .....	5A002a.7
Cables, Optical fibre .....	5A001c.1
CAD (Computer-aided-design) software for semiconductors .....	3D003
Cadmium telluride (CdTe) single crystals/epitaxial wafers .....	6C002b
Cadmium zinc telluride single crystals & epitaxial wafers .....	6C002b
Calcium .....	1C227
Calcium fluoride (CaF <sub>2</sub> ) made/coated crucibles .....	2A225a.2
Calcium zirconate (metazirconate) (Ca <sub>2</sub> ZrO <sub>3</sub> ) crucibles .....	2A225a.2
Cameras & components .....	ML15b
Cameras and components .....	6A003
Cameras and components .....	6A203
Cameras, electronic framing type .....	6A003a.4
Cameras, electronic framing type .....	6A203b.3
Cameras, electronic streak type .....	6A003a.3
Cameras, electronic streak type .....	6A203b.1
Cameras, framing .....	6A003a
Cameras, framing .....	6A203
Cameras, imaging .....	6A203c
Cameras, imaging .....	6A003b
Cameras, imaging .....	ML15d
Cameras, mechanical .....	6A003a
Cameras, mechanical .....	6A203a.1
Cameras, mechanical .....	ML15b,d
Cameras, military .....	ML15b
Cameras, radiation hardened TV .....	6A203c
Cameras, scanning & scanning camera systems .....	6A003b.2
Cameras, scanning & scanning camera systems .....	ML15
Cameras, underwater photographic .....	8A002e
Cameras, video using solid state sensors .....	6A003b.1
Canisters, smoke .....	ML4a
Canned drive pumps .....	2B350i
Cannons, large calibre .....	ML2a
Capacitors .....	3A001e.2
Capacitors .....	3A201a
Carbines .....	ML1a
Carbines, non-military .....	ML901a
Carbon dioxide (CO <sub>2</sub> ) lasers .....	6A005a.4
Carbon fibre & filamentary materials .....	1C010b
Carbon fibre & filamentary materials .....	1C210
Carbon monoxide (CO) lasers .....	6A005a.3
Carbon or alumina fibre conversion equipment .....	1B001d
Carbon or alumina fibre conversion equipment .....	1B101d
Carbon-carbon exit cones .....	9A0006h
Carbon-carbon materials .....	1A102
Carbon-carbon thrust chambers .....	9A0006h
Carbonyl dichloride .....	1C450a.7
Carboranes & derivatives .....	ML8c.3
Carboxy-terminated polybutadiene (CTPB) .....	1C111b.1
Cargo carriers, military .....	ML6
Cargo parachutes .....	ML10h.2
Cartridges .....	ML3
Cartridges .....	ML4a
Casting and remelt arc furnaces .....	2B227a
Castings, military .....	ML16
Castings, non-military firearms .....	ML903
Catalysts, platinized .....	1A225
Catalytic burners .....	0B004b.7
CATB (Diaminotrinitrobenzene) .....	ML8a.9
Cathodes (Impregnated) for electronic microwave tubes .....	3A001b.1.c
Cathodic arc deposition production equipment .....	2B005f
Catocene .....	ML8f.4.b
Cell culture development/production/use technology .....	ML7i.2
Cell cultures, biocatalyst production systems .....	ML7h.2
Cell cultures, chemical warfare (CW) agent identification .....	ML7g
Cells or batteries (high energy), primary .....	3A001e.1.a

Cells or batteries (high energy), rechargeable .....	3A001e.1.b
Cellular radio systems development/production technology.....	5E001b.3
Centrifugal decanters .....	2B352c
Centrifugal fixtures for gyro bearings.....	0B001b
Centrifugal fixtures for gyro bearings.....	0B002
Centrifugal fixtures for gyro bearings.....	7B003e
Centrifugal isotope separation plant, equipment & components.....	0B001a.1
Centrifugal multiplane balancing machine, use software .....	2D201
Centrifugal multiplane balancing machines for flexible rotors.....	2B229a
Centrifugal multiplane balancing machines, fixed or portable .....	2B219
Centrifugal pumps.....	2B350i
Centrifugal separators .....	2B352c
Centrifuge rotor assembly equipment.....	2B228a
Centrifuge rotor balancing equipment.....	2B229
Centrifuges, gas.....	0B001b.1
Ceramic base materials development/production technology.....	1E002c.1
Ceramic base materials, single or complex borides of Ti.....	1C007a
Ceramic composite materials, useable for radomes or nose tips.....	1C107b
Ceramic core manufacturing equipment.....	9B001c
Ceramic cores for blades & vanes .....	9B001d
Ceramic materials & composites .....	1C007
Ceramic shell manufacturing equipment .....	9B001c
Ceramic shell wax pattern preparation equipment .....	9B001d
Ceramic shells for blades & vanes.....	9B001b
Ceramic-ceramic composite materials.....	1C007f
Ceramic-matrix composite materials .....	1C007c
Ceramic-matrix composite materials .....	1C007d
Ceramic-matrix non-composite materials.....	1C007b
Cerium sulphide (Ce <sub>2</sub> S <sub>3</sub> ) made/coated crucibles .....	2A225a.2
Certification software for information security software .....	5D002c.2
Chambers, aerosol challenge testing (capacity of 1 m <sup>3</sup> or more) .....	2B352g
Changers, frequency (converters or inverters).....	0B001b.13
Changers, frequency (converters or inverters) .....	3A225
Charge (explosive) activation equipment .....	ML4b
Charge (explosive) control equipment.....	ML4b
Charges, military explosive.....	ML4a
Charges, military explosive.....	ML8a,b
Chemical exchange isotope separation process plant, components .....	0B001e
Chemical exchange isotope separation process plant, equipment.....	0B001a.4
Chemical incinerators.....	2B350j
Chemical lasers .....	6A005a.5
Chemical manufacturing equipment .....	2B350
Chemical manufacturing facilities .....	2B350
Chemical storage tanks & containers.....	2B350c
Chemical vapour deposition (CVD) equipment, epitaxial growth.....	3B001
Chemical vapour deposition (CVD) equipment, plasma enhanced .....	3B001d
Chemical vapour deposition (CVD) equipment, production .....	2B005a
Chemical vapour deposition (CVD) equipment, production (fibre).....	1B001d
Chemical warfare (CW) binary precursors .....	ML7b
Chemical warfare (CW) precursors .....	1C350
Chemical warfare agent identification biopolymers & cultures.....	ML7g
Chemicals, precursors for toxic chemical agents .....	1C350
Chemostats for biological processing (capacity 300 L or more).....	2B352b
Chikungunya virus (Human pathogen).....	1C351a.1
Chlamydia psittaci.....	1C351c.5
Chlorates composited with metal or high energy fuels .....	ML8a.3
Chlorine trifluoride (ClF <sub>3</sub> ).....	1C238
Chlorofluorocarbon compoundsoils as hydraulic fluids.....	1C006a.2
Chloropicrin .....	1C450a.3
Chlorosarin .....	ML7b.3
Chlorosoman .....	ML7b.4
Chromates composited with metal or high energy fuels .....	ML8a.3
Cinema recording cameras.....	6A003a.1
CL 14 (Diamino dinitrobenzofurozan) .....	ML8a.25
CL 20 (Hexanitrohexaazaisowurtzitane or HNIW).....	ML8a.30
Cladding test/inspection equipment, for reactor fuel elements .....	0B005
Clathrates of CL-20.....	ML8a.4
Clicker dies.....	1B101e
Climatic chambers.....	9B106
Clips, ammunition.....	ML1d
Closed circuit diving apparatus.....	8A002q

Closed-cycle refrigeration systems .....	9A006b
Clostridium botulinum .....	1C351c.6
Clostridium perfringens toxins .....	1C351d.2
Clothing & materials, bullet proof .....	ML13d
Clothing & materials, bullet resistant .....	ML13d
Clothing & materials, bullet-resistant .....	1A005
CN (Phenylacetyl chloride) .....	ML7c.3
CNTD (Controlled nucleation thermal decomposition) equipment .....	2B005a.1.b
Coating & processing equipment, for non-electronic substrates .....	2B005
Coating application technology, for non-electronic substrates .....	2E003f
Coatings for reduced electromagnetic visibility .....	1C101
Coatings, designed for reduced reflectivity .....	ML17c
Cochliobolus miyabeanus (Helminthosporium oryzae) .....	1C354b.2
Cold boxes, hydrogen distillation .....	0B004b
Cold traps/desublimers for UF6 removal .....	0B001d.7.d
Cold traps/desublimers for UF6 removal .....	0B002b
Cold-cathode tubes .....	3A228a
Colletotrichum coffeanum var. virulans, fungi .....	1C354b.1
Colour centre lasers .....	6A005c.1
Columbium (Niobium) alloys .....	1C002a.2.b
Column, absorption or distillation .....	2B350e
Column, liquid-liquid exchange, for lithium amalgams .....	1B233
Combat aircraft .....	ML10a
Combat parachutes .....	ML10h
Combatant vessels & components .....	ML9
Combined cycle engines/components .....	9A011
Combustion regulation devices, jet engines .....	9A118
Command, Communications, Control & Intelligence software .....	ML21b.1.d
Common channel signalling equipment/systems .....	5B001b.5
Common channel signalling equipment/systems, technology .....	5E001c.5
Communications cable systems, secure .....	5A002a.7
Communications Systems (underwater) .....	5A001b.1
Compasses (gyro-astro) & devices .....	7A004
Compasses (gyro-astro) & devices, other than those of 7A004 .....	7A104
Compilers (Software) for multi-data-stream processing equipment .....	4D003a
Composite components/structures for rockets .....	9A010
Composite conductors, superconductive .....	1C005
Composite materials .....	1C007f
Composite materials software .....	1D002
Composite structures for propulsion systems or space vehicles .....	9A110
Composite structures, as tubes .....	1A202
Composite structures, laminates or tubes .....	1A002
Composite temperature/pressure/atmosphere regulation technology .....	1E103
Composite/laminate manufactures for rockets .....	9A110
Compound semiconductor integrated circuits, industrial .....	3A001a.11
Compound semiconductor photocathodes .....	6A002a.2.b.3
Compounds composed of fluorine & other halogens, oxygen or nitrogen .....	ML8a.5
Compressors .....	0B001c.3
Compressors .....	0B001d.3
Compressors .....	0B001h.3
Compressors .....	0B004b.2
Compressors, .....	1B232
Computer interconnect equipment .....	4A003g
Computer, electronic assemblies & equipment & components .....	4A001-4
Computer, electronic components .....	4A101
Computer, electronic components .....	4A102
Computer-aided-design (CAD) software for IC's & semiconductors .....	3D003
Computer/assemblies/components, neural .....	4A004b
Computer/assemblies/components, optical .....	4A004c
Computer/assemblies/components, systolic array .....	4A004a
Computers, analogue .....	4A001
Computers, analogue & analogue ruggedised .....	4A101
Computers, digital .....	4A001
Computers, digital .....	4A003
Computers, digital .....	4A004
Computers, digital ruggedised .....	4A101
Computers, having information security characteristics .....	4A001b
Computers, hybrid .....	4A102
Computers, radiation hardened .....	4A001a.2
Computers, with extended operating temperature range .....	4A001a.1
Condensers or heat exchangers .....	0A001i

Condensers or heat exchangers .....	0B001d.4
Condensers or heat exchangers .....	0B001c.5
Condensers or heat exchangers .....	2B350d
Conductive polymers .....	1C001
Congo-Crimean haemorrhagic fever virus .....	1C351a.2
Connectors, Optical fibre .....	5A001c.1
Conotoxin .....	1C351d.3
Construction equipment, military .....	ML17b
Contactors, chemical exchange (ammonia hydrogen).....	0B004b.4
Contactors, liquid liquid centrifugal .....	0B001e
Containers, chemical .....	2B350e
Containment facilities .....	2B352a
Continuous mixers with vacuum & temperature control facility .....	1B111 & 1B118
Continuous-flow systems for biological processing.....	2B352b
Contrarotating propellers .....	8A002o.1.b
Control agents, riot .....	ML7c
Control apparatus and devices for rocket launchers.....	9A115a
Control equipment, explosive .....	ML4b
Control rods, for nuclear reactors .....	0A001d
Control units for metallurgical melting & casting furnaces .....	2B227
Controllable-pitch propellers .....	8A002o.2.a
Controlled atmosphere melting & casting furnaces.....	2B227
Controlled environment (vacuum or inert gas) induction furnaces.....	2B226
Controlled nucleation thermal decomposition (CNTD) equipment.....	2B005a.1.b
Controllers for high explosive handling robots .....	2B207
Controllers, machine tool (CNC).....	1B001a
Controllers, robot .....	2B007
Converter integrated circuits.....	3A001a.5
Converter interfaces for digital video magnetic tape recorders.....	3A002a.4
Converters, frequency .....	0B001b.13
Converters, frequency .....	3A225
Converters, microwave frequency extender .....	3A001b.7
Cooling equipment for molten uranium.....	0B001g.2
Cooling fluids - electronic.....	1C006d
Copper metal vapour lasers.....	6A005a.2.a
Copper or phosphor bronze mesh packings.....	1A226
Copper salicylate.....	ML8
Coprocessor microcircuits.....	3A001a.3
Coprocessors or accelerators, graphics .....	4A003d
Correlation-velocity sonar log equipment .....	6A001c
Counter current solvent extractors.....	0B006
Countermeasure & counter countermeasure equipment, military.....	ML15f
Countermeasure equipment, fire control systems.....	ML5c
Couplers, Optical fibre .....	5A001c.1
Coxiella burnetii.....	1C351b.1
CP (2 (5 Cyanotetrazolato) pentaamminecobalt(III) perchlorate).....	ML8a.22
CR (Dibenz-(b,f)-1,4-oxazepine) .....	ML7c.4
Critically safe tanks, nuclear fuel reprocessing .....	0B006
Cross-flow filtration equipment.....	2B352d
Crossed-field amplifier tubes .....	3A001b.1.b
Crucibles, liquid actinide resistant.....	2A225
Crucibles, resistant to molten uranium .....	0B001i.5
Crucibles, resistant to molten uranium .....	0B001g.2
Crucibles, resistant to molten uranium .....	0B001g.2
Crucibles, tantalum .....	2A225c.2
Cryocoolers for optical sensors.....	6A002d.1
Cryocoolers for optical sensors .....	6A002d.2
Cryogenic containers.....	9A006b
Cryogenic distillation columns .....	1B228
Cryogenic distillation towers & cold boxes.....	0B004b
Cryogenic equipment/accessories/components, military .....	ML20
Cryogenic heat exchangers .....	0B001d.7.a
Cryogenic heat pipes .....	9A006a
Cryogenic refrigeration units .....	0B001d.7.b
Cryogenic refrigerators .....	9A006a
Cryoseparators.....	0B001d.7.a
Cryptanalytic equipment or devices, digital .....	5A002a.2
Cryptography equipment or devices, analogue.....	5A002a.3
Cryptography equipment or devices, digital.....	5A002a.1
CS (o-Chlorobenzylidenemalononitrile).....	ML7c.2
Cs bis(5 nitrotetrazolato)pentaaminecobalt(III) perchlorate (BNCP).....	ML8a.23

CTPB (Carboxy-terminated polybutadiene).....	1C111b.1
Cultures of bacteria .....	1C351c
Cultures of bacteria .....	1C352b
Cultures of bacteria .....	1C353
Cultures of bacteria .....	1C354a
Cultures of fungi.....	1C353
Cultures of fungi.....	1C354b
Cultures of rickettsiae .....	1C351b
Cultures of rickettsiae .....	1C353
Cultures of viruses.....	1C351a
Cultures of viruses.....	1C352a
Cultures of viruses.....	1C353
Custom integrated circuits, industrial .....	3A001a.10
Cutting machines, gears .....	2B003
Cutting tool inserts, single diamond point.....	2B008e
CVD (Chemical vapour deposition) equipment .....	1B001d
CVD (Chemical vapour deposition) equipment .....	1B101d
CVD (Chemical vapour deposition) equipment .....	2B005a
CVD (Chemical vapour deposition) equipment, plasma enhanced .....	3B001d
CVD (Chemical vapour deposition) furnaces .....	2B104b & 2B105
CW (Chemical warfare) precursors .....	1C350
CW defoliants.....	ML7a
CW incapacitating agents.....	ML7a
CW nerve agents .....	ML7a
CW vesicant agents .....	ML7a
Cyanoethylated polyamine.....	ML8e.12
Cyanoethylated polyamine.....	ML8e.13
Cyanoethylated polyamine.....	ML8e.37
Cyanoethylated polyamine.....	ML8e.38
Cyanogen chloride .....	1C450a.4
Cyclonite (RDX) .....	ML8a.20
Cyclotetramethylenetetranitramine (HMX).....	ML8a.7
Cyclotrimethylenetrinitramine (RDX).....	ML8a.20
Cylinder wall lubrication technology, diesel engines.....	9E003e.3

## D

DACs (Digital-to-analogue converters).....	3A001a.5
Damping, flotation or lubricating fluids .....	1C006
Data acquisition equipment for wind tunnels, automatic .....	9B005
Data acquisition systems for gas turbine development .....	9B002
Databases libraries, parametric technical data .....	ML17f
Decanters, centrifugal .....	2B352c
Decaborane & derivatives.....	ML8a.6
Decontamination biocatalysts, chemical warfare (CW) agent .....	ML7h.1
Decoying equipment/apparatus/devices.....	ML4b
Deep-hole drilling machines .....	2B001f
Defensive systems against toxicological agents.....	ML7e
Deformable mirrors .....	6A004a.1
Degassing equipment .....	2B350
DEGDN (diethylene glycol dinitrate).....	1C111c
Degradation biocatalysts, chemical warfare (CW) agent .....	ML7h.1
Demolition charges & components.....	ML4a
Demolition charges & components.....	ML8a.b
Demolition kits & components, military .....	ML4a
Dengue fever virus .....	1C351a.3
Depleted uranium .....	0C001
Depth charges & components .....	ML4a
Depth sounders .....	6A001a.1
Design integration of guidance sets, software .....	7D103
Desublimers for UF <sub>6</sub> removal .....	0B002b
Detection and protection equipment (software).....	1A004
Detection devices, underwater.....	ML9c
Detection equipment explosive.....	ML4b
Detection or location systems (acoustic) .....	6A001a.1.b
Detection/defence systems, directed energy weapon systems.....	ML19d
Detectors, optical .....	6A002a
Detectors, radiation hardened .....	6A102
Detectors, space-qualified solid state optical.....	6A002a.1
Detonation apparatus/devices/equipment (explosive).....	ML4a



Detonation apparatus/devices/equipment (explosive).....	ML4b
Detonation apparatus/devices/equipment (explosive).....	ML8a c
Detonation apparatus/devices/equipment (explosive).....	ML909
Detonator firing sets, for multiple detonators of 3A232.....	3A229a
Detonator materials & devices containing them, military.....	ML8
Detonators, electric explosive.....	ML4a
Detonators, exploding bridge (EB).....	3A232a.1
Detonators, exploding bridge wire (EBW).....	3A232a.2
Detonators, exploding foil initiators (EFI).....	3A232a.4
Detonators, slapper (electric).....	3A232a.3
Deuterated compounds, (eg Deuterated paraffins).....	0C003
Deuterium & deuterium compounds as mixtures & solutions.....	0C003
Deuterium fluoride (DF) lasers.....	6A005a.5.b
Deuterium fluoride-carbon dioxide (DF-CO <sub>2</sub> ) lasers.....	6A005a.5.c.2
Deuterium/deuterium compound production plant, equipment & components.....	0B004
Devices containing military explosives, propellants & related substances.....	ML8
DF (Methyl phosphonyl difluoride).....	ML7b.1
DF (Methyl Phosphonyldifluoride).....	ML7b.1
Di-isopropylamine.....	1C350.48
Dialkyl N,N-dialkyl-phosphoramidates.....	1C450b.2
Diamino dinitrobenzofurozan (CL 14).....	ML8a.25
Diaminohexanitrobiphenyl (DIPAM).....	ML8a.15
Diaminotrinitrobenzene (DATB).....	ML8a.9
Diamond film substrate development/production technology.....	3E002d
Diamond point cutting tool inserts, single.....	2B008e
Diaphragm pumps.....	2B350i
Diaphragm valves.....	2B350g
Diaphragms, made from fluorinated compounds.....	1A001a
Dibenz-(b,f)-1,4-oxazepine (CR).....	ML7c.4
Dibromotetrafluoroethane based damping or flotation fluids.....	1C006c.1
Dies, bellows-forming.....	2B228c
Diesel cycle engine, air independent.....	8A002j
Diethyl ethylphosphonate.....	1C350.17
Diethyl methylphosphonate.....	1C350.56
Diethyl methylphosphonite.....	1C350.33
Diethyl phosphite.....	1C350.19
Diethyl-N, N-dimethylphosphoramidate.....	1C350.18
Diethylaminoethanol.....	1C350.49
Diethylene glycol dinitrate (DEGDN).....	1C111c
Diffusion bonding technology, metal working.....	2E003b.1.b
Diffusion bonding technology/data, super alloys or Ti alloys.....	2E003b.2.b
Diffusion bonding tools, dies, moulds or fixtures.....	1B003
Digital array processors.....	3A001a.3
Digital computer electronic assemblies, parallel processing.....	4A003c
Digital computer systems.....	4A001
Digital computer systems.....	4A003b
Digital computer systems.....	4A003c
Digital computer systems.....	4A004
Digital computers,.....	4A003
Digital computers, electronic assemblies & related equipment.....	4A001
Digital computers, electronic assemblies & related equipment.....	4A003
Digital computers, fault tolerant.....	4A003a
Digital computers, logic processors.....	4A003
Digital computers, ruggedised.....	4A101
Digital computers, signal processing.....	4A003
Digital computers, vector processors.....	4A003
Digital coprocessors.....	3A001a.3
Digital differential analysers, ruggedised.....	4A101
Digital electronic engine control software.....	9D003a
Digital instrumentation tape data recorders.....	3A002a.3
Digital signal processors.....	3A001a.3
Digital signal processors.....	4A003
Digital video magnetic tape recorders.....	3A002a.2
Digital-to-analogue converter integrated circuits (DACs).....	3A001a.5
Digitally controlled radio receivers.....	5A001b.4
Digitisers, waveform.....	3A002a.5
Dimensional inspection equipment/systems.....	2B006a
Dimensional inspection equipment/systems.....	2B006c
Dimensional Inspection machines.....	2B206
Dimensional measuring equipment, instruments/systems.....	2B006b
Dimensional measuring equipment, instruments/systems.....	2B006d

Dimethyl ethylphosphonate .....	1C350.34
Dimethyl hydrazine, symmetrical/unsymmetrical .....	ML8a.18
Dimethyl methylphosphonate .....	1C350.3
Dimethyl phosphite .....	1C350.6
Dimethylamine .....	1C350.16
Dimethylamine hydrochloride .....	1C350.20
DINGU (Dinitroglycoluril or DNGU) .....	ML8a.13
Dinitroazetidene t butyl salt .....	ML8e.14
Dinitrogen pentoxide .....	1C111a.3.c
Dinitrogen tetroxide (Nitrogen dioxide) .....	1C111a.3.b
Dinitrogen trioxide .....	1C111a.3.a
Dinitroglycoluril (DINGU/DNGU) .....	ML8a.13
Diodes, laser .....	6A005b
DIPAM (Diaminohexanitrobiphenyl) .....	ML8a.15
Diphenyl methylphosphonate .....	1C450b.1
Direct view imaging equipment .....	6A002c
Direct-acting hydraulic pressing technology for metal working .....	2E003b.2.c
Directed energy weapons (DEW) .....	ML19
Direction finding systems, equipment & components .....	7A007
Direction finding systems, equipment & components .....	7A103
Directional solidification casting control software .....	9D004c
Directional solidification casting equipment .....	9B001a
Discharging equipment, explosive .....	ML4b
Dissemination equipment for biological agents .....	ML7d
Dissemination equipment for radioactive materials .....	ML7d
Dissolvers, for nuclear fuel .....	0B006
Distillation columns .....	2B350e
Distillation columns, cryogenic .....	1B228
Distillation Towers (ammonia) .....	0B004b
Distillation towers and cold boxes (hydrogen cryogenic) .....	0B004b
Distillation towers, packings .....	1A226
Diving apparatus, articles & components .....	8A002q
Diving apparatus, articles & components .....	ML17a
DMCDB (Elastomer modified cast double based propellants) .....	ML8b.7
DNGU (Dinitroglycoluril or DINGU) .....	ML8a.13
Doppler laser interferometers (DLIs) .....	6A225
Double seal pumps .....	2B350i
Double seal valves .....	2B350g
Drag parachutes .....	ML10h.3
Drilling machines, deep-hole .....	2B001f
Drogue parachute ejector seats .....	ML10h.4
Drogue parachutes .....	ML10h.3,4
Drones .....	ML10d
Dry boxes capable of use with biological agents .....	2B352a.3
Dry etching equipment, anisotropic plasma .....	3B001c
Dummy ammunition, large bore weapons .....	ML3
Dye lasers .....	6A005d
Dye lasers .....	6A205
Dynamic adaptive routing software .....	5D001c.3
Dynamic signal analysers .....	3A002c.2
Dynamic wavefront (phase) measuring equipment .....	6A005f

**E**

Eastern equine encephalitis virus .....	1C351a.4
EB-PVD (Electron beam physical vapour deposition) equipment .....	2B005c
Ebola virus .....	1C351a.5
EDMs, non wire feed types .....	2B001d
EEFO (Bis (2 fluoro 2,2 dinitroethyl) formal) .....	ML8e.4
EEPROMs (Electrical erasable programmable read-only memories) .....	3A001a.4
Ejector seats .....	ML10a,b
Elastomer modified cast double based propellants (EMCDB) .....	ML8b.5
Electric detonators, explosive .....	3A232a
Electric detonators, explosive .....	ML4a
Electric propulsion engines .....	8A002o.2.b
Electrical discharge machines, non wire feed CNC .....	2B001d
Electrical erasable programmable read-only memories .....	3A001a.4
Electrically driven explosive detonators .....	3A232a
Electro-optic materials .....	6C004
Electro-optical integrated circuits .....	3A001a.6

Electrochemical reduction cells .....	0B001e.3
Electrochemical reduction cells .....	0B001e.4
Electrolysis cells, amalgam lithium isotope separation .....	1B233
Electrolytic cells, fluorine production .....	1B225
Electromagnetic amplifiers, superconductive devices .....	3A001d.1
Electromagnetic energy storage, superconductive devices .....	3A001e.3,4
Electromagnetic interference (EMI) protection technology .....	7E102
Electromagnetic isotope separation equipment & components .....	0B001j
Electromagnetic isotope separation plant .....	0B001a.9
Electromagnetic isotope separators .....	1B226
Electromagnetic pulse (EMP) protection technology, avionics .....	7E102
Electromagnetic pulse (EMP) protection, detectors .....	6A102
Electromagnetic radiation sensors, optical fibre .....	6A002d.3.a
Electromagnetic signature reduction material & devices .....	1C101
Electromagnetic underwater communications systems .....	5A001b.1
Electromagnets, superconductive .....	3A001e.3
Electromagnets, superconductive .....	ML20
Electromagnets, superconductive .....	3A201b
Electron beam cutting machines (CNC) .....	2B001e.1.b
Electron beam equipment for mask making/semiconductor devices .....	3B001f
Electron beam guns .....	0B001g.1
Electron beam melting furnaces .....	2B227b
Electron beam physical vapour deposition (EB-PVD) equipment .....	2B005c
Electron beam sensitive resist materials .....	3C002b
Electron beam systems, for probing semiconductor devices .....	3B002d
Electron bombardment mass spectrometers .....	3A233d
Electron cyclotron resonance (ECR) CVD equipment .....	3B001d
Electron cyclotron resonance (ECR) plasma dry etching equipment .....	3B001c
Electronic assemblies .....	4A003
Electronic cameras .....	6A003a.5
Electronic components .....	3A001
Electronic components .....	3A101
Electronic components .....	3A201
Electronic components .....	ML11
Electronic computers & related equipment .....	4A001-4
Electronic computers & related equipment .....	4A101
Electronic computers & related equipment .....	4A102
Electronic cooling fluids .....	1C006d
Electronic devices, high current/voltage/speed switching .....	3A228
Electronic devices, high current/voltage/speed switching .....	ML11
Electronic equipment for reentry vehicles .....	9A116c
Electronic equipment, military .....	ML11
Electronic framing cameras .....	6A203b.3
Electronic streak cameras & streak tubes .....	6A003a.3
Electronic streak cameras & streak tubes .....	6A203b
Electronic vacuum tubes, microwave/millimetre wave devices .....	3A001b.1
Electronic vacuum tubes, microwave/millimetre wave devices .....	ML11
Electronic valves, industrial vacuum .....	3A228
Electronically steerable antennae, phased array .....	5A001d
EMP/EMI protection technology, avionic systems .....	7E102
Encoders, rotary input shaft type .....	3A001f
Encrypted GPS (Global Positioning System) equipment & components .....	7A005a
Encryption equipment, assemblies & components .....	5A002
Encryption software .....	5D002
End effectors, robot .....	2B007
End effectors, robot .....	2B207
End effectors, robot .....	ML17e
Energetic monomers, plasticisers & polymers .....	ML8e.15
Energy storage capacitors (high capacity) .....	3A001e.2
Energy storage, superconductive devices .....	3A001e.3
Energy storage, superconductive devices .....	3A001e.4
Engines & related equipment/components, military vehicles .....	ML6i
Engines, aircraft military .....	ML10c
Enriched uranium or materials containing it .....	0C002
Enrichment plant, isotope .....	0B001
Environmental chambers, capable of simulating flight conditions .....	9B106a
Environmental test facilities, military .....	ML18b
Epitaxial growth equipment .....	3B001a
Epitaxial wafers, Cadmium telluride (CdTe) .....	6C002b
Erbium oxide (erbia) (Er <sub>2</sub> O <sub>3</sub> ) made/coated crucibles .....	2A225a.2
Ethers (alkylphenylene) in the form of a lubricating fluid .....	1C006b.1

Ethyl diethanolamine .....	1C350.59
Ethyl phosphinyl dichloride .....	1C350.21
Ethyl phosphinyl difluoride .....	1C350.35
Ethyl phosphonyl dichloride .....	1C350.22
Ethyl phosphonyl difluoride .....	1C350.23
Ethyl diethanolamine .....	1C450b.7
Evaporators for concentrated lithium hydroxide solution .....	1B233
Exchange columns, liquid-liquid for lithium amalgams .....	1B233
Excimer lasers .....	6A005a.1
Exit cones, liquid rocket propulsion .....	9A006h
Expander cycle turbine drive systems .....	9A006d
Expert systems - integration systems technology .....	2E003d
Expert systems software .....	4D003b
Exploding bridge (EB) detonators .....	3A232a.1
Exploding bridge wire (EBW) detonators .....	3A232a.2
Exploding foil initiators (EFI) .....	3A232a.4
Explosive charge activation equipment .....	ML4b
Explosive charge control equipment .....	ML4b
Explosive charge decoying equipment .....	ML4b
Explosive charge detection equipment .....	ML4b
Explosive charge handling equipment .....	ML4b
Explosive charge jamming equipment .....	ML4b
Explosive charge laying equipment .....	ML4b
Explosive detection equipment .....	ML4b
Explosive detonators, industrial electric .....	3A232a
Explosive detonators, military .....	ML4a
Explosive detonators, military .....	ML8a,b
Explosive detonators, non-military .....	ML909
Explosive devices .....	ML4a
Explosive devices .....	ML8a,b
Explosive devices, non-military .....	ML909
Explosive, high (industrial) .....	1C239
Explosive, material .....	ML8a,b
Explosive, material, non-military .....	ML908
Explosive/munitions environment handling robots .....	2B007b
Explosives/propellants/pyrotechnics .....	ML8b.6
Expression vectors, biocatalyst production systems .....	ML7h.2
Extended temperature range semiconductor components .....	3A001a.2

**F**

FADEC (Full authority digital electronic engine control)-software .....	9D003
Fast exchange liquid liquid centrifugal contactors .....	0B001e.2
Fast exchange liquid liquid pulse columns .....	0B001e.1
Fast Fourier Transform (FFT) processors .....	3A001a.12
Fast Fourier Transform processors, acoustic signal processing .....	6A001c
Fast switching function modules or assemblies .....	3A228c
Fault tolerance FADEC software .....	9D003b
Fault tolerant digital computers .....	4A003a
Fe <sub>2</sub> O <sub>3</sub> (Hematite), superfine .....	ML8e.24
Feed preparation systems for Uranium Chloride production .....	0B001e.5
Fermenters, biological processing .....	2B352b
Fibre and filamentary material .....	1C010
Fibre and filamentary material .....	1C210
Fibre optic cable .....	5A001c.1
Fibre optic hull penetrators/connectors .....	8A002c
Fibre optic magnetometers .....	6A006e
Fibre surface treatment equipment .....	1B101e
Fibrous & filamentary materials .....	1C010d
Fibrous or filamentary material production .....	1B001
Fibrous or filamentary material production .....	1B101
Fibrous or filamentary materials .....	1C010
Fibrous or filamentary materials .....	1C210
Field engineer equipment .....	ML17d
Field programmable gate arrays (FPGA) .....	3A001a.7
Field programmable logic arrays (FPLA) .....	3A001a.8
Filament winding machine software .....	1D001
Filament winding machine software .....	1D101
Filament winding machine software .....	1D201
Filament winding machines .....	1B001a

Filament winding machines .....	1B101a
Filament winding machines .....	1B201
Filament-wound composite motor cases .....	9A008a
Filamentary materials .....	1C010b
Filling equipment, remotely controlled .....	2B350f
Film processing equipment, military .....	ML15b
Film type integrated circuits .....	ML11
Film type integrated circuits, industrial .....	3A001a
Filters, optical opacity switch .....	6A004d.3
Filters, tunable band-pass .....	3A001b.5
Fingers, for surface effect vessels .....	8A002k
Finishing machines, gear .....	2B003
Fire bombs & components .....	ML4a
Fire control (military) equipment & related systems .....	ML5
Firearms .....	ML1
Firearms, non-military .....	ML901
Firing sets .....	ML4b
Firing sets, for multiple detonators of 3A232 .....	3A229a
Fissile materials or materials containing them .....	0C002
Fittings, designed for reduced reflectivity .....	ML17c
Flame throwers, military .....	ML2a
Flash discharge X-ray generators .....	3A201c
Flash suppressors .....	ML1d
Flexible isolators capable of use with biological agents .....	2B352a.3
Flexible nozzles, solid rocket motor .....	9A108c
Flexible nozzles, thrust vector control sub-system .....	9A106b
Flexible rotor centrifugal balancing machines .....	2B229a
Flexible sensors for hydrophones .....	6A001a.2.a.1
Flight control actuator technology .....	7E004a.5
Flight control system development technology .....	7E004
Flight control systems .....	7A116
Flight control systems - software .....	7D003e
Flight instrument systems, integrated .....	7A103
Flight management system integration technology .....	1E104
Flight simulators .....	ML14
Flightweight Dewars .....	9A006a
Flow forming/Spin forming equipment, software .....	2D101
Flow forming/Spin forming equipment, software .....	2D201
Flow-forming machines .....	2B009
Flow-forming machines .....	2B109
Flow-forming machines .....	2B209
Fluid energy mills .....	1B119
Fluid or secondary gas injection thrust systems .....	9A108c
Fluorinated compounds .....	1C009
Fluorinated compounds, components .....	1A001
Fluorinated phosphazene elastomers .....	1C009c
Fluorinated polyimides .....	1C009b
Fluorinated silicone fluid .....	1C006b.2
Fluorinating equipment, UF <sub>5</sub> to UF <sub>6</sub> .....	0B001h.4
Fluorine production (electrolysis cells) .....	1B225
Fluoroelastomer compounds, technology .....	1E002b
Fluorophosphate glass .....	6C004e
Fluorocarbon electronic cooling fluids .....	1C006d
Fluxgate magnetometer technology .....	6E003c
Fly-by-light flight control system software .....	7D003e
Fly-by-wire control system technology .....	7E004b
Fly-by-wire flight control system software .....	7D003e
Fly-by-wire systems .....	7A116
Foam mirror structures, lightweight .....	6A004a.3
Foam, syntactic for underwater use .....	8C001
Focal plane arrays, direct view .....	6A002c.2
Focal plane arrays, linear & 2D .....	6A002a.3
Focal plane arrays, space qualified .....	6A002e
Foot & mouth disease virus .....	1C352a.4
Forgings, for non-military firearms .....	ML903
Forgings, military .....	ML16
PPF 1 (Poly 2,2,3,3,4,4 hexafluoropentane 1,5 diol formal) .....	ML8e.16
PPF 3 (Poly 2,4,4,5,5,6,6 heptafluoro 2 trifluoromethyl 3 oxahепtane 1,7 diol formal) .....	ML8e.17
FPGA's (Field programmable gate arrays) .....	3A001a.7
FPLA's (Field programmable logic arrays) .....	3A001a.8
Framing cameras, electronic type .....	6A203b.3

Framing cameras, electronic type .....	6A003a.4
Framing cameras, mechanical.....	6A203a.1
Framing tubes & solid state imaging devices .....	6A203b.4
Francisella tularensis.....	1C351c.7
Freeze drying equipment, steam sterilisable.....	2B352e
Frequency agile systems .....	5A002a.5
Frequency agile tubes.....	3A001b.1
Frequency agility development technology.....	5E001b.10
Frequency analysers (signal analysers).....	3A002c.1
Frequency changers (converters or inverters).....	0B001b.13
Frequency changers (converters or inverters) .....	3A225
Frequency extenders, mixers/converters.....	3A001b.7
Frequency hopping (frequency agile) radio equipment.....	5A001b
Frequency standards, atomic.....	3A002g
Frequency synthesised signal generators.....	3A002d
Frequency synthesiser, electronic assemblies.....	3A002b
Fuel cell air independent power systems .....	8A002j
Fuel element chopping or shredding machines.....	0B006
Fuel element fabrication plant, for nuclear reactors .....	0B005
Fuel element handling equipment, for nuclear reactors .....	0A001c
Fuel, aircraft (military high energy).....	ML8d
Fuels, industrial metal powder.....	1C111a.1
Fuels, industrial metal powder.....	1C111a.2
Full Authority Digital Electronic Engine Control software .....	9D003
Functional testing equipment, for integrated circuits .....	3B002b
Fungi, plant pathogens .....	1C354b
Furnaces.....	2B226
Furnaces.....	2B227
Furnaces, Chemical Vapour Deposition (CVD).....	2B104b
Fused silica, low optical absorption types .....	6C004e

## G

GA (Tabun).....	ML7a
GaAs photocathodes.....	6A002a.2.b.2
GaAs semiconductor integrated circuits, industrial.....	3A001a.11
GaInAs photocathodes .....	6A002a.2.b.2
Gallium III/V compound substrates, hetero-epitaxial grown-multi-layer.....	3C001c
Gallium organo-metallic compounds.....	3C003
GAP (Glycidylazide Polymer).....	0B001d.3
GAP (Glycidylazide Polymer).....	ML8e.18
Gas blowers .....	0B001c.3
Gas centrifuge isotope separation equipment & components .....	0B001b
Gas centrifuge isotope separation plant.....	0B001a.1
Gas centrifuge plant auxiliary equipment.....	0B002
Gas centrifuge rotor assembly equipment .....	2B228a
Gas centrifuge rotor balancing equipment.....	2B229
Gas centrifuges.....	0B001b.1
Gas discharge & ion lasers.....	6A005a.6
Gas generator turbine drive system.....	9A006d
Gas krytron tubes .....	3A228a
Gas lasers.....	6A005a
Gas monitoring systems, toxic.....	2B351
Gas projectors/generators.....	ML2b
Gas turbine (aero engine) test software .....	9D004b
Gas turbine aeroengine assemblies/components.....	ML10c
Gas turbine aeroengines, civil non-certified/supersonic.....	9A001
Gas turbine aeroengines, military .....	ML10c
Gas turbine blade technology.....	9E003a
Gas turbine blade, manufacturing or measuring equipment.....	9B001
Gas turbine brush seal production/test equipment.....	9B003
Gas turbine components, solid state joining equipment .....	9B004
Gas turbine development control systems or instrumentation.....	9B002
Gas turbine engine development systems/instrumentation .....	9B002
Gas turbine engine propulsion systems & assemblies/components .....	9A003
Gas turbine engine technology.....	9E003
Gas turbine engines & assemblies/components, marine .....	9A002
Gas turbine engines, aero .....	ML10c
Gas turbine test/flow modelling software.....	9D004a
Gas, tear .....	ML7c

Gaseous diffusion barriers .....	0B001c.1
Gaseous diffusion housings .....	0B001c.2
Gaseous diffusion isotope separation equipment & components .....	0B001c
Gaseous diffusion isotope separation plant .....	0B001a.2
Gaseous diffusion plant auxiliary equipment .....	0B002
Gaskets .....	1A001a
Gate arrays, field programmable (FPGA) .....	1A001a.7
Gate silicon intensifier target (SIT) videcon tubes .....	6A203b.4.b
GB (Sarin) .....	ML7a
GD (Soman) .....	ML7a
GDMS (Glow discharge mass spectrometers) .....	3A233b
Gear cutting machines .....	2B003
Gear finishing machines .....	2B003
Gear grinding machines .....	2B003
Gear honing machines .....	2B003
Generation of machine tool instruction - technology .....	2E003d
Generator systems, neutron .....	3A231
Generators, high-current pulse for detonators .....	3A229
Generators, high-speed pulse .....	3A230
Generators, pyrotechnic .....	ML2b
Genetically-modified microorganisms .....	1C353
Geophones, terrestrial .....	6A001b
Germanium, hetero-epitaxial grown multi-layer substrates .....	3C001b
Gimbals, optical control .....	6A004d.3
Glass fibre or filamentary materials .....	1C210b
Glass fibre, for optical communications .....	5A001c.1
Glass matrix reinforced composite materials .....	1C007f
Glass preforms, for optical fibre production .....	5C001
Glass Windows, nuclear radiation shielding .....	1A227
Glass, high homogeneity .....	6C004e
Global positioning system (GPS) equipment & components .....	7A005
Glove boxes capable of use with biological agents .....	2B352a.3
Glow discharge mass spectrometers (GDMS) .....	3A233b
Glycidylazide Polymer (GAP) & its derivatives .....	ML8e.18
Goat pox virus .....	1C352a.5
Gold (Au) metal vapour lasers .....	6A005a.2.b
GPS (Global positioning system) equipment/components .....	7A005
GPS equipment, other than those of 7A005 .....	7A105
Gradiometers & components, gravity .....	6A007c
Gradiometers & components, gravity .....	6A107
Gradiometers & components, magnetic .....	6A006
Graphics accelerators or graphics coprocessors .....	4A003d
Graphite heat exchangers .....	2B350d
Graphite, bulk .....	1C107a
Graphite, fine grain recrystallised high density .....	1C107a
Graphite, nuclear-grade .....	0C004
Gravimeters (Gravity meters) & components, gravity .....	6A007a
Gravimeters (Gravity meters) & components, gravity .....	6A007b
Gravimeters (Gravity meters) & components, gravity .....	6A107
Gravity gradiometer software .....	6D003c
Gravity gradiometers & components .....	6A007c
Gravity gradiometers & components .....	6A107
Gravity meter (gravimeters) products & calibration equipment .....	6B007
Gravity meters (gravimeters) & components .....	6A007a
Gravity meters (gravimeters) & components .....	6A007b
Gravity meters (gravimeters) & components .....	6A107
Gravity meters (gravimeters) software .....	6D003c
Grenades & components .....	ML4a
Grinding machines .....	2B001c
Grinding machines .....	2B201b
Grinding machines, gear .....	2B003
Ground support launch vehicles .....	9A115b
Guanidine nitrate .....	1C011
Guanidine nitrate .....	ML8e.19
Guidance set, production facilities .....	7B103
Guidance sets .....	7A117
Gun carriers & related equipment/components .....	ML6f
Gun laying equipment .....	ML5a
Gun mountings .....	ML1d
Gun propellants .....	ML8a,b
Guns & components .....	ML1

Guns, large calibre .....	ML2a
Gyro dynamic balance stations .....	7B003b
Gyro evacuation/fill stations .....	7B003d
Gyro run-in/motor test stations .....	7B003c
Gyro tuning test stations.....	7B003a
Gyro-astro compasses & devices .....	7A104
Gyros & gyro components .....	7A002
Gyros & gyro components .....	7A102
Gyroscope production/manufacturing/test equipment.....	7B003

**H**

Hafnium fluoride (HfF <sub>4</sub> ) glass .....	6C004e
Hafnium metal, alloys & compounds .....	1C231
Hafnium oxide (hafnia) (HfO <sub>2</sub> ) made/coated crucibles .....	2A225a.2
Hair type absorbers .....	1C001a
Half tracks & related equipment/components .....	ML6d
HAN (Hydroxylammonium nitrate) .....	ML8a.21
Handling apparatus/devices for explosives & explosive devices .....	ML4b
Handling equipment for propellants and their constituents .....	1B111
Handling equipment for rocket launchers .....	9A115a
Handling systems, semiconductor wafers .....	3B001e
Hantaan virus.....	1C351a.6
HAP (Hydroxylammonium perchlorate) .....	ML8a.21
HBIW (Hexabenzylhexaazaisowurtzitane).....	ML8e.20
Heading sensors.....	6A001a.2.d
Heading sensors, towed hydrophones .....	6A001a.2.b.4
Heat exchangers & condensers .....	0A001i
Heat exchangers & condensers .....	0B001c.5
Heat exchangers & condensers .....	0B001d.4
Heat exchangers & condensers .....	2B350d
Heat pipe cooled mirrors.....	6A005e.1
Heat shields/components, reentry vehicle .....	9A116a
Heat sinks/components, reentry vehicle .....	9A116b
Heat source materials .....	1C012
Heavy artillery transporters.....	ML6i
Heavy duty recovery vehicles, military .....	ML6e
Heavy water (Deuterium oxide).....	0C003
Heavy water concentration equipment.....	0B004b.8
Heavy water production plant, equipment & components .....	0B004
Helicopter power transfer system technology .....	9E003d
Helicopter system development technology .....	7E004c
Helicopters, military.....	ML10a,b
Helium refrigeration units .....	1B231
Helium, enriched .....	1C232
Helmets, military.....	ML13c
Helmets, military .....	ML10g
Helminthosporium oryzae (Cochliobolus miyabeanus) .....	1C354b.2
Hematite (Fe <sub>2</sub> O <sub>3</sub> ), superfine .....	ML8e.24
Hemishell dimensional inspection equipment/systems .....	2B006c
Hetero-epitaxial grown multi-layer substrates.....	3C001
Hetero-structure semiconductor technology.....	3E002b
Hexabenzylhexaazaisowurtzitane (HBIW).....	ML8e.20
Hexahydro 1,3,5 trinitro 1,3,5 triazine.....	ML8a.20
Hexanitrohexaazaisowurtzitane (CL 20 or HNIW).....	ML8a.30
Hexanitrostilbene (HNS).....	ML8a.8
Hexogen.....	ML8a.20
Hexogene.....	ML8a.20
High birefringence optical fibre.....	6A002d.3.b
High energy fuels (military aircraft).....	ML8d
High energy photovoltaic arrays .....	3A001e.1.c
High energy storage capacitors .....	3A001e.2
High energy storage capacitors .....	3A201a
High power electron beam guns .....	0B001g.1
High pressure nozzles .....	9A006d
High pressure thrust chambers.....	9A006e
High pressure turbo pumps, pump components.....	9A006d
High voltage power supplies for ion sources.....	0B001j.5
High-speed cameras .....	6A003
High-speed cameras .....	6A203



High-speed pulse generators .....	3A230
High-velocity gun systems .....	2B232
HIPS (Hot Isostatic Presses) .....	2B004
HIPS (Hot Isostatic Presses) .....	2B104a
HIPS (Hot Isostatic Presses) .....	2B204
HMX (Cyclotetramethylenetetranitramine) .....	ML8a.7
HN1 (bis (2-chloroethyl) ethylamine) .....	ML7a
HN2 (bis (2-chloroethyl) methylamine) .....	ML7a
HN3 (tris (2-chloroethyl) amine) .....	ML7a
HNIW (Hexanitrohexaazaisowurtzitane or CL 20) .....	ML8a.30
HNS (Hexanitrostilbene) .....	ML8a.8
Holding or storage vessels, critically safe .....	0B006
Hollow cylinder centrifugal balancing machines .....	2B229b
Honing machines, gear .....	2B003
Hopping code generation capability, equipment with .....	5A002a.5
Hopping code generation capability, equipment with .....	ML11
Hot cell manipulators .....	2B225
Hot isostatic densification technology/data, Al/Ti/Superalloys .....	2E003b.2.d
Hot isostatic press, use software .....	2D201
Hot isostatic presses (HIPS) .....	2B004
Hot isostatic presses (HIPS) .....	2B104a
Hot isostatic presses (HIPS) .....	2B204
Hovercraft .....	8A001
Howitzers .....	ML2a
HTPB (Hydroxy-terminated polybutadiene) propellant additive .....	1C111b.2
HTPB (Hydroxyl terminated polybutadiene) .....	ML8e.22
Hull penetrators, military .....	ML9f
Hull penetrators/connectors, fibre optic .....	8A002c
Human pathogens .....	1C351a-c
Hybrid computer electronic systems/electronic assemblies .....	4A001a
Hybrid computer electronic systems/electronic assemblies .....	4A001b
Hybrid computers .....	4A102
Hybrid computers & components .....	4A001
Hybrid computers, containing digital computers of 4A003 .....	4A002
Hybrid integrated circuits, industrial .....	3A001a
Hybrid integrated circuits, military .....	ML11
Hybrid rocket motors/propulsion systems .....	9A009
Hybrid rocket motors/propulsion systems .....	9A109
Hydraulic fluids, pressure transmission .....	1C006a
Hydraulic pressing technology (metal working) .....	2E003b
Hydraulic stretch-forming machines technology .....	2E003c
Hydrazine in concentrations of 70% or more .....	ML8c.4.a
Hydrazine nitrate .....	ML8d.8
Hydrazine perchlorates .....	ML8d.9
Hydrides of Antimony, arsenic & phosphorus .....	3C004
Hydrocarbon fuels thickeners (including M1, M2, M3) .....	ML8d
Hydrocarbon oils, synthetic .....	1C006
Hydroclave regulation technology .....	1E103
Hydrocyanic acid .....	1C450a.5
Hydrofoil vessels .....	8A001h
Hydrofoils .....	8A002m
Hydrogen cyanide .....	1C450a.5
Hydrogen fluoride .....	1C350.24
Hydrogen fluoride (HF) lasers .....	6A005a.5.a
Hydrogen isotope storage & purification systems .....	1B231
Hydrogen refrigeration units .....	1B231
Hydrogen sulphide water exchange plant, equipment & components .....	0B004a.1
Hydrogen sulphide water exchange plant, equipment & components .....	0B004a.1
Hydrogen sulphide-water exchange plant, equipment & components .....	1B229
Hydrophone arrays, towed acoustic .....	6A001a.2.b
Hydrophones .....	6A001a.2.a
Hydrophones, military .....	ML9c
Hydroxy-terminated polybutadiene (HTPB) .....	1C111b.2
Hydroxyl terminated polybutadiene (HTPB) .....	ML8e.22
Hydroxylammonium nitrate (HAN) .....	ML8a.21
Hydroxylammonium perchlorate (HAP) .....	ML8a.21

**I**

ICP/MS (Inductively coupled plasma mass spectrometers)	3A233a
Identification systems, directed energy weapon systems	ML19d
III/V compound substrates, gallium or indium	3C001c
Image enhancement, digital equipment	4A003
Image intensifier tubes & components	6A002a.2
Image intensifier tubes, direct view	6A002c.1
Image intensifier tubes, military	ML15c,d
Image processing equipment, military	ML15a
Imaging cameras	6A003b
Imaging cameras	6A203c
Imaging cameras	ML15b
Imaging cameras with focal plane arrays of 6A002a.2.b	6A003b.4
Imaging cameras with image intensifiers of 6A002a.2.a	6A003b.3
Imaging devices	6A002
Imaging devices	6A203b.4
Imaging devices	ML15b e
Imaging equipment, visible & infrared	6A002c
Imaging equipment, visible & infrared	ML15d
Imaging radar sensor equipment	ML15e
Imaging sensors, multispectral and monospectral	6A002b
Imaging systems, underwater electronic	8A002f
Impregnated cathodes for electronic microwave tubes	3A001b.1.c
Incendiary bombs & components	ML4a
Incendiary munitions	ML3
Incinerators designed to destroy the chemicals of 1C350	2B350j
Independent (air) power systems underwater	8A002j
Indium III/V compounds substrates	3C001c
Indium organo-metallic compounds	3C003
Induction coil magnetometers	6A006b
Induction furnace, controlled environment inert gas	2B226
Induction furnace, vacuum	2B226
Inductively coupled plasma mass spectrometers (ICP/MS)	3A233a
Inert gas environment induction furnaces	2B226
Inertial navigation system software, source code	7D002
Inertial navigation systems integration software	7D102
Inertial navigation, systems/equipment/components	7A003
Inertial navigation, systems/equipment/components	7A103
Inertial sensors, optical fibre	6A002d.3.a
Information security - test, inspection equipment for	5B002
Information security software	5D002
Information security systems/equipment/devices	5A002
Information security technology	5E002
Information security technology support software	5D002b
Infrared (thermal) imaging equipment	ML15d
Infrared absorption analysers, on line	0B004b.6
Infrared cameras, industrial	6A003b
Infrared cameras, military	ML15
Infrared detectors	ML15
Infrared detectors, industrial space qualified	6A002a.1
Infrared detectors, industrial space qualified	6A002a.3
Infrared detectors, industrial space qualified	6A002a.4
Infrared sensors, industrial	6A002a,b
Infrared sensors, military	ML15d
Inhibited red fuming nitric acid (IRFNA)	ML8d
Initiation systems, single or multipoint (electric)	3A232b
Initiators, explosive detonators (electric)	3A232a
Injectors for use with liquid propelling charges	ML2a
Inorganic fibres & filamentary materials	1C010c
Inorganic fibres & filamentary materials	1C210b
Inorganic overlay coating application technology	2E003f
Inspection equipment (linear-angular for hemishells)	2B006c
Instruction generators for machine tools - technology	2E003d
Instrumentation cameras	6A003a
Instrumentation cameras	6A203
Instrumentation for gas turbine development	9B002
Instrumentation for wind tunnels	9B005
Instrumentation systems, inertial navigation	7A003
Insulation bonding/liner system components, rocket motor	9A008a
Insulation, rocket motor case	9A108a

Integrated circuit computer-aided-design (CAD) software .....	3D003
Integrated circuit test equipment, .....	3B002b
Integrated circuit test equipment, .....	3B002c
Integrated circuit, masks .....	3B001g
Integrated circuits .....	ML11
Integrated circuits, general purpose industrial .....	3A001a
Integrated circuits, microwave .....	3A001b.2
Integrated flight instrument systems/components .....	7A103
Integrated system source code, avionic/mission systems .....	7D003c
Integration software for expert systems .....	2E003e
Integration technology for flight management systems .....	1E104
Interconnect equipment (Computer) .....	4A003g
Interferometers, velocity (VISARs) .....	6A225
Interior linings, rocket motor case .....	9A108a
Interlacing machines .....	1B001c
Internals, reactor nuclear .....	0A001h
Interstages for rockets .....	9A117
Intrinsic magnetic gradiometers .....	6A006f
Inverse synthetic aperture radar (ISAR) .....	6A008d
Inverters (Frequency changers or converters) .....	0B001b.13
Inverters (Frequency changers or converters) .....	3A225
Ion beam equipment for mask making/semiconductor devices .....	3B001f
Ion beam sensitive resist materials .....	3C002b
Ion collector plates, Uranium fluoride resistant .....	0B001j.2
Ion exchange columns .....	0B001f.2
Ion exchange isotope separation plant .....	0B001a.5
Ion exchange processing .....	0B006
Ion exchange reflux systems .....	0B001f.3
Ion exchange resins .....	0B001f.1
Ion exchange separation process equipment & components .....	0B001f
Ion implantation equipment .....	3B001b
Ion implantation production equipment .....	2B005b
Ion lenses .....	6A005a.6
Ion plating production equipment .....	2B005g
Ion sources, electron bombardment mass spectrometers .....	3A233d
Ion sources, glow discharge mass spectrometers (GDMS) .....	3A233b
Ion sources, ICP/MS mass spectrometers .....	3A233a
Ion sources, mass spectrometers (UF6 enrichment plant) .....	0B002g
Ion sources, molecular beam mass spectrometers .....	3A233e
Ion sources, single or multiple .....	0B001j.1
Ion sources, thermal ionization mass spectrometers (TIMS) .....	3A233c
IRFNA (Inhibited red fuming nitric acid) .....	ML8d
Iron metal/alloy powder (fuel) .....	ML8a.2.c
Iron oxide .....	ML8f.19
Iron powder .....	ML8a.2.c
Isolators capable of use with biological agents .....	2B352a.3
Isostatic press, software for use of .....	2D201
Isostatic presses, hot .....	2B004
Isostatic presses, hot .....	2B104a
Isostatic presses, hot .....	2B204
Isotope separation plant, systems, equipment & components .....	0B001
Isotope separators, electromagnetic .....	0B001a.9
Isotope separators, electromagnetic .....	1B226
Isotopic analysis, collector systems .....	0B002g.4

## J

Jamming equipment, explosive device .....	ML4b
Japanese encephalitis virus .....	1C351a.20
Jet engine combustion regulation devices .....	9A118
Jet engines/components, pulse .....	9A111
Jet probes, thrust vector control sub-system .....	9A106b
Jet probes, thrust vector control sub-system .....	9A108c
Jet vane, thrust vector control sub-systems .....	9A106b
Jet vanes/probes, thrust vector control sub-systems .....	9A108c
Josephson effect devices .....	6A006h
Joule-Thomson self-regulating minicoolers .....	6A002d.2.b.6
Junin virus .....	1C351a.7

**K**

K 55 (Tetranitrosemiglycouril).....	ML8a.27
K 6 (2,4,6 Trinitro 2,4,6 triazacyclohexanone) .....	ML8a.26
Kerr or Pockel cells, electro-optical shuttering .....	6A203b.4.c
Keto bicyclic HMX.....	ML8a.27
Keto RDX (2,4,6 Trinitro 2,4,6 triazacyclohexanone or K 6).....	ML8a.26
KICA 12 (Neopentyl (diallyl) oxy, tri (dioctyl) phosphatoti butanolate tris(dioctyl) phosphato O).....	ML8e.30.a
Kinetic energy weapon systems & related equipment.....	ML12a
KR3512 (Titanium IV, ((2 propenolato 1)methyl, N propanolato methyl)butanolato 1 .....	ML8e.30.c
KR3538 (Titanium IV, ((2 propenolato 1)methyl, N propanolato methyl)butanolato 1 .....	ML8e.30.b
Krypton ion lasers .....	6A005a.6
Krytron tubes, gas .....	3A228a

**L**

Laminates & composite structures, organic or carbon .....	1A002
Laminates, in tube form .....	1A202
Laminates, rockets/propulsion systems/space vehicles .....	9A110
Land inertial navigation equipment .....	7A003
Land-based gravity meters production equipment .....	6B007
Large calibre weapons.....	ML2a
Laser altimeters .....	7A106
Laser based linear position feedback units .....	2B008b
Laser based measuring instruments .....	2B006b.1.c
Laser beam cutting machines (CNC).....	2B001e.1.c
Laser beam equipment for mask making/semiconductor devices.....	3B001f
Laser beam systems, for probing semiconductor devices .....	3B002d
Laser communication technique software .....	5D001d.2
Laser communication technique technology .....	5E001b.2
Laser diagnostic equipment .....	6A005f
Laser diodes, general purpose .....	6A005b
Laser gyro mirror characterisation equipment.....	7B102
Laser isotope plant, systems, equipment & components .....	0B001
Laser isotope plant, systems, equipment & components.....	0B001g
Laser isotope plant, systems, equipment & components.....	0B001h
Laser radar or Light Detection & Ranging (LIDAR) equipment .....	6A008j
Laser radar systems .....	6A108
Laser ring gyro test equipment.....	7B002
Laser ring gyros & gyro components.....	7A002
Laser weapon systems.....	ML19a
Lasers.....	ML19a
Lasers or laser systems, uranium isotope separation .....	0B001g.5
Lasers or laser systems, uranium isotope separation.....	0B001h.6
Lasers, industrial .....	6A005
Lasers, industrial .....	6A205
Lassa fever virus.....	1C351a.8
Lathes (CNC) .....	2B001a
Launch apparatus or devices, missile.....	9A115a
Launch ground support vehicles .....	9A115b
Launch vehicle components/structures .....	9A010
Launchers, projectile .....	ML4b
Launchers, projectile .....	ML2a
Launching equipment .....	ML2a
Launching equipment.....	ML4b
Laying equipment, explosive .....	ML4b
Lead beta resorcyate.....	ML8e.25
Lead citrate .....	ML8f.6
Lead copper chelates.....	ML8e.27
Lead maleate .....	ML8e.26
Lead salicylate.....	ML8e.2
Lead stannate.....	ML8e.26
Lenses for radiation hardened TV cameras .....	6A203c
Lewisites.....	ML7a
Libraries, of military parametric technical databases.....	ML17f
Lidar equipment (Laser radar) .....	6A008j
Lift fans, for surface effect vessels .....	8A002l
Light gas guns .....	ML12a
Light gas guns (multistage) systems .....	2B232
Light systems, underwater .....	8A002d.2

Light systems, underwater .....	8A002g
Light-weight reduction gearing, marine transmissions .....	8A002o.1.d
Lightweight composite or foam mirror structures .....	6A004a.3
Lightweight monolithic mirrors .....	6A004a.2
Lightweight turbofan/turbojet engines .....	9A101
Linear focal plane arrays .....	6A002a.3
Linear measuring equipment/instruments .....	2B006b.1
Linear measuring equipment/instruments .....	2B006b.2
Linear position feedback units or sensors .....	2B008b
Linear voltage displacement transformer (LVDT) based instruments .....	2B006b.1.b.1
Linear-angular inspection equipment for hemishells .....	2B006c
Liquid fuels, military high energy .....	ML8a,b,d
Liquid lasers .....	6A005d
Liquid or water jet cutting machines (CNC) .....	2B001e.1.a
Liquid oxidisers .....	ML8d
Liquid oxidisers, various nitrous oxides .....	1C111a.3
Liquid propellant control systems .....	9A106b
Liquid propellant injectors .....	9A006g
Liquid propellant rocket engines .....	9A005
Liquid propellant rocket engines .....	9A105
Liquid rocket fuels .....	ML8a,b,d
Liquid rocket propulsion systems & components .....	9A005
Liquid rocket propulsion systems & components .....	9A006
Liquid rocket propulsion systems & components .....	9A010
Liquid rocket propulsion systems & components .....	9A105
Liquid rocket propulsion systems & components .....	9A106
Liquid rocket propulsion systems & components .....	9A119
Liquid Uranium handling systems .....	0B001i.4
Liquid-liquid exchange columns, for lithium amalgams .....	1B233
Lithium amalgam electrolysis cells .....	1B233
Lithium amalgam processing equipment .....	1B233
Lithium amalgam pumps .....	1B233
Lithium hydroxide solution, evaporators for .....	1B233
Lithium isotope separation facilities, plant and equipment .....	1B233
Lithium metal, hydrides or alloys .....	1C233
Lithography equipment, mask making for semiconductor wafer-processing .....	3B001f
Live cultures, isolated .....	1C351
Live cultures, isolated .....	1C352
Live cultures, isolated .....	1C353
Live cultures, isolated .....	1C354
Location & object detection systems, acoustic .....	6A001a.1.b
Logic arrays, field programmable (FPLA) .....	3A001a.8
Logic processors and assemblies .....	4A003
Lubricating materials .....	1C006b
LVDT (Linear voltage displacement transformer) based instruments .....	2B006b.1.b.1
Lymphocytic choriomeningitis virus .....	1C351a.9
Lyssa virus .....	1C352a.8

## M

M1 thickeners for hydrocarbon fuels .....	ML8d
M2 thickeners for hydrocarbon fuels .....	ML8d
M3 thickeners for hydrocarbon fuels .....	ML8d
Machine guns & components .....	ML1a,d
Machine pistols .....	ML1a
Machine tool assemblies for equipment of 2B006 & 2B007 .....	2B008
Machine tool components for equipment of 2B006 & 2B007 .....	2B008
Machine tool controller instruction development technology .....	2E003a
Machine tool cutting tools .....	2B008
Machine tool feedback units .....	2B008b
Machine tool instruction generators - technology .....	2E003d
Machine tool slides .....	2B008d
Machine tool spindles .....	2B008a
Machine tools for grinding (CNC) .....	2B001c
Machine tools for grinding (CNC) .....	2B201b
Machine tools, E-beam .....	2B001e.1.b
Machine tools, laser .....	2B001e.1.c
Machine tools, numerically controlled .....	2B201
Machine tools, numerically controlled .....	2B001
Machine tools, water/other liquid jet .....	2B001e.1.a

Machines for milling (CNC).....	2B001b
Machines for milling (CNC).....	2B201a
Machines for turning (CNC).....	2B001a
Machining centres (CNC).....	2B001
Machining centres (CNC).....	2B201
Machupo virus.....	1C351a.10
Magnesium metal, alloys & powders.....	1C002a.2.e
Magnesium metal, alloys & powders.....	1C002b.1.e
Magnesium metal, alloys & powders.....	1C011
Magnesium metal, alloys & powders.....	1C111a.2.d
Magnesium metal, alloys & powders.....	1C228
Magnesium metal/alloy powder (fuel).....	ML8c.5.b.1
Magnesium oxide (MgO) made or coated crucibles.....	2A225a.2
Magnet power supplies, direct current).....	0B001j.6
Magnetic alloy strips.....	1C003c
Magnetic anomaly detection software.....	6D003b.2
Magnetic bearings (suspension).....	0B001b.7
Magnetic bearings (suspension).....	2A001c
Magnetic compensation systems for magnetic sensors.....	6A006g
Magnetic compensation systems software.....	6D003b.1
Magnetic confinement CVD equipment.....	3B001d.1
Magnetic confinement plasma dry etching equipment.....	3B001c.1.a
Magnetic drive pumps.....	2B350i
Magnetic gradiometers.....	6A006d
Magnetic gradiometers, intrinsic.....	6A006f
Magnetic metals.....	1C003
Magnetic pole pieces, diameter over 2 metre.....	0B001j.4
Magnetic sensor, magnetic compensation systems.....	6A006g
Magnetometer systems.....	6A006
Magnetometers.....	6A006
Magnetometers.....	ML9e
Magnetostrictive alloys.....	1C003b
Magnetrons.....	3A001b.1.a
Mandrels for rotor assembly, bellows forming.....	2B228a
Mandrels, bellows-forming.....	2B228c
Manganin gauges, pressure.....	6A226a
Manifolds, vacuum.....	0B002f
Manipulators.....	2B225
Manipulators, for submersibles.....	8A002i
Manned, submersible vehicles.....	ML9
Manned, tethered submersible vehicles.....	8A001a
Manned, untethered submersible vehicles.....	8A001b
MAPO & MAPO derivatives.....	ML8e.41
MAPO (Tris 1 (2 methyl)aziridinyl phosphine oxide).....	ML8e.41
MAPO derivatives.....	ML8e.41
Maraging steel.....	1C116
Maraging steel.....	1C216
Marburg virus.....	1C351a.11
Marine acoustic systems.....	6A001a
Marine engines, diesel.....	ML9b
Marine engines, electric.....	ML9b
Marine gas turbine engines.....	9A002
Masks, integrated circuits of 3A001.....	3B001g
Mass spectrometers & ion sources (UF6 enrichment plant).....	0B002g
Mass spectrometers & ion sources (UF6 enrichment plant).....	3A233
Materials development, production & use software.....	1D001
Materials for military systems ballistic protection.....	ML13b
Materials for reduced electromagnetic reflectivity.....	1C101
Materials for reduced electromagnetic reflectivity.....	ML17c
Materials processing equipment, use technology.....	2E101
Materials processing equipment, use technology.....	2E201
Materials processing equipment, use technology.....	2E301
MCT (HgCdTe) crystals & epitaxial wafers.....	6C002b
Measurement equipment, underwater velocity.....	6A001c
Measuring instruments or systems.....	2B006
Mechanical cameras, framing.....	6A003a.1-3
Melting furnaces.....	2B227b
Memory integrated circuits.....	3A001a.4
Mercury amalgam pumps.....	1B233
Mercury cadmium telluride crystals & epitaxial wafers.....	6C002b
Metal & metal alloy powder production equipment.....	1B002

Metal alloy powders	1C002b
Metal alloy powders	1C011
Metal alloy powders	1C111a
Metal alloys	1C002a
Metal alloys	1C002b
Metal alloys	1C002c
Metal alloys	1C003
Metal alloys	1C004
Metal alloys	1C111a.2.f
Metal alloys	1C116
Metal alloys	1C117
Metal alloys	1C202
Metal alloys	1C216
Metal alloys	1C226
Metal alloys	1C230
Metal alloys	1C231
Metal alloys	1C233
Metal alloys	1C234
Metal coated fibre preforms	9A110
Metal organic chemical vapour deposition (MOCVD) reactors	3B001a.2
Metal palmates (or octol)	ML8d
Metal particulate	1C011
Metal powder fuels	1C011
Metal powder fuels	1C111a.1
Metal powder fuels	1C111a.2
Metal powder fuels	ML8a.2
Metal powder production equipment	1B002
Metal stearates	ML8d
Metal working process tools, die & fixture technology	2E003b.1
Metal-organic compounds, aluminium/gallium/indium	3C003
Metallurgical melting & casting furnace, software for	2D201
Metallurgical melting & casting furnaces	2B227
Metals with high initial relative (magnetic) permeability	1C003a
Metering devices for use with liquid propelling charges	ML2a
Methyl benzilate	1C350.25
Methyl phosphinyl dichloride	1C350.26
Methyl phosphinyl difluoride	1C350.36
Methylphosphonothioic dichloride	1C350.63
Methyl phosphonyl dichloride	1C350.5
Methyl phosphonyl difluoride (DF)	1C350.4
Methyl phosphonyl difluoride (DF)	ML7b.1
Methyl Phosphonyldifluoride (DF)	ML7b.1
Methyldiethanolamine	1C450b.8
Methylphosphonic acid	1C350.55
Microchannel plates, image intensifier tubes	6A002a.2
Microcircuit emulators	3A002h
Microcircuits, silicon/compound semiconductor	3A001a
Microcomputer microcircuits	3A001a.3
Microcontroller microcircuits	3A001a.3
Microcycclus ulei (syn. Dothidella ulei)	1C354b.3
Microcystins (Cyanginosins)	1C351d.10
Microfluorination ion sources	3A233f
Microorganisms, genetically modified	1C353
Microprocessor microcircuits	3A001a.3
Microwave amplifiers, solid state	3A001b.4
Microwave assemblies	3A001b.6
Microwave assemblies	ML11
Microwave devices	3A001b.1
Microwave devices	ML11
Microwave frequency extenders, mixers/converters	3A001b.7
Microwave integrated circuit test equipment	3B002c
Microwave integrated circuits	3A001b.2
Microwave modules	3A001b.2
Microwave power sources (frequency above 30 GHz)	0B001i.1
Microwave test receivers	3A002f
Microwave transistors	3A001b.3
Military aero engines	ML10c
Military aircraft	ML10a,b
Military bridges	ML17m
Military cartridges & components	ML4a
Military electronic equipment/components	ML11

Military engines & related equipment/components	ML6k
Military environmental test facilities	ML18b
Military explosives, propellants & related substances	ML8
Military flame throwers	ML2a
Military half tracks & related equipment/components	ML6d
Military helicopters	ML10a,b
Military helmets	ML10g
Military helmets	ML13c
Military high energy liquid fuels	ML8d
Military high energy solid fuels	ML8d
Military mobile repair shops & related equipment/components	ML6h
Military power transfer systems & related equipment	ML6k
Military production equipment	ML18a
Military production technology	ML18c
Military propellants	ML8
Military propellants	ML8b.6
Military propellants	ML8c
Military pyrotechnics & components	ML4a
Military recovery vehicles & related equipment/components	ML6e
Military simulators & components	ML4a
Military smoke projectors/generators	ML2b
Military trailers (ammunition)	ML6f
Military training equipment, accessories/components	ML14
Military type armed/armoured vehicles & related equipment	ML6b
Military vehicle suspensions	ML6m
Military vehicles & related equipment & components	ML6
Military weapon systems software	ML21
Millimetre wave devices	3A001b.1
Milling machines, (CNC) with two or more co-ordinated axes	2B001b
Milling machines, (CNC) with two or more co-ordinated axes	2B201a
Mine control equipment	ML4b
Mine decoying equipment	ML4b
Mine detection equipment	ML4b
Mine handling equipment	ML4b
Mine jamming equipment	ML4b
Mines & components, explosive	ML4a
Mirror assemblies/segments, space assembly	6A004c.3
Mirror characterisation equipment, reflectometers	7B102
Mirror control equipment, phased array/segment	6A004d.4
Mirror positioning gimbals	6A004d.3
Mirror structures, lightweight foam or composite type	6A004a.3
Mirrors, actively cooled or heat pipe cooled	6A005e.1
Mirrors, beam steering	6A004a.4
Mirrors, optical	6A004a
Mirrors, optical	6A005e.2
Missile (usable) guidance sets	7A117
Missile activation equipment	ML4b
Missile control equipment	ML4b
Missile handling equipment	ML4b
Missile telemetry, remote control	5A101
Missiles & missile components	ML4a
Mixers, batch & continuous	1B111
Mixers, microwave frequency extenders	3A001b.7
Mobile repair shops & related equipment, military	ML6h
Modelling/simulation of guidance sets, software	7D103
Models, military	ML19e
Modules, microwave	3A001b.2
Modules/assemblies, fast switching function	3A228c
Molecular beam epitaxial growth equipment using gas sources	3B001a.3
Molecular beam mass spectrometers	3A233e
Molecular laser isotopic separation plant	0B001a.7
Molecular laser separation process equipment & components	0B001h
Molecular pumps	0B001b.9
Molybdenum & tungsten metals alloys	1C117
Monitoring systems, toxic gas	2B351
Monkey pox virus	1C351a.12
Monolithic integrated circuits, industrial	3A001a
Monomethyl hydrazine	ML8a.18
Monospectral imaging sensors	6A002b
Mortars	ML2a
Motion simulators	2B120



Motor stators .....	0B001b.10
Movable nozzle control systems, rocket .....	9A0008d
Multi-chamber central wafer handling systems .....	3B001e
Multi-element detector arrays .....	6A002a.3
Multi-element photodiodes & phototransistors .....	6A002a.4
Multi-layer hetero-epitaxial material substrates & wafers .....	3C001
Multi-layer masks (with phase shift layer), for integrated circuits .....	3B001h
Multichip integrated circuits, industrial .....	3A001a
Multilevel security capability, equipment .....	5A002a.6
Multimode optical fibre & cables, high tensile strength .....	5A001c.1
Multiple seal valves incorporating a leak detection port .....	2B350g
Multipoint initiation systems .....	3A232b
Multispectral imaging sensors .....	6A002b
Multistage light gas gun systems .....	2B232
Multistage light gas gun systems .....	ML12a
Mustard Gas .....	ML7a
Mycoplasma mycoides.....	1C352b.1

## N

N,N-dialkyl aminoethane-2-ols .....	1C450b.5
N,N-dialkyl aminoethane-2-thiols .....	1C450b.6
N,N-dialkyl aminoethyl-2-chlorides .....	1C450b.4
N,N-dialkyl phosphoramidic dihalides .....	1C450b.3
N,N-diethylaminoethyl-2-chloride.....	1C450b.4
N,N-diethylaminoethyl-2-chloride, hydrochloride .....	1C450b.4
N,N-diisopropyl-(beta)-amino ethanol .....	1C350.27
N,N-diisopropyl-(beta)-aminoethane thiol .....	1C350.12
N,N-diisopropyl-(beta)-aminoethane-2-thiol hydrochloride .....	1C350.12
N,N-diisopropyl-(beta)-aminoethyl chloride .....	1C350.11
N,N-diisopropyl-(beta)-aminoethyl chloride hydrochloride .....	1C350.54
N,N-dimethylaminophosphoryl dichloride .....	1C350.57
N,N-dimethyl phosphoramidic dichloride .....	1C350.57
N,N-dimethylaminoethane-2-thiol hydrochloride .....	1C450b.6
N-butyl ferrocene & other ferrocene derivatives .....	ML8f.4.d&e
N-methyl p nitroaniline .....	ML8f.13
Nanocrystalline alloy strips .....	1C003
Natural uranium .....	0C001
Naval equipment or components.....	ML9
Naval vessels, with or without armaments or fittings.....	ML9
Navigation equipment, military .....	ML9e
Navigation systems, equipment & components, inertial .....	7A103
Navigation systems, equipment & components, inertial .....	7A003
NDT (non-destructive test) inspection equipment (3D) .....	1B001f
NDT (non-destructive test) inspection equipment (3D) .....	9B007
Neodymium lasers .....	6A005c.2
Neodymium lasers .....	6A205f
Neopentyl (diallyl) oxy, tri (dioctyl) phosphato titanate (LIC 12) .....	ML8e.30.a
Neptunium-237.....	1C012b
Nets, submarine .....	ML9d
Nets, torpedo .....	ML9d
Network analysers .....	3A002e
Neural computers/assemblies/components .....	4A004b
Neural network integrated circuits.....	3A001a.9
Neutron detection and measuring instruments.....	0A001j
Neutron generator systems & tubes .....	3A231
Newcastle disease virus .....	1C352a.9
Nickel alloys and powders .....	1C002b.1
Nickel alloys and powders .....	1C002c.1.a
Nickel alloys and powders .....	1C240
Nickel aluminides .....	1C002a.1
Nickel metal (made from powder metals/alloys/powders) .....	0C005
Nickel metal (made from powder metals/alloys/powders) .....	1C240
Nickel metal powders .....	0C005
Nickel metal powders .....	1C240
Niobium (Columbium) alloys and powders .....	1C002a.2.b
Niobium (Columbium) alloys/powders .....	1C002b.1.b
Nitratomethylmethyloxetane (NMMO or poly NIMMO) .....	ML8e.28
Nitrided niobium-titanium-tungsten alloy crucibles.....	2A225a.2
Nitrogen dioxide (dinitrogen tetroxide) .....	1C111a.3.b

Nitrogen mustards .....	ML7a
Nitroguanidine (NQ) .....	1C011.d
NMMO (Nitratomethylmethyloxetane or poly NIMMO) .....	ML8e.28
NNTA (3 Nitro 1,2,4 triazol 5 one or NTO).....	ML8a.17
Noise cancellation systems for vessels, active.....	8A002o.3.b
Noise reduction equipment for vessels, acoustic mounts .....	8A002o.3.a
Noise reduction systems for vessels, active.....	8A002o.3.b
Non-composite ceramic materials, technology.....	1E002c.2
Non-destructive test inspection equipment.....	1B001f
Non-destructive test inspection equipment, rocket motor .....	9B007
Non-fluorinated polymeric manufactures .....	1A003
Non-fluorinated polymeric substances .....	1C008
Non-linear optical materials.....	6C004b.3
Non-planar absorbers .....	1C001a
Non-tunable solid state lasers .....	6A005c.2
Nozzles, aerodynamic isotope separation.....	0B001d.1
Nozzles, for pyrolytic deposition.....	1B116
Nozzles, rocket motor (liquid) .....	9A006e
Nozzles, rocket motor (liquid) .....	9A008c
Nozzles, rocket motor (liquid) .....	9A106b
Nozzles, rocket motor (liquid) .....	9A108b
NQ (Nitroguanidine) .....	ML8a.4
NTO (3 Nitro 1,2,4 triazol 5 one or ONTA).....	ML8a.17
Nuclear grade graphite.....	0C004
Nuclear heat sources .....	1C012
Nuclear reactors & reactor components.....	0A001
Nuclear reactors fuel element fabrication plant/equipment.....	0B005
Nuclear reactors fuel element reprocessing plant/equipment.....	0B006
Numerical control for machine tools - software .....	2D002
Numerical control for machine tools - technology.....	2E003d

## O

O ethyl 2 diisopropylaminoethyl methylphosphonite (QL) .....	ML7b.2
O,O-Diethyl phosphorodithioate.....	1C350.61
O,O-Diethyl phosphorothioate.....	1C350.60
O,O-diethyl S-[2-(diethylamino)ethyl] phosphorothiolate.....	1C450a.1
O-alkyl alkyl - phosphonofluoridates .....	ML7a
O-alkyl N,N-dialkyl phosphoramidocyanidates .....	ML7a
O-alkyl O-2-dialkyl aminoethyl alkyl phosphonite.....	ML7b.2
O-alkyl S-2-dialkyl aminoethyl alkyl phosphonothiolates.....	ML7a
O-chlorobenzalmalononitrile (CS) .....	ML7c.2
O-chlorobenzylidenemalononitrile (CS).....	ML7c.2
O-ethyl N,N-dimethylphosphoramidocyanidate (Tabun).....	ML7a
O-ethyl S-2-diisopropylaminoethyl methyl phosphonothiolate (VX).....	ML7a
O-ethyl-2-diisopropylaminoethyl methylphosphonite.....	1C350.29
O-isopropyl methylphosphonochloridate .....	ML7b.3
O-isopropyl methylphosphonofluoridate (Sarin).....	ML7a
O-pinacolyl methylphosphonofluoridate (Soman) .....	ML7a
O-pinacolyl methylphosphonochloridate .....	ML7b.4
Object detection and location systems (acoustic).....	6A001a.1.b
Ocean salvage systems.....	8A001e
Octahydro 1,3,5,7 tetranitro 1,3,5,7 tetrazine .....	ML8a.7
Octogen (Octahydro 1,3,5,7 tetranitro 1,3,5,7 tetrazine).....	ML8a.7
Octogene (1,3,5,7 tetranitro 1,3,5,7 tetrazacyclooctane).....	ML8a.7
Octol (metal palmates).....	ML8d
On board weapon control systems .....	ML5a
Operating system development tools/compiler as source code .....	4D003a
Operating system software, development tools & compilers.....	4D003a
Operating system software, multi-data-stream processing equipment .....	4D003a
Operating systems for real time processing equipment, software.....	4D003d
Optical (Infrared) tracking (range) radars.....	6A108b.2
Optical components for lasers .....	6A005e
Optical components for lasers.....	6A004b
Optical components, space-qualified .....	6A004c
Optical computers .....	4A004c
Optical control equipment.....	6A004d
Optical detectors & sensors.....	6A002
Optical detectors, radiation hardened .....	6A102
Optical equipment .....	6A005f

Optical equipment .....	ML15
Optical equipment .....	ML19
Optical fabrication technologies .....	6E003a.2
Optical fibre & accessories, communications .....	5A001d.1
Optical fibre & accessories, underwater use .....	5A001c.2
Optical fibre characterisation equipment .....	5A001a
Optical fibre couplers or connectors for underwater use .....	5A001c.2
Optical fibre couplers or connectors for underwater use .....	8A002c
Optical fibre manufacturing equipment .....	5B001a
Optical fibre preforms .....	5C001
Optical fibre sensing elements, hydrophones .....	6A001a.2.a.2
Optical fibres/fibre cable, fluoride .....	6A004f
Optical fibres/fibre cable, sensing .....	6A001d.3
Optical integrated circuits .....	3A001a.6
Optical materials, with non-linear characteristics .....	6C004b.3
Optical mirrors (reflectors) .....	6A004a
Optical mirrors (reflectors) .....	6A005e.1
Optical sensor cryocoolers .....	6A001d.1
Optical sensors - flight control systems - technology .....	7E004
Optical sensors, optical fibre .....	6A001d.3.a
Optical surface coating/treatment technology .....	6E003a.1
Optical surface irregularity measuring equipment .....	1B006d
Optical switching software .....	5D001d.3
Optical switching technology .....	5E001c.3
Optical-electro shutters, Kerr or Pockel cells .....	6A103b.3.c
Optics, (optical components) .....	6A004
Optimisation of rocket systems trajectory technology .....	1E104
Organic fibres & filamentary materials .....	1C010a
Organic high explosives .....	ML8b.2
Organo metallic coupling agents .....	ML8e.30
Organo-metallic compounds .....	3C003
Oxalyl chloride .....	1C350.65
Oxide matrix reinforced materials .....	1C007f
Oxygen difluoride .....	ML8d
Oxygen equipment, aircraft .....	ML10i
Oxygen Iodine (OI-I) laser .....	6A005a.5

## P

Para-hydrogen Raman shifters .....	6A105e
Parachutes, military .....	ML10h.1.a
Parachutes, military .....	ML10h.1.b
Parachutes, military .....	ML10h.7
Paragliders .....	ML10h.3
Particle beam directed energy weapon systems .....	ML19b
Passive acoustic systems .....	6A001a.1
Passive sensors, direction finding systems .....	7A115
Pasteurella pseudotuberculosis var pestis (Yersinia pestis) .....	1C351c.13
Pathogens, animal .....	1C352
Pathogens, genetically modified microorganisms .....	1C353a
Pathogens, human .....	1C351
Pathogens, military .....	ML7a
Pathogens, plant .....	1C354
PBAA (Polybutadiene-acrylic acid) .....	1C111b.3
PBAN (Polybutadiene-acrylic acid-acrylonitrile) .....	1C111b.4
PCDE (Polycyanodifluoroaminoethyleneoxide) .....	ML8e.31
PCDE (Polycyanodifluoroaminoethyleneoxide) .....	ML8e.31
PEEK (Polyether ether ketone) .....	1C008c.1
PEK (Polyether ketone) .....	1C008c.3
PEKEKK (Polyether ketone ether ketone ketone) .....	1C008c.4
PEKK (Polyether ketone ketone) .....	1C008c.1
Penetrators/connectors (fibre optic), hull .....	8A001c
Pentaborane & derivatives .....	ML8a.6
Perchlorates composited with metal/high energy fuels .....	ML8a.3
Performance improvement software, navigation systems .....	7D003a
Performance improvement source code, navigation systems .....	7D003b
Peste des petits ruminants virus .....	1C351a.10
PFIB .....	1C450a.6
PGN (Poly(nitratomethyl oxirane or Poly GLYN) .....	ML8e.33
Phased array antennae (in radar) .....	5A001d

Phased array antennae (in radar).....	6A008e
Phased array/segment mirror control equipment.....	6A004d.4
Phenylacyl chloride (w-chloroacetophenone) (CN).....	ML7c.3
Phenylene, lubricating fluids.....	1C006b
Phosgene.....	1C450a.7
Phosphate glass.....	6C004e
Phosphonic acid, methyl-, (5-ethyl-2-methyl-1,3,2- dioxo-phosphorinan-5-yl) methyl methyl ester, P-oxide).....	1C450b.1
Phosphonic acid, methyl-, bis((5-ethyl-2-methyl-1,3,2- dioxo- phosphorinan-5-yl) methyl ester, P,P'-dioxide).....	1C450b.1
Phosphonic acid, methyl-, bis(3-(trimethoxysilyl)propyl) ester.....	1C450b.1
Phosphonic acid, methyl-, compd. with (aminoiminomethyl) urea (1:1).....	1C450b.1
Phosphonic acid, methyl-, methyl 3-(trimethoxysilyl)-propyl ester.....	1C450b.1
Phosphonic acid, methyl-, monoammonium salt.....	1C450b.1
Phosphonic acid, methyl-, monomethyl ester, monosodium salt.....	1C450b.1
Phosphonothioic dichloride, ethyl-.....	1C450b.1
Phosphor bronze or copper mesh packings.....	1A226
Phosphorus hydrides.....	3C004
Phosphorus oxychloride.....	1C350.2
Phosphorus pentachloride.....	1C350.38
Phosphorus pentasulphide.....	1C350.47
Phosphorus trichloride.....	1C350.7
Photocathodes.....	6A002a.2.b
Photodiodes, single & multi-element semiconductor type.....	6A001a.4
Photographic still cameras, underwater.....	8A001e
Photomultiplier tubes.....	6A202
Photomultiplier tubes.....	ML15c,d
Phototransistors, single & multi-element.....	6A001a.4
Photovoltaic arrays, space qualified or radiation hardened.....	3A001e.1
Physical test models/test results, directed energy weapons.....	ML23e
Picrylamino-dinitropyridine (PYX).....	ML8a.16
Piezoelectric polymer & copolymer, components.....	1A001b
Piezoelectric sensing elements, hydrophones.....	6A001a.2.a.2.b,c
Pinacolone.....	1C350.39
Pinacolyl alcohol.....	1C350.28
Piping, multi-walled incorporating a leak detection port.....	2B350h
Pistols.....	ML1a
Pistols, non-military.....	ML901a
Planar absorbers.....	1C001a
Plant pathogens, bacteria or fungi.....	1C354
PLAs (Programmable Logic Arrays).....	3A001a.8
Plasma atomisation & melting furnaces.....	2B227b
Plasma dry etching equipment.....	3B001c
Plasma enhanced CVD equipment.....	3B001d
Plasma enhanced or plasma assisted CVD production equipment.....	2B005a.1.c
Plasma isotope separation plant.....	0B001a.8
Plasma separation process equipment & components.....	0B001i
Plasma separation RF ion excitation coils.....	0B001i.2
Plasma spraying production equipment, with controlled atmosphere.....	2B005d
Plasticisers, military.....	ML8
Platinized catalysts.....	1A225
Plutonium.....	0C002
Plutonium metal production systems.....	0B006
Plutonium nitrate conversion systems.....	0B006
Plutonium-238 in any form with assay over 50%.....	1C012a
Pneumatic tyre casings.....	ML6j
Pockel cell electro-optical shuttering.....	6A203b.4.c
Poly 2,2,3,3,4,4 hexafluoropentane 1,5 diol formal (FPF 1).....	ML8e.16
Poly 2,4,4,5,5,6,6 heptafluoro 2 trifluoromethyl 3 oxahexane 1,7 diol formal (FPF 3).....	ML8e.17
Poly GLYN (Poly(nitratomethyl oxirane)).....	ML8e.33
Poly NIMMO (Nitratomethylmethyloxetane or NMMO).....	ML8e.28
Poly(3 Nitratomethyl,3 methyl oxetane).....	ML8e.28
Poly(epichlorohydrin).....	ML8e.48
Poly(epichlorohydrindiol) & triol.....	ML8e.48
Poly(nitratomethyl oxirane) (Poly GLYN or PGN).....	ML8e.33
Polybutadiene-acrylic acid (PBAA).....	1C111b.3
Polybutadiene-acrylic acid-acrylonitrile (PBAN).....	1C111b.4
Polycyanodifluoroaminoethyleneoxide (PCDE).....	ML8e.31
Polyfunctional aziridine amides.....	ML8e.32
Polyglycidyl nitrate (Poly GLYN or PGN).....	ML8e.33
Polynitrocubanes.....	ML8a.31
Polynitroorthocarbonates.....	ML8e.34
Polysilazanes, precursor for silicon nitride.....	1C007e.2

Polythiophene.....	1C001c
Porcine enterovirus type 9.....	1C352a.11
Porcine herpes virus (Aujeszky's disease).....	1C352a.6
Porous nickel metal.....	0C005
Porous nickel metal.....	1C240
Positioning equipment.....	7A105
Positioning equipment/components, global.....	7A005
Positioning systems, acoustic.....	6A001a.1.d
Positioning Tables.....	2B121
Positive resists for semiconductor lithography.....	3C002a
Post-flight data processing software.....	6D103
Potassium bifluoride.....	1C350.41
Potassium cyanide.....	1C350.40
Potassium fluoride.....	1C350.14
Potassium hydrogen fluoride see potassium bifluoride.....	1C350.41
Potassium titanyl arsenate (KTA).....	6C004b.1
Powder metallurgy manufacturing equipment.....	9B009
Powdered metals, as fuel.....	1C111a.1
Powdered metals, as fuel.....	1C111a.2
Power supplies, direct current.....	0B001j.6
Power supplies, direct current high power (dc).....	3A226
Power supplies, direct current high-voltage.....	3A227
Power supplies, high current.....	0B001j.5
Power systems, air independent, for underwater use.....	8A002j
Power transfer systems/related equipment/components,.....	ML6i
Power transmission shaft systems, marine.....	8A002o.1.d
Power transmission shaft systems, marine.....	8A002o.1.e
Power transmission shaft systems, military vehicles.....	ML6i
Precision rotor forming mandrels.....	2B209b
Precision tracking systems, usable for missiles.....	6A108b
Precursors for military explosives/propellants.....	ML8
Precursors for toxic chemical agents.....	1C350
Preform production equipment.....	1B101e
Preforms for space vehicles (metal coated fibre).....	9A110
Preforms, fibrous or filamentary materials.....	1C010e
Preforms, fibrous or filamentary materials.....	9A110
Preforms, metal coated fibre (for propulsion systems).....	9A110
Prepreg production equipment.....	1B001e
Prepregs, fibrous or filamentary materials.....	1C010e
Prepregs, fibrous or filamentary materials.....	9A110
Presses, hot isostatic.....	2B004
Presses, hot isostatic.....	2B104a
Presses, hot isostatic.....	2B204
Pressure control systems, tyre.....	ML6i
Pressure refuellers, aircraft.....	ML10f
Pressure sensors, manganin & quartz.....	6A226
Pressure suits.....	ML10g
Pressure transducers.....	2B230
Pressure tubes, for fuel elements & primary coolant.....	0A001e
Pressure vessels, for nuclear reactors.....	0A001b
Primary cells/batteries, high energy.....	3A001e.1.a
Probing (test) systems, semiconductor devices.....	3B002d
Process control instrumentation, for reprocessing plant.....	0B006
Processing equipment for bay or bottom cable systems.....	6A001a.2.e.3
Processors, digital array.....	3A001a.3
Processors, digital array.....	4A003
Processors, digital signal.....	3A001a.3
Processors, digital signal.....	4A003
Product & tails collector systems, uranium vapour.....	0B001g.3
Product & tails collectors, uranium vapour.....	0B001i.1
Product & tails stations, UF <sub>6</sub> .....	0B002c
Production equipment, military.....	ML18a
Production equipment, propulsion systems & components.....	9B115
Production equipment, reentry vehicles.....	9B115
Production facilities, reentry vehicles.....	9B116
Production facilities, rockets/propulsion systems.....	9B116
Production technology, military.....	ML18c
Programmable gate & logic arrays (FPGA's & FPLA's), field.....	3A001a.7
Programmable gate & logic arrays (FPGA's & FPLA's), field.....	3A001a.8
Projectile accelerators.....	2B232
Projectile launchers.....	ML2a

Projectiles & components .....	ML3
Projectiles & components, non-military .....	ML902
Projection telescopes, laser diagnostics .....	6A005f.4
Projectors, acoustic .....	6A001a.1.c
Projectors, pyrotechnic .....	ML2b
Propellant bonding liner systems .....	9A008a
Propellant control systems .....	9A106b
Propellant production equipment .....	1B111
Propellant storage systems .....	9A006f
Propellant test and handling equipment .....	1B111
Propellants and their constituents .....	1B111
Propellants, additives & agents, spacecraft .....	1C111
Propellants, military .....	ML8a,b,d
Propellants, non-military .....	ML908
Propeller blades or propfans composite technology .....	9E003b.2
Propeller noise reduction software .....	8D002
Propeller noise reduction technology .....	8E002a
Propellers, contrarotating .....	8A002o.1.b
Propellers, water screw .....	8A002o.1
Propulsion system composite components/structures .....	9A110
Propulsion system composite components/structures, launch-vehicle .....	9A010
Propulsion system test/inspection/production software .....	9D101
Propulsion systems & components, military vehicles .....	ML6i
Propulsion systems, rocket .....	9A005
Propulsion systems, rocket .....	9A007
Propulsion systems, rocket .....	9A009
Propulsion systems, rocket .....	9A119
Propulsion systems/components, production equipment .....	9B115
Propyleneimide, 2 methylaziridine .....	ML8e.35
Protective and detection equipment .....	1A004
Protective clothing, independently ventilated .....	2B352f.1
Protective garments .....	ML13.d
Proximity focused image intensifier tubes .....	6A203b.4.a
Pseudomonas mallei (Burkholderia mallei) .....	1C351c.8
Pseudomonas pseudomallei (Burkholderia pseudomallei) .....	1C351c.9
Puccinia graminis (syn. Puccinia graminis f. sp. tritici) .....	1C354b.4
Puccinia striiformis (syn. Puccinia glumarum) .....	1C354b.5
Pulsating Chemical Vapour Deposition production equipment .....	2B005a.1.a
Pulse excited Q switched neodymium-doped lasers .....	6A205f
Pulse generators, high-current for detonators .....	3A229
Pulse generators, high-speed .....	3A230
Pulse jet engines/components .....	9A111
Pulse liquid rocket engines .....	9A010d
Pulse radar cross-section measurement systems & components .....	6B008
Pulsed electron accelerators .....	3A201c
Pumpjet propulsion systems .....	8A002p
Pumps, bellows .....	2B350i
Pumps, canned drive .....	2B350i
Pumps, centrifugal .....	2B350i
Pumps, diaphragm .....	2B350i
Pumps, double-seal .....	2B350i
Pumps, liquid propellant .....	9A106c
Pumps, lithium amalgam .....	1B233
Pumps, magnetic drive .....	2B350i
Pumps, mercury amalgam .....	1B233
Pumps, molecular .....	0B001b.9
Pumps, multiple seal .....	2B350i
Pumps, nuclear reactor coolant .....	0A001g
Pumps, potassium amide in liquid ammonia .....	1B230
Pumps, submersible stage recirculation .....	0B004b.4
Pumps, vacuum .....	0B002f
Pumps, vacuum .....	2B231
Pumps, vacuum .....	2B350i
Pyrolytic deposition nozzles .....	1B116
Pyrolytic deposition systems .....	2B104b
Pyrolytically derived materials production technology .....	1E104
Pyrolyzed carbon-carbon materials .....	1A102
Pyrolysis equipment, for rocket nozzles/re-entry nose tips .....	2B104b
Pyrolysis equipment, use software .....	2D101
Pyrolysis process control equipment .....	2B104b
Pyrotechnic flare signals & components, military .....	ML4a

Pyrotechnic materials, military .....	ML8b.6
Pyrotechnic projectors/generators .....	ML2b
Pyrotechnics & components, military .....	ML8c
Pyrotechnics & components, military .....	ML4a
PYX (Picrylamino dinitropyridine) .....	ML8a.16

## Q

Q-switched lasers .....	6A005c.2
Q-switched lasers .....	6A205f
QAM based radio equipment operating above level 128 .....	5B001b.4
QAM based radio equipment operating above level 128, software .....	5D001d.4
QAM techniques development technology .....	5E001c.4
QL (o Ethyl 2 di isopropylamino ethyl methylphosphonite) .....	ML7b.2
Quadrature amplitude modulation equipment .....	5B001b.4
Quartz pressure sensors/transducers .....	6A226b

## R

Radar altimeters .....	7A106
Radar cross section measurement systems .....	ML11
Radar cross section measurement systems .....	ML18
Radar cross section measurement systems .....	ML21
Radar cross section measurement systems, missile .....	6B108
Radar systems & components .....	ML11
Radar systems & components .....	ML5b
Radar systems & components, civilian .....	6A008
Radar systems, employing automatic pattern recognition .....	6A008I.3
Radar systems, employing signal processing .....	6A008h
Radar systems, employing signal processing, pulse compression .....	6A008k
Radiation hardened designed (or rated) robots .....	2B007c
Radiation hardened detectors .....	6A002
Radiation hardened detectors .....	6A102
Radiation hardened electronic computers .....	4A001a.2
Radiation hardened integrated circuits, industrial .....	3A001a.1
Radiation hardened robots .....	2B007c
Radiation hardened sensors .....	6A002
Radiation hardened TV cameras .....	6A203c
Radiation sensors, optical fibres .....	6A002d.3
Radiation shielding windows .....	1A227
Radio equipment .....	5A001
Radio equipment .....	5B001
Radio equipment .....	ML11
Radio frequency directed energy weapon systems .....	ML19c
Radio frequency ion excitation coils .....	0B001i.2
Radioactive materials adapted for use in war .....	ML7a
Radiographic equipment .....	3A101b
Radionuclides, alpha-emitting .....	1C236
Radium-226 .....	1C237
Radome design software .....	6D003d
Ram type electrical discharge machines (CNC) .....	2B001d
Raman shift lasers .....	6A205e
Ramjet engines and components .....	9A011
Range finding systems .....	ML5b
Range gated illumination systems, underwater .....	8A002d.2
Range instrumentation radars .....	6A108b.2
Rankine cycle engine, air independent .....	8A002j
Rate tables .....	2B120
RDX (Cyclonite) .....	ML8a.20
Reactor fuel elements, reprocessing plant & equipment .....	0B006
Reactor vessels, chemical .....	2B350a
Reactors, metal organic chemical vapour deposition (MOCVD) .....	3B001a.2
Reactors, nuclear .....	0A001a
Real time processing .....	2D002
Rebreathing apparatus, underwater swimming .....	8A002q
Rebreathing apparatus, underwater swimming .....	ML17a
Receivers, microwave test .....	3A002f
Receivers, radio .....	5A001
Receivers, radio .....	5B001
Receivers, radio .....	ML11

Rechargeable cells/batteries, high energy.....	3A001e.1.b
Reciprocating diesel engine & component technology.....	9E003e.2
Reciprocating engines.....	ML10c
Recoilless rifles.....	ML2a
Recorders, military.....	ML15a
Recording equipment, analogue & digital tape recorders.....	3A002a
Recovery of source code - software.....	5D001c.2
Recovery parachutes.....	ML10h.5
Recovery vehicles & related equipment/components.....	ML6e
Reduced observables analysis software.....	1D103
Reduction gearing, light-weight marine transmissions.....	8A002o.1.d
Reentry vehicles & equipment.....	9A116
Reentry vehicles/components, production equipment.....	9B115
Reflectance measuring equipment, absolute.....	6B004
Reflectivity (electromagnetic) reducing materials.....	1C101
Reflectivity reducing materials.....	ML17c
Reflectometers, mirror characterisation.....	7B102
Reflectors (mirrors), optical.....	6A004a.1
Refrigeration units, cryogenic.....	0B001d.7.b
Refrigeration units, hydrogen or helium.....	1B231
Refuellers (pressure), aircraft.....	ML10f
Regulation of composites technology.....	1E103
Reinforced composite materials.....	1C007f
Remote manipulators.....	2B225
Remotely controlled manipulators, for submersibles.....	8A002i
Remotely operated (air) vehicles (ROVs).....	ML10d
Remotely operated filling equipment, chemical.....	2B350f
Remotely piloted (air) vehicles (RPVs).....	ML10d
Reprocessing plant, nuclear fuel.....	0B006
Resaturated pyrolyzed materials.....	1A102
Resaturated pyrolyzed materials, carbon & carbon.....	1C102
Resin (thermoset) impregnated continuous materials.....	1C210c
Resin impregnated fibre prepregs, propulsion & space systems.....	9A110
Resins, fast reacting ion exchange.....	0B001f.1
Resist material, coated (semiconductor) substrates.....	3C002
Resist materials, semiconductor lithography.....	3C002
Reticles, integrated circuits of 3A001.....	3B001h
Revolvers.....	ML1a
Revolvers, non-military.....	ML901a
Ricin.....	1C351d.4
Rickettsia prowasecki.....	1C351b.2
Rickettsia quintana.....	1C351b.3
Rickettsia rickettsii.....	1C351b.4
Rickettsiae.....	1C351b
Rifles, military.....	ML1a
Rifles, non-military.....	ML901a
Rift Valley fever virus.....	1C351a.13
Rinderpest virus.....	1C352a.12
Ring gyros (laser) & gyro components.....	7A002
Ring laser gyro mirror characterizing equipment.....	7B002
Ring shaped motor stators for AC motors.....	0B001b.10
Riot control agents.....	ML7a
Riot control agents.....	ML7c
Robot & end-effectors, use Software.....	2D201
Robot controllers.....	ML17e
Robot controllers for high explosive handling.....	2B207
Robot controllers, industrial.....	2B007
Robot end-effectors.....	2B007
Robot end-effectors.....	2B207
Robots.....	ML17e
Robots with real time 3D image processing or scene analysis.....	2B007a
Robots with real time 3D image processing or scene analysis.....	2B007b
Robots with real time 3D image processing or scene analysis.....	2B007c
Robots with real time 3D image processing or scene analysis.....	2B207
Robots with real time 3D image processing or scene analysis.....	8A002h
Rocket decoying equipment.....	ML4b
Rocket engines, liquid propellant.....	9A005
Rocket engines, solid propellant.....	9A107
Rocket fuels.....	1C111
Rocket fuels.....	ML8a.1,2
Rocket handling & control equipment.....	9A115a



Rocket handling & control equipment.....	ML4b
Rocket launching equipment.....	9A115a
Rocket launching equipment.....	ML2b
Rocket launching equipment.....	ML4b
Rocket modelling, simulation & integration software.....	9D103
Rocket motor cases, solid.....	9A008b
Rocket motor cases, solid.....	9A108a
Rocket motor inspection equipment.....	9B007
Rocket motor insulation, solid rocket motor.....	9A008a
Rocket motor insulation, solid rocket motor.....	9A108a
Rocket motors, hybrid.....	9A005
Rocket motors, hybrid.....	9A007
Rocket motors, hybrid.....	9A009
Rocket motors, hybrid.....	9A105
Rocket motors, hybrid.....	9A109
Rocket nozzles, liquid fuel motor.....	9A006e
Rocket nozzles, liquid fuel motor.....	9A106a
Rocket nozzles, solid fuel motor.....	9A008c
Rocket nozzles, solid fuel motor.....	9A108b
Rocket stages, hybrid.....	9A009
Rocket stages, liquid fuel.....	9A005
Rocket stages, other than those of 9A005/7/9, 9A105/107/109.....	9A119
Rocket stages, solid fuel.....	9A007
Rocket/rocket motor, test benches/stands.....	9B117
Rockets & components, military.....	ML4a
Rockets, sounding.....	9A104
Rockets, space launch.....	9A004
Roller bearings, solid.....	2A001a
Roller bearings, solid.....	2A001b
Rotary position feedback units.....	2B008c
Rotary shaft seals (for compressors/blowers), UF <sub>6</sub> resistant.....	0B001c.4
Rotor assemblies, gas centrifuge.....	0B001b.2
Rotor assembly mandrels, bellows forming.....	2B228a
Rotor blade components, tooling for manufacture.....	9B009
Rotor blade tip clearance control, compensating system software.....	9D004d
Rotor centrifugal balancing machines.....	2B229
Rotor fabrication/assembly equipment.....	2B228a
Rotor forming mandrels, precision.....	2B209b
Rotor straightening equipment or systems.....	0B001b.5
Rotor straightening equipment or systems.....	0B001b.6
Rotor straightening equipment or systems.....	2B228b
Rotor tube cylinders & components, gas centrifuge.....	0B001b.3
Rotor tube rings or bellows, gas centrifuge.....	0B001b.4
ROVs (Remotely operated air vehicles).....	ML10d
RPVs (Remotely piloted air vehicles).....	ML10d
Russian Spring-Summer encephalitis virus.....	1C351a.14

## S

S-parameter test/measurement equipment.....	3B002a
S20 and S25 photocathodes.....	6A002
Safety cabinets, capable of biological use.....	2B352a.3
Salicyclate, basic copper & lead.....	ML8e.2
Salmonella typhi.....	1C351c.10
Salvage systems, ocean.....	8A001e
Sarin (GB).....	ML7a
Satellite communication equipment technology.....	5E001b.1
Satellite radio systems.....	5E001b.1
Satellite receivers.....	7A005
Satellite receivers, other than those of 7A005.....	7A105
Satellites.....	9A004
SAW (Surface Acoustic Wave) components.....	3A001c.1
Saxitoxin.....	1C351d.5
Scanning cameras & systems.....	6A003b.2
Scoops for UF <sub>6</sub> extraction in gas centrifuges.....	0B001b.12
Scramjet engines.....	ML10c
Scramjet engines/components.....	9A011
Sea-induced motion control systems, automatic.....	8A002n
Seal test/inspection equipment, for reactor fuel elements.....	0B005
Sealing equipment, for reactor fuel elements.....	0B005

Seals, aircraft/aerospace use .....	1A001a
Seals, for surface effect vessels.....	8A002k
Secondary cells/batteries, high energy.....	3A001e.1.b
Security equipment, information.....	5A002
Security equipment, information, software.....	5D002
Segmented mirrors, assembly in space.....	6A004c.3
Self propelled guns & related equipment/components.....	ML6a
Self-contained diving apparatus.....	8A002q
Semi finished products, military.....	ML16
Semi-closed diving apparatus.....	8A002q
Semiconductor component design software, computer-aided-design.....	3D003
Semiconductor components, extended temperature range.....	3A001a.2
Semiconductor compound photocathodes.....	6A002a.2.b.3
Semiconductor lasers.....	6A005b
Semiconductor probing systems, electron & laser beam.....	3B002d
Semiconductor, test equipment.....	3B002
Sensing elements, hydrophone.....	6A001a.2.a
Sensors, direction finding systems (passive).....	7A115
Sensors, industrial infrared.....	6A002a
Sensors, industrial infrared.....	6A002b
Sensors, linear position feedback unit.....	2B008b
Sensors, military infrared.....	ML15d
Sensors, multispectral imaging.....	6A002b
Sensors, on-line development of gas turbines.....	9B002
Sensors, optical.....	6A002
Sensors, pressure (manganin & quartz).....	6A226
Sensors, radiation hardened.....	6A102
Sensors, superconductive electromagnetic.....	6A006h
Separation mechanisms for rockets.....	9A117
Separation nozzles, aerodynamic isotope separation.....	0B001d.1
Separation nozzles, UF <sub>6</sub> /Carrier gas separation.....	0B001d.7.c
Separation plant, aerodynamic isotope separation.....	0B001a.3
Separation process (aerodynamic) equipment.....	0B001d
Separation tubes, aerodynamic isotope separation.....	0B001d.2
Separation tubes, aerodynamic isotope separation.....	0B001i.6
Separator module housings.....	0B001g.4
Separators, centrifugal (biological).....	2B352c
Separators, electromagnetic isotope.....	1B226
Separators, laser isotopic separation.....	0B001g
Separators, molecular laser.....	0B001h
Servo valves, propellant control systems.....	9A106b
Sesquimustard.....	ML7a
Shaft encoders (rotary input type).....	3A001f
Sheep pox virus.....	1C352a.13
Shiga toxin.....	1C351d.6
Shigella dysenteriae.....	1C351c.11
Ship positioning systems, acoustic.....	6A001a.1.d
Shotguns.....	ML901a
Shrink fit machines for rotor fabrication/assembly.....	2B228a
Sidelooking airborne radar.....	ML5b
Sidelooking airborne radar (SLAR).....	6A008d
Sighting devices, military.....	ML5a
Sights, weapon.....	ML5a
Sights, weapon, for small calibre weapons.....	ML1d
Sights, weapon, for large calibre weapons.....	ML2c
Sights, weapon, non-military.....	ML904
Signal analysers.....	3A002c.1
Signal generators, frequency synthesiser based.....	3A002d
Signal processing devices, acousto-optic.....	3A001c.3
Signal processing equipment, general purpose digital.....	4A003
Signal processing equipment, hydrophone arrays.....	6A001a.2.c
Signal processing equipment, sonar.....	6A001c
Signal processor microcircuits.....	3A001a.3
Signal tracking development/use technology, laser.....	5E001b.2
Signature (electromagnetic) reduction devices.....	1C001
Signature (electromagnetic) reduction devices.....	1C101
Signature reduction devices, fittings & components.....	ML17c
Signature reduction devices, fittings & components.....	ML2a
Signature suppression coatings/treatments for military use.....	ML17c
Signature suppression components.....	ML17c
Signature suppression devices, treatments & fittings.....	1C001

Signature suppression devices, treatments & fittings .....	1C101
Silahydrocarbon oils .....	1C006a.1
Silencers .....	ML1d
Silent bearings .....	ML9g
Silicon carbide (SiC) substrate blanks .....	6C004d
Silicon microcircuits, industrial .....	3A001a
Silicon, hetero-epitaxial grown multi-layer substrates .....	3C001a
Silicon-on-sapphire integrated circuits .....	3A001a
Silicone fluid, fluorinated .....	1C006b.2
Silver gallium selenide (AgGaSe <sub>2</sub> ) .....	6C004b.2
Silyated resists for semiconductor lithography .....	3C002d
Simulation equipment & accessories, military aircraft .....	ML14
Simulators & components, military ordnance .....	ML4a
Simulators, flight .....	ML14
Simultaneous initiation arrangements or systems, single & multipoint .....	3A232b
Single crystal casting control software .....	9D004c
Single crystal casting equipment .....	9B001a
Single crystals .....	6C002b
Single mode optical fibre & cable .....	5A001c.1
Single point diamond cutting tool inserts .....	2B008e
Single point diamond turning techniques, technology .....	6E003a.2.b
Single-element & focal plane arrays, space-qualified .....	6A002a.1
Single-element photodiodes & phototransistors .....	6A002a.4
Skin friction transducers, wall .....	9B008
Skirts, for surface effect vessels .....	8A002k
Slapper detonators (Electric) .....	3A232a.3
Slide way assemblies for machine tools .....	2B008d
Slurry propellant control systems .....	9A106b
Slush hydrogen storage .....	9A006c
Slush hydrogen transfer systems .....	9A006c
Small arms, weapons .....	ML1a
Small waterplane area vessels .....	8A001i
Smoke canisters & components .....	ML4a
Smoke grenades & components .....	ML4a
Smoke projectors or generators .....	ML2b
Smooth bore weapons .....	ML1b
Smooth bore weapons, non-military .....	ML901a
Sodium (Na) metal vapour lasers .....	6A005a.2
Sodium bifluoride .....	1C350.44
Sodium cyanide .....	1C350.45
Sodium fluoride .....	1C350.43
Sodium hexafluorosilicate .....	1C350.62
Sodium sulphide .....	1C350.50
Software, adaptive control .....	2D002
Software, analysis of reduced observables .....	1D103
Software, composite materials (organic/metal/carbon matrix) .....	1D002
Software, digital computers .....	4D
Software, electronic devices .....	2D002
Software, filament winding machine use .....	1D201
Software, military systems software .....	ML21
Software, multi-data-stream processing equipment compilers .....	4D003a
Software, multi-data-stream processing equipment operating systems .....	4D003a
Software, numerical control .....	2D002
Software, real time processing equipment operating systems .....	4D003d
Software, real time processing in machine tools .....	2D002
Software, recovery of source code .....	5D001c.2
Software, software development tools as source code .....	4D003a
Software, source code .....	4D003a
Software, tools in source code .....	4D003a
Solar cells, space qualified or radiation hardened .....	3A001e.1.c
Solenoids, superconductive .....	3A001e.3
Solenoids, superconductive .....	3A201b
Solid fuels, military high energy .....	ML8a,b,d
Solid propellant rocket engines .....	9A107
Solid rocket fuels .....	ML8a,b,d
Solid rocket fuels, industrial .....	1C111
Solid rocket propulsion system, components .....	9A008
Solid rocket propulsion system, components .....	9A108
Solid rocket propulsion systems .....	9A007
Solid rocket propulsion systems .....	9A119
Solid roller bearings .....	2A001a

Solid roller bearings .....	2A001b
Solid state cameras .....	6A003b.1
Solid state imaging devices .....	6A203b.4
Solid state joining equipment, tools/dies/fixtures .....	9B004
Solid state lasers, tunable .....	6A005c.1
Solid state lasers, tunable .....	6A005c.2
Solid state microwave amplifiers .....	3A001b.4
Solid state switches .....	3A228
Solid-state imaging devices .....	6A002
Soman (GD) .....	ML7a
Sonar log equipment .....	6A001c
Sonar processing equipment .....	6A001a.2.b
Sonar signal processing equipment .....	6A001c
SORGUYL (Tetranitroglycoluril or TNGU) .....	ML8a.13
Sounding rocket test, inspection & production software .....	9D101
Sounding rockets .....	9A104
Source code recovery software .....	5D001c.2
Source code, development of goods as specified .....	7D003d
Source code, for multi-data-stream processing equipment .....	4D003a
Space launch vehicle test, inspection & production software .....	9D101
Space launch vehicles .....	9A004
Space probes .....	9A004
Space qualified focal plane arrays .....	6A002e
Space-qualified optical components .....	6A004c
Space-qualified solid state detectors .....	6A002a.1
Spacecraft .....	9A004
Spacecraft components .....	9A010
Spacecraft inertial navigation equipment/components .....	7A003
Spark-gaps, triggered .....	3A228b
Special gun mountings .....	ML1d
Spectrum analysers .....	3A002c.1
Spherical aluminium powder .....	1C111a.1
Spherical aluminium powder .....	ML8a.1
Spin forming machines .....	2B009
Spin forming machines .....	2B209
Spin forming machines combining a flow-forming function .....	2B009
Spin forming machines combining a flow-forming function .....	2B209
Spin forming/Flow forming equipment, software for .....	2D201
Spindle assemblies, machine tools .....	2B008a
Spraying production equipment, plasma with controlled atmosphere .....	2B005d
Spread spectrum development technology techniques .....	5E001b.4
Spread spectrum radio equipment .....	5A001b.3
Spread spectrum spreading code generation .....	5A002a.5
Sprytron tubes, vacuum .....	3A228a
Sputter deposition production equipment .....	2B005e
SQUIDS (Superconducting quantum interference devices) .....	6A006h
SR 19 (ammonium dinitramide) .....	ML8a.32
SRAMs (Static random-access memories) .....	3A001a.4
Stabilisers, military explosives/propellants .....	ML8
Staging mechanisms for rockets .....	9A117
Staphylococcus aureus toxins .....	1C351d.7
START gyros & gyro components .....	7A002
Static random-access memories (SRAMs) .....	3A001a.4
Stators, ring shaped (centrifugal rotor motor) .....	0B001b.10
Stealth technology .....	ML5c
Steam sterilisable freeze drying equipment .....	2B352e
Steel, maraging .....	1C116
Steel, maraging .....	1C216
Step & repeat equipment, semiconductor wafer processing .....	3B001f
Stirling cycle engine, air independent .....	8A002j.4
Storage integrated circuits .....	3A001a.4
Storage tank components used with liquid propelling charges .....	ML2a
Storage tanks, chemical (capacity greater than 100 L) .....	2B350c
Strap down/gimbal gyros & gyro components .....	7A002
Streak cameras, electronic type .....	6A203b.1
Streak cameras, mechanical or electronic .....	6A003a.3
Streak cameras, mechanical type .....	6A203a.2
Streak tubes, electronic streak cameras .....	6A203b.2
Subcavitating hydrofoils .....	8A002m
Submarine nets .....	ML9d
Submarine vessel positioning systems, acoustic .....	6A001a.1.d

Submarines, military .....	ML9
Submersible stage recirculation pumps .....	0B004b.4
Submersible vehicles/vehicle systems or equipment .....	8A001
Submersible vehicles/vehicle systems or equipment .....	8A002a
Substrate development/production technology, diamond film .....	3E002d
Substrates, multi-layer hetero-epitaxial materials .....	3C001
Substrates, semiconductor with resist coating .....	3C002
Sulphur dichloride .....	1C350.52
Sulphur monochloride .....	1C350.51
Sulphur mustards .....	ML7a
Super-ventilated propellers .....	8A002o.1.a
Supercavitating hydrofoils .....	8A002m
Supercavitating propellers .....	8A002o.1.a
Superconducting quantum interference devices (SQUIDs) .....	6A006h
Superconductive circuits/systems, energy storage .....	3A001e.4
Superconductive composite conductors .....	1C005
Superconductive devices or circuits .....	3A001d
Superconductive electromagnetic sensors .....	6A006h
Superconductive electromagnets or solenoids .....	3A001e.3
Superconductive electromagnets or solenoids .....	3A201b
Superconductive electronic device technology .....	3E002c
Superconductive equipment/accessories/components, military .....	ML20
Superconductive gates, current switching .....	3A001d.2
Superconductive propulsion engines .....	8A002o.2.c
Superconductive quantum interference devices (SQUIDs) .....	6A006h
Superfine iron oxide (Fe2O3 or hematite) .....	ML8e.24
Superplastic forming technology, metal working .....	2E003b.1.a
Superplastic forming technology/data, Al/Ti/Super alloys .....	2E003b.2.a
Superplastic forming tools, dies, moulds or fixtures .....	1B003
Supersonic expansion nozzles for UF6 carrier gas .....	0B001h.1
Surface acoustic wave devices .....	3A001c.1
Surface coating & processing equipment .....	2B005
Surface effect vehicles .....	ML9
Surface irregularity measuring equipment/instruments .....	2B006d
Surface skimming (shallow bulk) acoustic wave devices .....	3A001c.1
Surface vessel positioning systems, acoustic .....	6A001a.1.d
Surface vessels .....	ML9
Surface vessels & components .....	8A001
Surface-effect vehicles, (fully skirted variety) .....	8A001f
Surface-effect vehicles, (fully skirted variety) .....	8A001g
Surface-effect vehicles, (fully skirted variety) .....	8A002k
Surveillance systems .....	ML5b
Survey systems, bathymetric .....	6A001a.1.b
Suspensions, military vehicle .....	ML6m
Sweeping equipment, military explosive .....	8A002q
Sweeping equipment, military explosive .....	ML4b
Swept frequency network analysers .....	3A002e
Swimming apparatus, underwater .....	ML17a
Swine fever virus (African) .....	1C352a.1
Swine fever virus (Hog cholera virus) .....	1C352a.7
Switches, solid state .....	3A228
Switching devices/modules or assemblies .....	3A228
Symmetrical dimethyl hydrazine .....	ML8a.18
Syntactic foam, underwater use .....	8C001
Synthetic aperture radar .....	ML5b
Synthetic aperture radar (SAR) .....	6A008d
Synthetic diamond material .....	6C004f
Systolic array computers/assemblies/components .....	4A004a

## T

T4 (Cyclotrimethylenetrinitramine or RDX) .....	ML8a.20
Tabun (GA) .....	ML7a
TACOT (Tetranitrobenzotriazolobenzotriazole) .....	ML8a.14
TAGN (Triaminoguanidinenitrate) .....	ML8a.11
TAIW (Tetraacetyldibenzylhexaazaisowurtzitane) .....	ML8e.36
Tank destroyers .....	ML2a
Tank transporters .....	ML6i
Tanks & related equipment/components .....	ML6a
Tanks, chemical storage (capacity greater than 100 L) .....	2B350c

Tantalum crucibles coated with tantalum carbide/nitride/boride .....	2A225c.3
Tantalum made or lined crucibles .....	2A225c.2
Tape designed for testing recording equipment of entry 3A002a .....	3A002a
Tape recording equipment .....	3A002a
Tape-laying machines .....	1B001b
Tape-laying machines .....	1B101b
Target acquisition systems .....	ML5b
Target designation systems .....	ML5b
TATB (Triaminotrinitrobenzene) .....	ML8a.10
Tear gases .....	ML7c
Technical military databases libraries, parametric .....	ML17f
Technology, airbourne equipment .....	7E004a
Technology, composite materials installation, maintenance or repair .....	1E002e
Technology, composite structures repair .....	1E002f
Technology, development of frequency agility techniques .....	5E001b.4
Technology, development of spread spectrum techniques .....	5E001b.4
Technology, diamond substrate film .....	3E002d
Technology, gas turbine engines & components .....	9E003a
Technology, gas turbine engines & components .....	9E003c
Technology, helicopter power transfer systems .....	9E003d
Technology, hetero-structure semiconductor development .....	3E002b
Technology, high output type diesel engines .....	9E003e
Technology, integration software for expert systems .....	2E003e
Technology, machine tool instruction generators .....	2E003d
Technology, materials processing equipment .....	2E0
Technology, military goods .....	ML18c
Technology, military goods .....	ML18d
Technology, superconductive electronic device .....	3E002c
Technology, tilt rotor/wing power transfer systems development .....	9E003d
Technology, vacuum microelectronic device .....	3E002a
TEGDN (Triethylene glycol dinitrate) propellant additive .....	1C111b.2
Telecommunications equipment .....	5A001
Telecommunications equipment/system software .....	5D001c.1
Telecommunications production equipment .....	5B001a
Telecommunications test equipment .....	5B001a
Telemetry & telecontrol equipment .....	5A101
Telemetry & telecontrol equipment .....	ML11
Telemetry equipment/systems .....	5A101
Telescopic sights, non-military firearms .....	ML904
Television cameras, underwater .....	8A002d.1.b
Television cameras, underwater .....	8A002d.3
Television cameras, underwater .....	8A002d.1.a
Tellurium (Te) with purity of 5N5 % or better .....	6C002a
Tempest type equipment .....	5A002a.4
Tension stretchers for prepregs/preform production .....	1B101e
TEPAN (Tetraethylenepentamineacrylonitrile) .....	ML8e.37
TEPANOL (Tetraethylenepentamineacrylonitrileglycidol) .....	ML8e.38
Terrestrial geophones .....	6A001b
Teschen disease virus .....	1C352a.14
Test & evaluation facilities, kinetic energy weapons .....	ML12b
Test (physical models) results, directed energy weapon .....	ML19e
Test benches/stands, rockets/rocket motors .....	9B117
Test chambers, aerosol challenge .....	2B352g
Test equipment - propellants and their constituents .....	1B111
Test equipment, semiconductor devices .....	3B002
Test facilities, military environmental .....	ML18b
Test receivers, microwave .....	3A002f
Test tape designed for recording equipment of entry 3A002a .....	3A002a
Tetraacetyldibenzylhexaazaisowurtzitane (TAIW) .....	ML8e.36
Tetraethylenepentamineacrylonitrile (TEPAN) .....	ML8e.37
Tetraethylenepentamineacrylonitrileglycidol (TEPANOL) .....	ML8e.38
Tetranitrobenzotriazolobenzotriazole (TACOT) .....	ML8a.14
Tetranitroglycoluril (TNGU or SORGUYL) .....	ML8a.13
Tetranitrosemiglycouril (K 55) .....	ML8a.27
Tetrodotoxin .....	1C351d.8
Thallium arsenic selenide (Tl <sub>3</sub> AsSe <sub>3</sub> or TAS) .....	6C004b.3
Thermal imaging equipment .....	6A002c
Thermal imaging equipment .....	ML15d
Thermal ionization mass spectrometers (TIMS) .....	3A233c
Thermal sensors, optical fibre .....	6A002d.3
Thermoplastic liquid crystal copolymers .....	1C008b

Thermoset resin impregnated materials .....	1C210c
Thickeners for hydrocarbon fuels (including M1, M2, M3) .....	ML8d
Thio-ethers (alkylphenylene), lubricating fluids .....	1C006b.1
Thiodiglycol .....	1C350.1
Thionyl chloride .....	1C350.9
Thiophosphoryl chloride .....	1C350.64
Thorium metal/alloys/compounds/concentrates .....	0C001
Thrust chamber, high pressure .....	9A006e
Thrust chamber, high pressure .....	9A106b
Thrust chamber, high pressure .....	9A108c
Thrust chambers - liquid rocket propulsion systems .....	9A006h
Thrust vector control systems & sub-systems .....	9A008d
Thulium-YAG (Tm:YAG) lasers .....	6A005c.1
Thulium-YSGG (Tm:YSGG) lasers .....	6A005c.1
Tick-borne encephalitis virus .....	1C351a
Tilt rotor/tilt wing power transfer system technology .....	9E003d
Time or frequency domain processing & correlation equipment .....	6A001a.2.c
TIMS (Thermal ionization mass spectrometers) .....	3A233c
Titanium alloys, as tubes/solid forms/forgings .....	1C202
Titanium alloys, powders, forgings and manufactures .....	1C002a.1.b
Titanium alloys, powders, forgings and manufactures .....	1C002a.2.c
Titanium alloys/alloy powders/forgings/manufactures .....	1C002b.1.c
Titanium aluminides .....	1C002a.1.b
Titanium doped sapphire laser host material .....	6C005a
Titanium IV, ((2-propanolato-1)methyl, N-propanolatomethyl)-butanolato-1, tris(dioctyl)phosphate .....	ML8e.30.c
Titanium IV, ((2-propanolato-1)methyl, N-propanolatomethyl)-butanolato-1, tris(dioctyl)pyrophosphato .....	ML8e.30.b
Titanium IV, 2,2(bis 2 propanolato methyl, butanolate] (LICA 12) .....	ML8e.30.a
Titanium subhydride of stoichiometry TiH 0.65 1.68 .....	ML8a.12
Titanium-sapphire (Ti: Al <sub>2</sub> O <sub>3</sub> ) lasers .....	6A005c.1
Titanium-stabilised duplex stainless steel (Ti-DSS) .....	1C118
TMETN (trimethylolethane trinitrate) .....	1C111c
TNAZ (1,1,3 Trinitroazetidine) .....	ML8a.28
TNGU (Tetranitroglycoluril or SORGUYL) .....	ML8a.13
Tooling for powder metallurgy rotor blade component manufacture .....	9B009
Torpedo activation equipment .....	ML4b
Torpedo control equipment .....	ML4b
Torpedo handling equipment .....	ML4b
Torpedo nets .....	ML9d
Torpedoes & components .....	ML4a
Tow-placement machines .....	1B001b
Towed acoustic hydrophone arrays .....	6A001a.2.b
Toxic chemicals .....	1C450a
Toxic chemicals precursors .....	1C450b
Toxic gas monitoring systems .....	2B351
Toxicological agent defence systems/equipment/products .....	ML7e
Toxicological agent dissemination equipment & components .....	ML7d
Toxicological agents .....	ML7a
Toxicological agent development/production/use technology .....	ML7i.1
Toxicological agents/tear gases & related equipment & materials .....	ML7
Toxins, natural .....	1C351d
TPB (Triphenyl bismuth) .....	ML8e.39
Tracking radar .....	6A008I.1
Tracking systems, .....	ML5b
Tracking systems, precision .....	6A008I
Tracking systems, precisioo .....	6A108b.1
Tractors, designed/modified for military use .....	ML6i,f
Trailers, ammunition .....	ML6f
Training equipment, military .....	ML14
Transceivers, radio .....	5A001b.2
Transceivers, radio .....	ML11
Transducers, acoustic projectors .....	6A001a.1.c
Transducers, hydrophone .....	6A001a.2.a
Transducers, wall skin friction .....	9B008
Transient recorders (Waveform digitisers) .....	3A002a.5
Transistor test equipment, S-parameter measurement .....	3B002a
Transistors, microwave .....	3A001b.3
Transmitters, radio .....	ML11
Travelling wave tubes (TWTs) .....	ML11
Travelling wave tubes (TWTs), industrial .....	3A001b.1.a
Tray exchange towers, hydrogen sulphide water .....	0B004b.1
Treatments, designed for reduced reflectivity .....	ML17c

Triaminoguanidinenitrate (TAGN)	ML8a.11
Triaminotrinitrobenzene (TATB)	ML8a.10
Trichloronitromethane	1C450a.3
Triethanolamine	1C350.46
Triethanolamine hydrochloride	1C350.53
Triethyl phosphite	1C350.30
Triethylene glycol dinitrate (TEGDN)	1C111c.2
Triisopropyl phosphite	1C350.58
Triggered spark-gaps	3A228b
Trimethyl phosphite	1C350.8
Trimethyladipic backbone structures	ML8e.32
Triodes, cold cathode	3A228a
Triodes, cold cathode	ML11
Triphenyl bismuth (TPB)	ML8e.39
Tris (2-chloroethyl) amine (HN3)	ML7a
Tris (2-chlorovinyl) arsine	ML7a
Tris 1 (2 methyl)aziridiny phosphine oxide (MAPO)	ML8e.41
Tris vinox propane adduct (TVOPA)	ML8e.40,43
Tris vinox propane adduct (TVOPA)	ML8e.43
Tris(dioctyl)phosphate (KR3512)	ML8e.30.c
Tris(dioctyl)phosphato O (LICA 12)	ML8e.30.a
Tris(dioctyl)pyrophosphato (KR3538)	ML8e.30.b
Tritium plant	1B231
Tritium recovery, extraction & concentration facilities	1B231
Tritium, compounds & mixtures	1C235
Trusted Computer System Evaluation Criteria (TCSEC) capability	5A002a.6
Tubes, frequency agile	3A001b.1
Tubes, gas krytron	3A228a
Tubes, vacuum sprytron	3A228a
Tunable band-pass filters	3A001b.5
Tunable lasers, solid state	6A005c.1
Tungsten & molybdenum metal alloys	1C117
Tungsten alloys	1C004
Tungsten alloys, as parts	1C226
Tungsten carbide, as parts	1C226
Tungsten, as parts	1C226
Turbines, gas aero engines	9A001
Turbines, gas aero engines, test software	9D004b
Turbocompound engines	9A101
Turboexpanders and turboexpander compressors	0B004b
Turboexpanders and turboexpander-compressors	1B232
Turbofan & turbojet engines, lightweight	9A101
Turning machines (CNC)	2B001a
TV cameras, radiation-hardened	6A203c
TVOPA (1,2,3 Tris(1,2 bis(difluoroamino)ethoxy)propane)	ML8e.43
TVOPA (Tris vinox propane adduct)	ML8e.40
Two dimensional focal plane arrays	6A002a
TWTs (Travelling Wave Tubes)	3A001b.1.a
TWTs (Travelling Wave Tubes)	ML11
Tyre pressure control systems, military	ML61

## U

UF <sub>6</sub> / carrier gas separation systems	0B001d.7
UF <sub>6</sub> / carrier gas separation systems	0B001h.5
UF <sub>6</sub> auxiliary isotope separation/enrichment equipment	0B002
UF <sub>6</sub> cold traps	0B001d.7.d
UF <sub>6</sub> cold traps	0B002b
UF <sub>6</sub> desublimers	0B002b
UF <sub>6</sub> Gaseous diffusion barriers & housing	0B001b.3,4
UF <sub>6</sub> liquefaction stations	0B002d
UF <sub>6</sub> mass spectrometers/ion sources	0B002g
UF <sub>6</sub> piping & header systems	0B002e
UF <sub>6</sub> product & tails stations	0B002c
UF <sub>6</sub> resistant compounds & powders	0C005
UF <sub>6</sub> vacuum pumps	0B002f
UN Class 1.1 solid propellants	ML8b.3
UN Class 1.3 solid propellants	ML8b.4
Underwater (propeller) noise reduction software	8D002
Underwater cameras, photographic	8A002d-f



Underwater communication cable .....	5A001c.2
Underwater communications systems.....	5A001b.1
Underwater detection devices .....	ML9c
Underwater electronic imaging systems.....	8A002f
Underwater noise reduction technology .....	8E002
Underwater optical fibre cables & accessories .....	5A001C.2
Underwater robots, computer controlled .....	8A002h
Underwater swimming apparatus .....	8A002q
Underwater swimming apparatus .....	ML17a
Underwater vehicles, industrial.....	8A001
Underwater velocity measurement equipment .....	6A001c
Underwater vision systems .....	8A002d
Unmanned aerial vehicles .....	9A012
Unmanned airborne vehicles & launchers .....	ML10c
Unmanned tethered submersible vehicles.....	8A001c
Unmanned untethered submersible vehicles.....	8A001d
Unsymmetrical dimethyl hydrazine .....	ML8a.18
Uranium conversion plant & equipment.....	0B003
Uranium cooling equipment.....	0B001g.2
Uranium electromagnetic separator vacuum housings.....	0B001j.3
Uranium fluoride (UF <sub>5</sub> ) product collectors.....	0B001h.2
Uranium fluoride (vapour product & tails collector systems).....	0B001g.3
Uranium hexafluoride (UF <sub>6</sub> ) resistant compounds & powders .....	0C005
Uranium isotopes separation, lasers or laser systems.....	0B001g.5
Uranium isotopes separation, lasers or laser systems.....	0B001h.6
Uranium metal, alloys, compounds & concentrates .....	0C001
Uranium metal, alloys, compounds & concentrates .....	0C002
Uranium oxidation systems.....	0B001e.6
Uranium plasma generation systems .....	0B001i.3
Uranium titanium alloys.....	1C004
Uranium vapour product & tails collector systems .....	0B001g.3
Uranium, enriched in Uranium 233 or Uranium 235 .....	0C002

## V

Vacuum furnaces.....	2B226
Vacuum furnaces.....	2B227
Vacuum headers .....	0B002f
Vacuum housings for uranium electromagnetic separators.....	0B001j.3
Vacuum induction furnace, power supplies.....	2B226
Vacuum induction furnaces .....	2B226
Vacuum manifolds .....	0B002f
Vacuum melting, remelt & casting furnaces .....	2B227
Vacuum microelectronic device development/production technology .....	3E002a
Vacuum pumps.....	0B002f
Vacuum pumps.....	2B231
Vacuum pumps.....	2B350i
Vacuum pumps for UF <sub>6</sub> bearing atmospheres .....	0B002f
Vacuum tubes .....	ML11
Vacuum tubes, industrial electronic .....	3A228
Vacuum tubes, industrial electronic microwave .....	3A001b.1
Valve seals.....	1A001a
Valves, bellows .....	2B350g
Valves, bellows seal .....	2A226
Valves, diaphragm.....	2B350g
Valves, double-seal .....	2B350g
Valves, electronic (vacuum microwave).....	ML11
Valves, gaseous diffusion isotope separation .....	0B001c.6
Valves, industrial electronic (vacuum - microwave).....	3A001b.1
Valves, industrial electronic vacuum .....	3A228a
Valves, industrial electronic vacuum .....	3A228b
Valves, multiple seal incorporating a leak detection port .....	2B350g
Valves, non-return (check).....	2B350g
Variola virus .....	1C351a.15
Vector processors/assemblies .....	4A003
Vehicles & related equipment/components, military .....	ML6
Vehicles fitted with mountings for arms.....	ML6b
Vehicles modified for military use .....	ML6
Vehicles, space/space craft/rocket launch support .....	9A115b
Velocity interferometers (VISARs) .....	6A225

Velocity measurement equipment, underwater .....	6A001c
Venezuelan equine encephalitis virus .....	1C351a.16
Ventilated full or half (protective clothing) suits .....	2B352a.2
Ventilated propellers .....	8A002o.1.a
Verotoxin .....	1C351d.9
Vesicular stomatitis virus .....	1C352a.15
Vessel noise reduction equipment .....	8A002.o.3
Vessel positioning systems, acoustic .....	6A001a.1.d
Vessels .....	ML9
Vessels, marine .....	8A001
Vibration test equipment production and use software .....	2D101
Vibration test equipment using digital control techniques .....	2B116
Vibration test equipment, acoustic .....	9B006
Vibrio cholerae .....	1C351c.12
Video cameras incorporating solid state sensors .....	6A003b.1
Vinylidene fluoride copolymers .....	1C009a
Vinylidene fluoride copolymers, components of .....	1A001
Viruses .....	1C351
Viruses .....	1C352
Viruses .....	ML7a
Viruses, animal pathogens .....	1C352a
Viruses, human pathogens .....	1C351a
Viscous software, 2D or 3D engine flow modelling .....	9D004a
Vision systems, underwater .....	8A002d
Vortex tube units, UF <sub>6</sub> separation from carrier gas .....	0B001d.7.c
Vortex tubes, aerodynamic isotope separation .....	0B001d.2
VX (O-Ethyl S-2-diisopropylaminoethyl methyl phosphonothiolate) .....	ML7a

## W

Wafer handling systems, semiconductor .....	3B001e
Wafer processing, semiconductor manufacture .....	3B001f
Wafers, comprising multiple epitaxially grown layers .....	3C001
Wafers, semiconductor with function determined .....	3A001a
Wall skin friction transducers .....	9B008
Warning systems/equipment/components .....	ML5
Warships .....	ML9
Water distillation towers .....	0B004b
Water jet (pumpjet) propulsion systems .....	8A002p
Water jet cutting machines (CNC) .....	2B001e.1.a
Water tunnels, propulsion model acoustic field measurement .....	8B001
Water-hydrogen sulphide exchange tray columns .....	1B229
Water-screw propellers .....	8A002o.1
Waveform digitisers (Transient recorders) .....	3A002a.5
Wax pattern preparation equipment, ceramic core .....	9B001d
Weapon control systems .....	ML5a
Weapon sights .....	ML5a
Weapon sights, for small calibre weapons .....	ML1d
Weapon sights, for large calibre weapons .....	ML2c
Weapon sights, for non-military rifles .....	ML904
Weapons using caseless ammunition .....	ML1c
Weapons using caseless ammunition .....	ML2a
Weapons, other than small arms/firearms .....	ML12
Weapons, other than small arms/firearms .....	ML19
Weapons, other than small arms/firearms .....	ML2
Weapons, other than small arms/firearms .....	ML4
Weapons, small arms/firearms .....	ML1
Weapons, small arms/firearms, non-military .....	ML901
Weaving machines .....	1B001c
Western equine encephalitis virus .....	1C351a.17
Wet-spinning equipment for refractory ceramics .....	1B001d
Wet-spinning equipment for refractory ceramics .....	1B101d
White pox .....	1C351a.18
Wide-swath bathymetric survey systems .....	6A001a.1
Wind tunnel aero-model technology .....	9E003b.1
Wind tunnel, control systems .....	9B005
Wind tunnels, usable for missiles .....	9B105
Windows, glass for nuclear radiation shielding .....	1A227
Work stations, as computers having a CTP above 28,000 Mtops .....	4A003b

**X**

X-ray (non planar) inspection equipment, rocket motors .....	9B007
X-ray equipment, radiographic .....	3A201c
X-ray equipment, radiographic .....	3A101b
X-ray generators, flash discharge .....	3A201c
X-ray sensitive resist materials .....	3C002c
Xanthomonas albilineans .....	1C354a.1
Xanthomonas campestris pv. aurantifolia .....	1C354a.2
Xanthomonas citri .....	1C354a.2

**Y**

Yellow fever virus .....	1C351a.19
Yttrium oxide (yttria) ( $Y_2O_3$ ), crucibles made of or coated with .....	2A225a.2

**Z**

Zinc selenide (ZnSe), substrate blanks .....	6C004a
Zinc sulphide (ZnS), substrate blanks .....	6C004a
Zirconium fluoride ( $ZrF_4$ ) glass .....	6C004e
Zirconium metal and alloy powder .....	ML8c.5.b.1
Zirconium metal and alloy powder .....	1C111a.2.a
Zirconium metal and alloy tubes & assemblies .....	0A001f
Zirconium metal, alloy and compounds .....	1C234
Zirconium oxide (zirconia) ( $ZrO_2$ ) made/coated crucibles .....	2A225a.2
Zoonoses .....	1C351