2026/2288

19.11.2026

COMMISSION DELEGATED REGULATION (EU) 2026/2288

of 14 September 2026

amending Regulation (EU) 2021/821 of the European Parliament and of the Council as regards the list of dual-use items subject to controls on export

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Regulation (EU) 2021/821 of the European Parliament and of the Council of 20 May 2021 setting up a Union regime for the control of exports, brokering, technical assistance, transit and transfer of dual-use items ([1]), and in particular Article 17(1), point (a), thereof,

Whereas:

(1) Pursuant to Regulation (EU) 2021/821 dual-use items are to be subject to effective control when they are exported from or in transit through the Union, or are delivered to a third country as a result of brokering services provided by a broker resident or established in the Union.

(2) Annex I to Regulation (EU) 2021/821 contains a common list of dual-use items that are subject to controls in the Union. Decisions regarding the items subject to such controls are taken within the framework of internationally agreed controls of dual-use items.

(3) The list of dual-use items set out in Annex I to Regulation (EU) 2021/821 is to be updated regularly in order to ensure full compliance with international security obligations and commitments which the Member States and, where applicable, the Union, have accepted as members of the Australia Group ([2]), the Missile Technology Control Regime ([3]), the Nuclear Suppliers Group ([4]), the Wassenaar Arrangement ([5]) and the Chemical Weapons Convention ([6]). In this regard, the control lists adopted by the international non-proliferation regimes and export control arrangements have been changed during 2025. In addition, Member States have informed the Commission on 15 April 2026 that they have all accepted, also as members of the Wassenaar Arrangement, further commitments in order to control additional items. Annex I to Regulation (EU) 2021/821 should be amended in conformity with those obligations and commitments. In order to facilitate references for export control authorities and economic operators, Annex I to Regulation (EU) 2021/821 should be replaced by a new text.

(4) In order to ensure full compliance with international security obligations as soon as possible, this Regulation should enter into force on the day following that of its publication in the *Official Journal of the European Union*.

(5) Regulation (EU) 2021/821 should therefore be amended accordingly,

HAS ADOPTED THIS REGULATION:

Article 1

Annex I to Regulation (EU) 2021/821 is replaced by the text set out in the Annex to this Regulation.

([1]) OJ L 206, 11.6.2021, p. 1, ELI: http://data.europa.eu/eli/reg/2021/821/oj.
([2]) http://www.australiagroup.net.
([3]) http://mtcr.info/.
([4]) http://www.nuclearsuppliersgroup.org/.
([5]) https://www.wassenaar.org/.
([6]) https://www.opcw.org/chemical-weapons-convention.

Article 2

This Regulation shall enter into force on the day following that of its publication in the *Official Journal of the European Union*.

This Regulation shall be binding in its entirety and directly applicable in all Member States.

Done at Brussels, 14 September 2026.

For the Commission
The President
Ursula VON DER LEYEN

ANNEX

'ANNEX I

LIST OF DUAL-USE ITEMS REFERRED TO IN ARTICLE 3 OF THIS REGULATION

The list of dual-use items contained in this Annex implements internationally agreed controls of dual-use items including the Australia Group ([1]), the Missile Technology Control Regime (MTCR) ([2]), the Nuclear Suppliers Group (NSG) ([3]), the Wassenaar Arrangement ([4]) and the Chemical Weapons Convention (CWC) ([5]).

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PART I

General Notes, Acronyms and Abbreviations, and Definitions

GENERAL NOTES TO ANNEX I

1. For control of goods which are designed or modified for military use, see the Common Military List of the European Union ([6]) and relevant list(s) of controls on military goods maintained by individual Member States. References in this Annex that state "SEE ALSO MILITARY GOODS CONTROLS" refer to the same lists.

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

   NB: 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 this Annex include both new and used goods.

([1]) https://www.australiagroup.net/.
([2]) http://mtcr.info/.
([3]) http://www.nuclearsuppliersgroup.org/.
([4]) http://www.wassenaar.org/.
([5]) https://www.opcw.org/chemical-weapons-convention.
([6]) Common Military List of the European Union (equipment covered by Council Common Position 2008/944/CFSP defining common rules governing the control of exports of military technology and equipment).

4. In some instances, chemicals are listed by name and Chemical Abstracts Service (CAS) Registry Number. The list applies to chemicals of the same structural formula (including hydrates, isotopically-labelled forms or all possible stereoisomers) regardless of name or CAS Registry Number. CAS Registry Numbers are shown to assist in identifying a particular chemical or mixture, irrespective of nomenclature. CAS Registry Numbers cannot be used as unique identifiers because some forms of the listed chemical have different CAS Registry Numbers, and mixtures containing a listed chemical may also have different CAS Registry Numbers.

NUCLEAR TECHNOLOGY NOTE (NTN)

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

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

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

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

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

GENERAL TECHNOLOGY NOTE (GTN)

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

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

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

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

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

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

NUCLEAR SOFTWARE NOTE (NSN)

(This note overrides any control within section D of Category 0)

Section D of Category 0 of this list does not control "software" which is the minimum necessary "object code" for the installation, operation, maintenance (checking) or repair of those items whose export has been authorised.

The approval of goods for export also authorises the export to the same end-user of the minimum necessary "object code" for the installation, operation, maintenance (checking) or repair of the goods

Note: *The Nuclear Software Note does not release "software" specified in Category 5, Part 2 ("Information Security").*

GENERAL SOFTWARE NOTE (GSN)

(This note overrides any control within section D of Categories 1 to 9.)

Categories 1 to 9 of this list do not control "software" which is any of the following:

a. Generally available to the public by being:

1. Sold from stock at retail selling points, without restriction, by means of:

a. Over-the-counter transactions;

b. Mail order transactions;

c. Electronic transactions; or

d. Telephone call transactions; and

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

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

b. "In the public domain"; or

c. The minimum necessary "object code" for the installation, operation, maintenance (checking) or repair of those items whose export has been authorised.

Note: Entry c. of the General Software Note does not release "software" specified in Category 5, Part 2 ("Information Security").

GENERAL "INFORMATION SECURITY" NOTE (GISN)

"Information security" items or functions should be considered against the provisions in Category 5, Part 2, even if they are components, "software" or functions of other items.

EDITORIAL PRACTICES IN THE *OFFICIAL JOURNAL OF THE EUROPEAN UNION*

In accordance with the rules set out in the Interinstitutional style guide, for texts in English published in the *Official Journal of the European Union*:

— a comma is used to separate the whole number from decimals,

— whole numbers are presented in series of three, each series being separated by a thin space.

The text reproduced in this Annex follows the above-described practice.

ACRONYMS AND ABBREVIATIONS USED IN THIS ANNEX

For acronyms and abbreviations used as defined terms, see 'Definitions of Terms used in this Annex'.

ACRONYMS AND ABBREVIATIONS	
ABEC	Annular Bearing Engineers Committee
ABMA	American Bearing Manufacturers Association
ADC	Analogue-to-Digital Converter
AGMA	American Gear Manufacturers Association
AHRS	Attitude and Heading Reference Systems
AISI	American Iron and Steel Institute
ALE	Atomic Layer Epitaxy

ACRONYMS AND ABBREVIATIONS	
ALU	Arithmetic Logic Unit
ANSI	American National Standards Institute
APP	Adjusted Peak Performance
APU	Auxiliary Power Unit
ASLR	Address Space Layout Randomisation
ASTM	American Society for Testing and Materials
ATC	Air Traffic Control
AV	Antivirus
BJT	Bipolar Junction Transistors
BPP	Beam Parameter Product
BSC	Base Station Controller
CAD	Computer-Aided-Design
CAS	Chemical Abstracts Service
CCD	Charge Coupled Device
CDU	Control and Display Unit
CEP	Circular Error Probable
CMM	Coordinate Measuring Machine
CMOS	Complementary Metal Oxide Semiconductor
CNTD	Controlled Nucleation Thermal Deposition
CPLD	Complex Programmable Logic Device
CPU	Central Processing Unit
CVD	Chemical Vapour Deposition
CW	Chemical Warfare
CW (for lasers)	Continuous Wave
DAC	Digital-to-Analogue Converter
DANL	Displayed Average Noise Level
DBRN	Data-Base Referenced Navigation
DDS	Direct Digital Synthesizer
DEP	Data Execution Prevention
DMA	Dynamic Mechanical Analysis
DME	Distance Measuring Equipment
DMOSFET	Diffused Metal Oxide Semiconductor Field Effect Transistor

ACRONYMS AND ABBREVIATIONS	
EB	Exploding Bridge
EB-PVD	Electron Beam Physical Vapour Deposition
EBW	Exploding Bridge Wire
ECAD	Electronic Computer-Aided Design
ECM	Electro-Chemical Machining
EDM	Electrical Discharge Machines
EFI	Exploding Foil Initiators
EIRP	Effective Isotropic Radiated Power
EMP	Electromagnetic Pulse
ENOB	Effective Number of Bits
ERF	Electrorheological Finishing
ERP	Effective Radiated Power
ESD	Electrostatic Discharge
ETO	Emitter Turn-Off Thyristor
ETSI TS	European Telecommunications Standards Institute Technical Specification
ETT	Electrical Triggering Thyristor
EU	European Union
EUV	Extreme Ultraviolet
FADEC	Full Authority Digital Engine Control
FFT	Fast Fourier Transform
FOV	Field of View
FPGA	Field Programmable Gate Array
FPIC	Field Programmable Interconnect
FPLA	Field Programmable Logic Array
FPLD	Field Programmable Logic Device
FPO	Floating Point Operation
FWHM	Full-Width Half-Maximum
GAAFET	Gate-All-Around Field-Effect Transistor
GDSII	Geometrical Database Standard II
GLONASS	Global Navigation Satellite System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System

ACRONYMS AND ABBREVIATIONS	
GSM	Global System for Mobile Communications
GTO	Gate Turn-off Thyristor
HBT	Heterojunction Bipolar Transistor
HDMI	High-Definition Multimedia Interface
HEMT	High Electron Mobility Transistor
ICAO	International Civil Aviation Organization
IDS	Intrusion Detection System
IEC	International Electro-technical Commission
IED	Improvised Explosive Device
IEEE	Institute of Electrical and Electronic Engineers
IFOV	Instantaneous Field of View
IGBT	Insulated Gate Bipolar Transistor
IGCT	Integrated Gate Commutated Thyristor
IHO	International Hydrographic Organization
ILS	Instrument Landing System
IMEI	International Mobile Equipment Identity
IMSI	International Mobile Subscriber Identity
IMU	Inertial Measurement Unit
INS	Inertial Navigation System
IP	Internet Protocol
IPS	Intrusion Prevention System
IRS	Inertial Reference System
IRU	Inertial Reference Unit
ISA	International Standard Atmosphere
ISAR	Inverse Synthetic Aperture Radar
ISO	International Organization for Standardization
ITU	International Telecommunication Union
JFET	Junction Field Effect Transistor
JT	Joule-Thomson
JTAG	Joint Test Action Group
LIDAR	Light Detection and Ranging
LIDT	Laser Induced Damage Threshold

ACRONYMS AND ABBREVIATIONS	
LOA	Length Overall
LOB	Line of Bearing
LRU	Line Replaceable Unit
LTT	Light Triggering Thyristor
LUT	Lookup Table
MCT	MOS Controlled Thyristors
MLS	Microwave Landing Systems
MMIC	Monolithic Microwave Integrated Circuit
MOCVD	Metal Organic Chemical Vapour Deposition
MOS	Metal Oxide Semiconductor
MOSFET	Metal Oxide Semiconductor Field Effect Transistor
MPM	Microwave Power Module
MRF	Magnetorheological Finishing
MRF	Minimum Resolvable Feature size
MRI	Magnetic Resonance Imaging
MTBF	Mean-Time-Between-Failures
MTTF	Mean-Time-To-Failure
NA	Numerical Aperture
NDT	Non-Destructive Test
NEQ	Net Explosive Quantity
NIJ	National Institute of Justice
OAM	Operations, Administration or Maintenance
OSI	Open Systems Interconnection
PAI	Polyamide-imides
PAR	Precision Approach Radar
PCL	Passive Coherent Location
PDK	Process Design Kit
PIN	Personal Identification Number
PMAC	Permanent Magnet Alternating Current
PMR	Private Mobile Radio
PSP	Personal Security Products
PVD	Physical Vapour Deposition

ACRONYMS AND ABBREVIATIONS	
ppm	parts per million
QAM	Quadrature-Amplitude-Modulation
QE	Quantum Efficiency
QLAs	Quantum-Limited Amplifiers
QoE	Quality of Experience
QoS	Quality of Service
RAN	Radio Access Network
RAP	Reactive Atom Plasmas
RCA	Riot Control Agent
RF	Radio Frequency
rms	root mean square
RNC	Radio Network Controller
RNSS	Regional Navigation Satellite System
ROIC	Read-Out Integrated Circuit
RTL	Register Transfer Level
S-FIL	Step and Flash Imprint Lithography
SAR	Synthetic Aperture Radar
SAS	Synthetic Aperture Sonar
SCR	Silicon Controlled Rectifier
SDR	Software Defined Radio
SEM	Scanning Electron Microscope
SFDR	Spurious Free Dynamic Range
SHPL	Super High Powered Laser
SLAR	Sidelooking Airborne Radar
SOI	Silicon-on-Insulator
SQUID	Superconducting Quantum Interference Device
SRA	Shop Replaceable Assembly
SRAM	Static Random Access Memory
SSB	Single Sideband
SSR	Secondary Surveillance Radar
SSS	Side Scan Sonar
TE-PVD	Thermal Evaporation-Physical Vapour Deposition
TIMSI	Temporary International Mobile Subscriber Identity

ACRONYMS AND ABBREVIATIONS	
TIR	Total Indicated Reading
TVR	Transmitting Voltage Response
TWPAs	Travelling Wave Parametric Amplifiers
u	Atomic Mass Unit
UV	Ultraviolet
VJFET	Vertical Junction Field Effect Transistor
VOR	Very High Frequency Omni-directional Range
WHO	World Health Organization
WLAN	Wireless Local Area Network
3GPP TS	Third Generation Partnership Project Technical Specification

DEFINITIONS OF TERMS USED IN THIS ANNEX

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:

NB: *Category references are given in brackets after the defined term.*

"Accuracy" (2 3 6 7), 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) is a minimum (single) element of the solid-state array which has a photoelectric transfer function when exposed to light (electromagnetic) radiation.

"Adjusted Peak Performance" (4) is an adjusted peak rate at which "digital computers" perform 64-bit or larger floating point additions and multiplications, and is expressed in Weighted TeraFLOPS (WT) with units of 10^{12} adjusted floating point operations per second.

NB: *See Category 4, Technical Note.*

"Aircraft" (1 6 7 9) means a fixed wing, swivel wing, rotary wing (helicopter), tilt rotor or tilt-wing airborne vehicle.

NB: *See also "civil aircraft".*

"Airship" (9) means a power-driven airborne vehicle that is kept buoyant by a body of gas (usually helium, formerly hydrogen) which is lighter than air.

"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 or measuring errors for the particular coordinate measuring machine 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.

NB: 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.

"Angle random walk" (7) means the angular error build up with time that is due to white noise in angular rate (IEEE 528-2001).

"APP" (4) is equivalent to "Adjusted Peak Performance".

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

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

"Authentication" (5) means verifying the identity of a user, process or device, often as a prerequisite to allowing access to resources in an information system. This includes verifying the origin or content of a message or other information, and 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.

"Average output power" (6) means the total "laser" output energy, in joules, divided by the period over which a series of consecutive pulses is emitted, in seconds. For a series of uniformly spaced pulses it is equal to the total "laser" output energy in a single pulse, in joules, multiplied by the pulse frequency of the "laser", in Hertz.

"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 the average over a specified time of accelerometer output, measured at specified operating conditions, that has no correlation with input acceleration or rotation. "Bias" is expressed in g or in metres per second squared (g or m/s^2). (IEEE 528-2001) (Micro g equals $1x10^{-6}$ g).

"Bias" (gyro) (7) means the average over a specified time of gyro output measured at specified operating conditions that has no correlation with input rotation or acceleration. "Bias" is typically expressed in degrees per hour (deg/hr). (IEEE 528-2001).

"Biological agents" (1) are pathogens or toxins, selected or modified (such as altering purity, shelf life, virulence, dissemination characteristics, or resistance to UV radiation) to produce casualties in humans or animals, degrade equipment or damage crops or the environment.

"Charge multiplication" (6) means a form of electronic image amplification defined as the generation of charge carriers as a result of an impact ionisation gain process. "Charge multiplication" sensors may take the form of an image intensifier tube, solid-state detector or "focal plane array"

"CEP" (7) means "Circular Error Probable" – In a circular normal distribution, the radius of the circle containing 50 % of the individual measurements being made, or the radius of the circle within which there is a 50 % probability of being located.

"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 3 4 7) means those "aircraft" listed by designation in published airworthiness certification lists by the civil aviation authorities of one or more Member States or Wassenaar Arrangement Participating States to fly commercial civil internal and external routes or for legitimate civil, private or business use.

NB: *See also "aircraft".*

"Compensation systems" (6) consist of the primary scalar sensor, one or more reference sensors (e.g., vector "magnetometers") together with software that permit reduction of the rigid body rotation noise of the platform.

"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.

"III/V compounds" (3 6) means polycrystalline or binary or complex monocrystalline products consisting of elements of groups IIIA and VA of Mendeleyev's periodic classification table (e.g., gallium arsenide, gallium-aluminium arsenide, indium phosphide).

"Contouring control" (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. (Reference: ISO/DIS–2806:1980).

"Critical temperature" (1 3 5) (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.

"Cryptographic activation" (5) means any technique that specifically activates or enables cryptographic capability of an item, by means of a mechanism implemented by the manufacturer of the item, where this mechanism is uniquely bound to any of the following:

1. A single instance of the item; or
2. One customer, for multiple instances of the item.

Technical Notes:

1. "Cryptographic activation" techniques and mechanisms may be implemented as hardware, "software" or "technology".

2. Mechanisms for "cryptographic activation" can, for example, be serial number-based licence keys or authentication instruments such as digitally signed certificates.

"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.

Notes:

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

2. "Cryptography" includes decryption.

Technical Notes:

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

2. 'Fixed': the coding or compression algorithm cannot accept externally supplied parameters (e.g., cryptographic or key variables) and cannot be modified by the user.

"CW laser" (6) means a "laser" that produces a nominally constant output energy for greater than 0,25 seconds.

"Cyber incident response" (4) means the process of exchanging necessary information on a cybersecurity incident with individuals or organisations responsible for conducting or coordinating remediation to address the cybersecurity incident.

"Data device" (def) means equipment capable of transmitting or receiving sequences of digital information.

"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.

"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) means a solid-state joining of at least two separate pieces of metals into a single piece with a joint strength equivalent to that of the weakest material, wherein the principal mechanism is interdiffusion of atoms across the interface.

"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.

NB: *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" (def) means the total bit rate of the information that is directly transferred on any type of medium.

NB: *See also "total digital transfer rate".*

"Drift rate" (gyro) (7) means the component of gyro output that is functionally independent of input rotation. It is expressed as an angular rate. (IEEE 528-2001).

"Effective gramme" (0 1) of "special fissile material" means:

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

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

c. For uranium enriched below 1 per cent in the isotope uranium-235, the element weight in grammes multiplied by 0,0001;

"Electronic assembly" (2 3 4) means a number of electronic components (i.e., 'circuit elements', 'discrete components', integrated circuits, etc.) connected together to perform (a) specific function(s), replaceable as an entity and normally capable of being disassembled.

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

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

"Energetic materials" (1) means substances or mixtures that react chemically to release energy required for their intended application. "Explosives", pyrotechnics and propellants are subclasses of energetic materials.

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

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

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

"Equivalent standards" (1) means comparable national or international standards recognised by one or more Member States or Wassenaar Arrangement Participating States and applicable to the relevant entry.

"Explosives" (1) means 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.

"Extreme Ultraviolet" ("EUV") (3) refers to electromagnetic spectrum wavelengths greater than 5 nm and less than 124 nm.

"FADEC Systems" (9) means Full Authority Digital Engine Control Systems – A digital electronic control system for a gas turbine engine that is able to autonomously control the engine throughout its whole operating range from demanded engine start until demanded engine shut-down, in both normal and fault conditions.

"Fibrous or filamentary materials" (0 1 8 9) 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.

"Fly-by-light system" (7) means a primary digital flight control system employing feedback to control the "aircraft" during flight, where the commands to the effectors/actuators are optical signals.

"Fly-by-wire system" (7) means a primary digital flight control system employing feedback to control the "aircraft" during flight, where the commands to the effectors/actuators are electrical signals.

"Focal plane array" (6 8) 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.

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

"Fractional bandwidth" (3 5) means the "instantaneous bandwidth" divided by the centre frequency, expressed as a percentage.

"Frequency hopping" (5 6) 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) means the time (i.e., delay) taken by a signal when switched from an initial specified output frequency, to arrive at or within any of the following:

a. ±100 Hz of a final specified output frequency of less than 1 GHz; or

b. ±0,1 part per million of a final specified output frequency equal to or greater than 1 GHz.

"Fuel cell" (8) is an electrochemical device that converts chemical energy directly into Direct Current (DC) electricity by consuming fuel from an external source.

"Fusible" (1) means capable of being cross-linked or polymerized further (cured) by the use of heat, radiation, catalysts, etc., or that can be melted without pyrolysis (charring).

"Gate-All-Around Field-Effect Transistor" ("GAAFET") (3) means a device having a single or multiple semiconductor conduction channel element(s) with a common gate structure that surrounds and controls current in all of the semiconductor conduction channel elements.

NB: *This definition includes nanosheet or nanowire field-effect and surrounding gate transistors and other "GAAFET" semiconductor channel element structures.*

"Guidance set" (7) means systems that integrate the process of measuring and computing a vehicles position and velocity (i.e., navigation) with that of computing and sending commands to the vehicles flight control systems to correct the trajectory.

"Hard selectors" (5) means data or set of data, related to an individual (e.g., family name, given name, email, street address, phone number or group affiliations).

"High output diesel engines" (9) means 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.

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

a. Containing at least one unencapsulated device;

b. Connected together using typical IC production methods;

c. Replaceable as an entity; and

d. Not normally capable of being disassembled.

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

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

"Image enhancement" (4) means the processing of externally derived information-bearing images by algorithms such as time compression, filtering, extraction, selection, correlation, convolution or transformations between domains (e.g., fast Fourier transform or Walsh transform). This does not include algorithms using only linear or rotational transformation of a single image, such as translation, feature extraction, registration or false coloration.

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

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

"Information security" (GSN GISN 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", "cryptographic activation", 'cryptanalysis', protection against compromising emanations and computer security.

Technical Note:

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

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

"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.

"Interleaved Analogue-to-Digital Converter (ADC)" (3) means devices that have multiple ADC units that sample the same analogue input at different times such that when the outputs are aggregated, the analogue input has been effectively sampled and converted at a higher sampling rate.

"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.

NB: *See also "Magnetic Gradiometer".*

"Intrusion software" (4 5) means "software" specially designed or modified to avoid detection by 'monitoring tools', or to defeat 'protective countermeasures', of a computer or network-capable device, and performing any of the following:

a. The extraction of data or information, from a computer or network-capable device, or the modification of system or user data; or

b. The modification of the standard execution path of a program or process in order to allow the execution of externally provided instructions.

Notes:

1. *"Intrusion software" does not include any of the following:*

   a. *Hypervisors, debuggers or Software Reverse Engineering (SRE) tools;*

   b. *Digital Rights Management (DRM) "software"; or*

   c. *"Software" designed to be installed by manufacturers, administrators or users, for the purposes of asset tracking or recovery.*

2. *Network-capable devices include mobile devices and smart meters.*

Technical Notes:

1. *'Monitoring tools': "software" or hardware devices, that monitor system behaviours or processes running on a device. This includes antivirus (AV) products, end point security products, Personal Security Products (PSP), Intrusion Detection Systems (IDS), Intrusion Prevention Systems (IPS) or firewalls.*

2. *'Protective countermeasures': techniques designed to ensure the safe execution of code, such as Data Execution Prevention (DEP), Address Space Layout Randomisation (ASLR) or sandboxing.*

"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 1 2 3 5 6 7 8 9) is an item that produces spatially and temporally coherent light through amplification by stimulated emission of radiation.

NB: *See also "CW laser";*

"Super High Power Laser".

"Library" (1 5) (parametric technical database) means a collection of technical information, reference to which may enhance the performance of relevant systems, equipment or components.

"Lighter-than-air vehicles" (9) means balloons and "airships" that rely on hot air or other 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 5) 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).

"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.

NB: 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.

"Materials resistant to corrosion by UF_6" (0) include copper, copper alloys, stainless steel, aluminium, aluminium oxide, aluminium alloys, nickel or alloys containing 60 % or more nickel by weight and fluorinated hydrocarbon polymers.

"Maintenance Level I" (7) means 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.

"Maintenance Level II" (7) means the defective LRU is sent to the maintenance workshop (the manufacturer's or that of the operator responsible for level II maintenance). At the maintenance workshop, the malfunctioning LRU is tested by various appropriate means to verify and localise the defective Shop Replaceable Assembly (SRA) module responsible for the failure. This SRA is removed and replaced by an operative spare. The defective SRA (or possibly the complete LRU) is then shipped to the manufacturer. "Maintenance Level II" does not include the disassembly or repair of specified accelerometers or gyro sensors.

"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).

"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.

NB: The internal storage may be augmented by an external storage.

"Microprocessor microcircuit" (3) means a "monolithic integrated circuit" or "multichip integrated circuit" containing an Arithmetic Logic Unit (ALU) capable of executing a series of general purpose instructions from an external storage.

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

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

"Microorganisms" (1 2) means bacteria, viruses, mycoplasms, rickettsiae, chlamydiae or fungi, whether natural, enhanced or modified, either in the form of "isolated live cultures" or as material including living material which has been deliberately inoculated or contaminated with such cultures.

"Missiles" (1 2 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.

NB: *'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.*

"Monolithic Microwave Integrated Circuit" ("MMIC") (3 5) means a "monolithic integrated circuit" that operates at microwave or millimetre wave frequencies.

"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".

"Multiple channel Analogue-to-Digital Converter (ADC)" (3) means devices that integrate more than one ADC, designed so that each ADC has a separate analogue input.

"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.

"Non-repetitive pulsed" (6) means "lasers" that produce either a single output pulse or that have a time interval between pulses exceeding one minute.

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

"Nuclear reactor" (0) means a complete reactor capable of operation so as to maintain a controlled self-sustaining fission chain reaction. A "nuclear reactor" includes all 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 (Reference: ISO 2382:2015).

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

"Operations, Administration or Maintenance" ("OAM") (5) means performing one or more of the following tasks:

a. Establishing or managing any of the following:

   1. Accounts or privileges of users or administrators;

   2. Settings of an item; or

   3. Authentication data in support of the tasks described in points a.1. or a.2.;

b. Monitoring or managing the operating condition or performance of an item; or

c. Managing logs or audit data in support of any of the tasks described in points a. or b.

Note: "OAM" does not include any of the following tasks or their associated key management functions:

a. Provisioning or upgrading any cryptographic functionality that is not directly related to establishing or managing authentication data in support of the tasks described in points a.1. or a.2. above; or

b. Performing any cryptographic functionality on the forwarding or data plane of an item.

"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).

"Participating State" (7 9) is a state participating in the Wassenaar Arrangement. (See www.wassenaar.org)

"Peak power" (6) means the highest power attained in the "pulse duration".

"Personal area network" (5) means a data communication system having all of the following characteristics:

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

b. Is confined to the communication between devices within the immediate physical vicinity of an individual person or device controller (e.g., single room, office, or automobile).

Technical Note:

The "local area network" extends beyond the geographical area of the "personal area network".

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

"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 "production equipment" and specially designed software therefor integrated into installations for "development" or for one or more phases of "production".

"Program" (1 7) means a sequence of instructions to carry out a process in, or convertible into, a form executable by an electronic computer.

"Pulse compression" (6) means the coding and processing of a radar signal pulse of long time duration to one of short time duration, while maintaining the benefits of high pulse energy.

"Pulse duration" (6) is the duration of a "laser" pulse and means the time between the half-power points on the leading edge and trailing edge of an individual pulse.

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

"Radar 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.

"Radiant sensitivity" (6) is Radiant sensitivity (mA/W) = 0,807 x (wavelength in nm) x Quantum Efficiency (QE).

Technical Note:

QE is usually expressed as a percentage; however, for the purposes of this formula QE is expressed as a decimal number less than one, e.g., 78 % is 0,78.

"Real-time processing" (6) 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.

"Refractory metals and alloys" (1 2) are metals and alloys of niobium, molybdenum, tungsten and tantalum.

"Repeatability" (7) means the closeness of agreement among repeated measurements of the same variable under the same operating conditions when changes in conditions or non-operating periods occur between measurements. (Reference: IEEE 528-2001 (one sigma standard deviation))

"Required" (GTN 3 5 6 7 9), as applied to "technology", refers to only that portion of "technology" which is peculiarly responsible for achieving or extending the controlled performance levels, characteristics or functions. Such "required" "technology" may be shared by different goods.

"Riot Control Agents" ("RCAs") (1) means substances which, under the expected conditions of use for riot control purposes, produce rapidly in humans sensory irritation or disabling physical effects which disappear within a short time following termination of exposure.

Note: "RCAs" include:

1. α-Bromobenzeneacetonitrile, (Bromobenzyl cyanide) (CA) (CAS 5798-79-8);
2. [(2-chlorophenyl) methylene] propanedinitrile, (o-Chlorobenzylidenemalononitrile) (CS) (CAS 2698-41-1);
3. 2-Chloro-1-phenylethanone, Phenylacyl chloride (ω-chloroacetophenone) (CN) (CAS 532-27-4);
4. Dibenz-(b,f)-1,4-oxazepine, (CR) (CAS 257-07-8);
5. 10-Chloro-5,10-dihydrophenarsazine, (Phenarsazine chloride), (Adamsite), (DM) (CAS 578-94-9);
6. N-Nonanoylmorpholine, (MPA) (CAS 5299-64-9).

Technical Note:

Tear gases are a subset of "riot control agents".

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

a. Is multifunctional;

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

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

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

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

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

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

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

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

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

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

NB: *‘Strand’ is a bundle of "monofilaments" (typically over 200) arranged approximately parallel.*

"Sample rate" (3) for an Analogue-to-Digital Converter (ADC) means the maximum number of samples that are measured at the analogue input over a period of one second, except for oversampling ADCs. For oversampling ADCs the "sample rate" is taken to be its output word rate. "Sample rate" may also be referred to as sampling rate, usually specified in Mega Samples Per Second (MSPS) or Giga Samples Per Second (GSPS), or conversion rate, usually specified in Hertz (Hz).

"Satellite" (5 9) means a "spacecraft", other than a "space vehicle", designed to operate in orbit around Earth or another celestial body; "satellites" include orbital space stations.

"Satellite navigation system" (5 7) means a system consisting of ground stations, a constellation of "satellites", and receivers, that enables receiver locations to be calculated on the basis of signals received from the "satellites". It includes Global Navigation Satellite Systems (GNSS) and Regional Navigation Satellite Systems (RNSS).

"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.

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

"Signal processing" (3 4 5 6) means the processing of externally derived information-bearing signals by algorithms such as time compression, filtering, extraction, selection, correlation, convolution or transformations between domains (e.g., fast Fourier transform or Walsh transform).

"Software" (GSN All) means a collection of one or more "programs" or ‘microprograms’ fixed in any tangible medium of expression.

NB: *‘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 into an instruction register.*

"Source code" (or source language) (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" (5 9) means a craft designed to operate in, persist in or transit through space in the form of a "satellite", "space probe", or "space vehicle".

Note: *"Spacecraft" does not include landers, rovers, or other craft, limited by design to operate on or beneath the surface of, or in the atmosphere of an extra-terrestrial celestial body, or "sub-orbital craft".*

"Spacecraft bus" (9) means equipment that provides the support infrastructure of the "spacecraft" and location for the "spacecraft mission equipment".

"Spacecraft mission equipment" (9) means equipment designed to be located on a "spacecraft bus", and to perform a mission in space or to enable the "spacecraft" to perform its mission (e.g., communications, observation, science, transport).

Technical Note:

"Spacecraft mission equipment" is sometimes referred to as a spacecraft payload.

"Space probe" (9) means a "spacecraft", other than a "satellite" or "space vehicle", designed not to return to Earth.

"Space vehicle" (9) means a "spacecraft" designed to provide transport for cargo or passengers.

Note: *"Space vehicles" include craft designed to safely return to Earth.*

"Space-qualified" (3 6 7) means designed, manufactured or qualified through successful testing, for operation at altitudes greater than 100 km above the surface of the Earth.

NB: *A determination that a specific item is "Space-qualified" by virtue of testing does not mean that other items in the same production run or model series are "Space-qualified" if not individually tested.*

"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 ± 2) K ((23 ± 2)°C) and a relative humidity of (50 ± 5)%.

"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 ± 2) K ((23 ± 2)°C) and a relative humidity of (50 ± 5)%.

"Spinning mass gyros" (7) means gyros which use a continually rotating mass to sense angular motion.

"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)

"Steady state mode" (9) defines engine operation conditions, where the engine parameters, such as thrust/power, rpm and others, have no appreciable fluctuations, when the ambient air temperature and pressure at the engine inlet are constant.

"Strong mechanical bond" (9) means a bond having a bond strength equal to or greater than propellant strength.

"Sub-orbital craft" (9) means a craft having an enclosure designed for the transport of people or cargo which is designed to:

a. Operate above the stratosphere;

b. Only perform a non-orbital trajectories; and

c. Land back on Earth with the people or cargo intact.

"Substrate" (3) means a sheet of base material with or without an interconnection pattern and on which or within which 'discrete components' or integrated circuits or both can be located.

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

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

"Substrate blanks" (3 6) means monolithic compounds with dimensions suitable for the production of optical elements such as mirrors or optical windows.

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

"Superalloys" (2 9) means nickel-, cobalt- or iron-base alloys having a stress rupture life greater than 1 000 hours at 400 MPa and an ultimate tensile strength greater than 850 MPa, at 922 K (649°C) or higher.

"Superconductive" (1 3 5 6 8) means materials, i.e., metals, alloys or compounds, which can lose all electrical resistance, i.e., which can attain infinite electrical conductivity and carry very large electrical currents without Joule heating.

NB: *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.

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

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

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

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

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

"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).

"Time-to-steady-state registration" (6) (also referred to as the gravimeter's response time) is the time over which the disturbing effects of platform induced accelerations (high frequency noise) are reduced.

"Tip shroud" (9) means a stationary ring component (solid or segmented) attached to the inner surface of the engine turbine casing or a feature at the outer tip of the turbine blade, which primarily provides a gas seal between the stationary and rotating components.

"Total control of flight" (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.

NB: *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".

"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".

"Unidirectional positioning repeatability" (2) means the smaller of values R ↑ and R ↓ (forward and backward), as defined by 3.21 of ISO 230-2:2014 or national equivalents, of an individual machine tool axis.

"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 0,71 per cent).

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

"User-accessible programmability" (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 electronic devices" (3) means electronic devices based on the interaction of an electron beam with an electromagnetic wave propagating in a vacuum circuit or interacting with radio-frequency vacuum cavity resonators. "Vacuum electronic devices" include klystrons, travelling-wave tubes, and their derivatives.

"Vulnerability disclosure" (4) means the process of identifying, reporting or communicating a vulnerability to, or analysing a vulnerability with, individuals or organisations responsible for conducting or coordinating remediation for the purposes of resolving the vulnerability.

"Wall-plug efficiency" (6) means the ratio of "laser" output power (or "average output power") to total electrical input power required to operate the "laser", including the power supply/conditioning and thermal conditioning/heat exchanger.

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

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

PART II

Category 0

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";

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

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 both fuel elements and the primary coolant in a "nuclear reactor";

f. Zirconium metal tubes or zirconium alloy tubes (or assembles of tubes) specially designed or prepared for use as fuel cladding in a "nuclear reactor", and in quantities exceeding 10 kg;

NB: For zirconium pressure tubes see 0A001.e. and for calandria tubes see 0A001.h.

g. Coolant pumps or circulators 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, calandria tubes, thermal shields, baffles, core grid plates, and diffuser plates;

Technical 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 as follows:

1. Steam generators specially designed or prepared for the primary, or intermediate, coolant circuit of a "nuclear reactor";

2. Other heat exchangers specially designed or prepared for use in the primary coolant circuit of a "nuclear reactor";

Note: 0A001.i. does not control heat exchangers for the supporting systems of the reactor, e.g., the emergency cooling system or the decay heat cooling system.

j. Neutron detectors specially designed or prepared for determining neutron flux levels within the core of a "nuclear reactor";

k. 'External thermal shields' specially designed or prepared for use in a "nuclear reactor" for the reduction of heat loss and also for the containment vessel protection.

Technical Note:

In 0A001.k. 'external thermal shields' means major structures placed over the reactor vessel which reduce heat loss from the reactor and reduce temperature within the containment vessel.

0B Test, Inspection and Production Equipment

0B001 Plant for the separation of isotopes of "natural uranium", "depleted uranium" or "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", or "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 plant;

7. Molecular "laser" isotope separation 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:

Technical Note:

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

1. Maraging steel capable of an ultimate tensile strength of 1,95 GPa or more;

2. Aluminium alloys capable of an ultimate tensile strength of 0,46 GPa or more; or

3. "Fibrous or filamentary materials" with a "specific modulus" of more than 3,18 x 10^6m and a "specific tensile strength" greater than 7,62 x 10^4 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 650 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 650 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 650 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 650 mm diameter to fit the ends of a rotor tube, made from 'high strength-to-density ratio materials';

7. Magnetic suspension bearings as follows:

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

b. Active magnetic bearings specially designed or prepared for use with gas centrifuges;

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

0B001 b. (*continued*)

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 at a frequency of 600 Hz or more and a power of 40 VA or more;

11. Centrifuge housing/recipients to contain the rotor tube assembly of a gas centrifuge, consisting of a rigid cylinder of wall thickness up to 30 mm with precision machined ends that are parallel to each other and perpendicular to the cylinder's longitudinal axis to within 0,05° or less;

12. Scoops consisting of specially designed or prepared tubes for the extraction of UF_6 gas from within the rotor tube by a Pitot tube action and capable of being fixed to the central gas extraction system;

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. A multiphase frequency output of 600 Hz or greater; and

b. High stability (with frequency control better than 0,2 %);

14. Shut-off and control valves as follows:

a. Shut-off valves specially designed or prepared to act on the feed, product or tails UF_6 gaseous streams of an individual gas centrifuge;

b. Bellows-sealed valves, shut-off or control, made of or protected by "materials resistant to corrosion by UF_6", with an inside diameter of 10 mm to 160 mm, specially designed or prepared for use in main or auxiliary systems of gas centrifuge enrichment plants;

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

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

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

3. Compressors or gas blowers with a suction volume capacity of 1 m^3/min or more of UF_6, with a discharge pressure up to 500 kPa, and having a pressure ratio of 10:1 or less, and made of or protected by "materials resistant to corrosion by UF_6";

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

5. Heat exchangers made of or protected by "materials resistant to corrosion by UF_6", and designed for a leakage pressure rate of less than 10 Pa per hour under a pressure differential of 100 kPa;

6. Bellows-sealed valves, manual or automated, shut-off or control, made of or protected by "materials resistant to corrosion by UF_6";

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

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

2. Cylindrical or conical tubes, (vortex tubes), made of or protected by "materials resistant to corrosion by UF_6" and with one or more tangential inlets;

0B001 d. (*continued*)

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

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

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

6. Bellows-sealed valves, manual or automated, shut-off or control, made of or protected by "materials resistant to corrosion by UF_6", with a diameter of 40 mm or more;

7. Process systems for separating UF_6 from carrier gas (hydrogen or helium) to 1 ppm UF_6 content or less, including:

a. Cryogenic heat exchangers and cryoseparators capable of temperatures of 153 K (-120°C) or less;

b. Cryogenic refrigeration units capable of temperatures of 153 K (-120°C) or less;

c. Separation nozzle or vortex tube units for the separation of UF_6 from carrier gas;

d. UF_6 cold traps capable of freezing out UF_6;

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 s or less and resistant to concentrated hydrochloric acid (e.g. made of or protected by suitable plastic materials such as fluorinated hydrocarbon polymers or glass);

2. Fast-exchange liquid-liquid centrifugal contactors with stage residence time of 30 s or less and resistant to concentrated hydrochloric acid (e.g. made of or protected by suitable plastic materials such as fluorinated hydrocarbon 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^{+4} from the organic stream and, for those parts in contact with the process stream, made of or protected by suitable materials (e.g. glass, fluorocarbon polymers, polyphenyl sulphate, polyether sulfone and resin-impregnated graphite);

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

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

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

1. Fast reacting ion-exchange resins, pellicular or porous macro-reticulated resins in which the active chemical exchange groups are limited to a coating on the surface of an inactive porous support structure, and other composite structures in any suitable form, including particles or fibres, with diameters of 0,2 mm or less, resistant to concentrated hydrochloric acid and designed to have an exchange rate half-time of less than 10 s and capable of operating at temperatures in the range of 373 K (100°C) to 473 K (200°C);

0B001 f. (*continued*)

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 laser-based separation processes using atomic vapour laser isotope separation, as follows:

1. Uranium metal vaporisation systems designed to achieve a delivered power of 1 kW or more on the target for use in laser enrichment;

2. Liquid or vapour uranium metal handling systems specially designed or prepared for handling molten uranium, molten uranium alloys or uranium metal vapour for use in laser enrichment, and specially designed components therefor;

NB: *SEE ALSO 2A225.*

3. Product and tails collector assemblies for collecting uranium metal in liquid or solid form, made of or protected by 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 specially designed or prepared for the separation of uranium isotopes with a spectrum frequency stabilisation for operation over extended periods of time;

NB: *SEE ALSO 6A005 AND 6A205.*

h. Equipment and components, specially designed or prepared for laser-based separation processes using molecular laser isotope separation, as follows:

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

2. Product or tails collector components or devices specially designed or prepared for collecting uranium material or uranium tails material following illumination with laser light, made of "materials resistant to corrosion by UF_6";

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

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

5. Process systems for separating UF_6 from carrier gas (e.g. nitrogen, argon or other gas) including:

a. Cryogenic heat exchangers and cryoseparators capable of temperatures of 153 K (-120°C) or less;

b. Cryogenic refrigeration units capable of temperatures of 153 K (-120°C) or less;

c. UF_6 cold traps capable of freezing out UF_6;

6. "Lasers" or "laser" systems specially designed or prepared for the separation of uranium isotopes with a spectrum frequency stabilisation for operation over extended periods of time;

NB: *SEE ALSO 6A005 AND 6A205.*

0B001 (*continued*)

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. Not used;

5. Product and tails collector assemblies for uranium metal in solid form, 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;

NB: *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.

NB: *SEE ALSO 3A226*.

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

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

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

0B002 (*continued*)

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

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

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

f. Vacuum systems and pumps as follows:

1. Vacuum manifolds, vacuum headers or vacuum pumps having a suction capacity of 5 m^3/minute or more;

2. Vacuum pumps specially designed for use in UF_6 bearing atmospheres made of, or protected by, "materials resistant to corrosion by UF_6"; or

3. Vacuum systems consisting of vacuum manifolds, vacuum headers and vacuum pumps, and designed for service in UF_6-bearing atmospheres;

g. UF_6 mass spectrometers/ion sources capable of taking on-line samples from UF_6 gas streams and having all of the following characteristics:

1. Capable of measuring ions of 320 atomic mass units or greater and having a resolution of better than 1 part in 320;

2. Ion sources constructed of or protected by nickel, nickel-copper alloys with a nickel content of 60 % or more by weight, or nickel-chrome alloys;

3. Electron bombardment ionisation sources; and

4. Having a collector system suitable for isotopic analysis.

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

a. Systems for the conversion of uranium ore concentrates to UO_3;

b. Systems for the conversion of UO_3 to UF_6;

c. Systems for the conversion of UO_3 to UO_2;

d. Systems for the conversion of UO_2 to UF_4;

e. Systems for the conversion of UF_4 to UF_6;

f. Systems for the conversion of UF_4 to uranium metal;

g. Systems for the conversion of UF_6 to UO_2;

h. Systems for the conversion of UF_6 to UF_4;

i. Systems for the conversion of UO_2 to UCl_4.

0B004 Plant for the production or concentration of heavy water, deuterium and deuterium compounds and specially designed or prepared equipment and components therefor, as follows:

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

1. Water-hydrogen sulphide exchange plants;

2. Ammonia-hydrogen exchange plants;

3. Combined Electrolysis and Catalytic Exchange (CECE) plants;

4. Combined Industrial Reforming and Catalytic Exchange (CIRCE) plants;

5. Bithermal Hydrogen-Water exchange (BHW) plants;

0B004 (*continued*)

b. Equipment and components, as follows:

1. Water-hydrogen sulphide exchange towers with diameters of 1,5 m or more, capable of operating at pressures greater than or equal to 2 MPa;

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 % by weight hydrogen sulphide, H_2S) with a throughput capacity greater than or equal to 5 m^3/s 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 or greater 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 utilising the ammonia-hydrogen exchange process;

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

6. Not used;

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

8. Complete heavy water finishing units, upgrade systems, or columns with diameters of 0,1 m or greater therefor, for the upgrade of heavy water to reactor-grade deuterium concentration;

9. Ammonia synthesis converters or synthesis units specially designed or prepared for heavy water production utilising the ammonia-hydrogen exchange process.

10. Complete columns or towers specially designed or prepared for hydrogen isotope exchange having all of the following:

1. Packed with random or structured wet-proofed platinised catalysts;

2. Constructed of carbon steel or stainless steel;

3. Capable of operating with pressure in the range of 0,1 to 4 MPa; and

4. Capable of operating at temperatures in the range of 293 K (20 °C) to 473 K (200 °C).

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

Technical Note:

Specially designed or prepared equipment for the fabrication of "nuclear reactor" fuel elements includes equipment which:

1. *Normally comes into direct contact with or directly processes or controls the production flow of nuclear materials;*

2. *Seals the nuclear materials within the cladding;*

3. *Checks the integrity of the cladding or the seal;*

4. *Checks the finish treatment of the sealed fuel; or*

5. *Is used for assembling reactor elements.*

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 decladding equipment and chopping or shredding machines, i.e., remotely operated equipment to cut, chop or shear irradiated "nuclear reactor" fuel assemblies, bundles or rods;

c. Dissolver vessels or dissolvers employing mechanical devices 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, operated and maintained;

d. Solvent extractors, such as packed or pulsed columns, mixer settlers or centrifugal contractors, resistant to the corrosive effects of nitric acid and specially designed or prepared for use in a plant for the reprocessing of irradiated "natural uranium", "depleted uranium" or "special fissile materials";

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

Technical 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. Neutron measurement systems specially designed or prepared for integration and use with automated process control systems in a plant for the reprocessing of irradiated "natural uranium", "depleted uranium" or "special fissile materials".

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

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

b. Systems for plutonium metal production.

0C Materials

0C001 "Natural uranium" or "depleted uranium" or thorium in the form of metal, alloy, chemical compound or concentrate and any other material containing one or more of the foregoing;

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

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

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

1. Shielding;

2. Packaging;

3. Ballasts having a mass not greater than 100 kg;

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

c. Alloys containing less than 5 % thorium;

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

0C002 "Special fissile materials"

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

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

0C004 Graphite having a purity level better than 5 parts per million 'boron equivalent' and with a density greater than 1,50 g/cm^3 for use in a "nuclear reactor", in quantities exceeding 1 kg.

NB: *SEE ALSO 1C107.*

Note 1: *For the purpose of export control, the competent authorities of the Member State in which the exporter is established will determine whether or not the exports of graphite meeting the above specifications are for "nuclear reactor" use. 0C004 does not control graphite having a purity level better than 5 ppm (parts per million) boron equivalent and with a density greater than 1,50 g/cm^3 not for use in a "nuclear reactor".*

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

$$BE_Z\ (ppm) = CF \times \text{concentration of element Z in ppm;}$$

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

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

0C005 Specially prepared compounds or powders for the manufacture of gaseous diffusion barriers, resistant to corrosion by UF_6 (e.g. nickel or alloys containing 60 % by weight or more nickel, aluminium oxide and fully fluorinated hydrocarbon polymers), having a purity of 99,9 % by weight or more and a particle size less than 10 μm measured by ASTM B330 standard and a high degree of particle size uniformity.

0D Software

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

0E Technology

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

PART III

Category 1

CATEGORY 1 – SPECIAL MATERIALS AND RELATED EQUIPMENT

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.;

1A001 (*continued*)

b. Not used;

c. Not used.

1A002 "Composite" structures or laminates, as follows:

NB: SEE ALSO 1A202, 9A010 and 9A110.

a. Made from any of the following:

1. An organic "matrix" and "fibrous or filamentary materials" specified in 1C010.c. or 1C010.d.: or

2. Prepregs or preforms specified in 1C010.e.;

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

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

a. A "specific modulus" exceeding 10,15 x 10^6 m; and

b. A "specific tensile strength" exceeding 17,7 x 10^4 m; or

2. Materials specified 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 "civil aircraft" structures or laminates, having all of the following:

a. An area not exceeding 1 m^2;

b. A length not exceeding 2,5 m; and

c. A width exceeding 15 mm.

Note 2: 1A002 does not control semi-finished items specially designed for purely civilian applications as follows:

a. Sporting goods;

b. Automotive industry;

c. Machine tool industry;

d. Medical applications.

Note 3: 1A002.b.1. does not control semi-finished items containing a maximum of two dimensions of interwoven filaments and specially designed for applications as follows:

a. Metal heat-treatment furnaces for tempering metals;

b. Silicon boule production equipment.

Note 4: 1A002 does not control finished items specially designed for a specific application.

Note 5: 1A002.b.1. does not control mechanically chopped, milled, or cut carbon "fibrous or filamentary materials" 25,0 mm or less in length.

1A003 Manufactures of non-"fusible" aromatic polyimides in film, sheet, tape or ribbon form having any of the following:

a. A thickness exceeding 0,254 mm; or

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

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

NB: For "fusible" aromatic polyimides in any form, see 1C008.a.3.

1A004 Protective and detection equipment and components not specially designed for military use, as follows:

NB: SEE ALSO MILITARY GOODS CONTROLS, 2B351 AND 2B352.

a. Full face masks, filter canisters and decontamination equipment therefor, designed or modified for defence against any of the following, and specially designed components therefor:

Note: 1A004.a. includes Powered Air Purifying Respirators (PAPR) that are designed or modified for defence against agents or materials, listed in 1A004.a.

Technical Note:

For the purposes of 1A004.a.:

1. Full face masks are also known as gas masks.

2. Filter canisters include filter cartridges.

1. "Biological agents";

2. 'Radioactive materials';

3. Chemical Warfare (CW) agents; or

4. "Riot Control Agents" ("RCAs");

b. Protective suits, gloves and shoes, specially designed or modified for defence against any of the following:

1. "Biological agents";

2. 'Radioactive materials'; or

3. Chemical Warfare (CW) agents;

c. Detection systems, specially designed or modified for detection or identification of any of the following, and specially designed components therefor:

1. "Biological agents";

2. 'Radioactive materials'; or

3. Chemical Warfare (CW) agents;

Note: 1A004.c. does not control detection systems limited to the detection of any of the following:

a. Cyanogen chloride (CAS 506-77-4);

b. Hydrocyanic acid (CAS 74-90-8);

c. Chlorine (CAS 7782-50-5);

d. Carbonyl chloride (phosgene) (CAS 75-44-5);

e. Diphosgene (trichloromethyl-chloroformate) (CAS 503-38-8);

f. Xylyl bromide, ortho: (CAS 89-92-9), meta: (CAS 620-13-3), para: (CAS 104-81-4);

g. Benzyl bromide (CAS 100-39-0);

h. Benzyl iodide (CAS 620-05-3);

i. Bromo acetone (CAS 598-31-2);

j. Cyanogen bromide (CAS 506-68-3);

k. Bromo methylethylketone (CAS 816-40-0);

l. Chloro acetone (CAS 78-95-5);

m. Ethyl iodoacetate (CAS 623-48-3);

n. Iodo acetone (CAS 3019-04-3);

o. Chloropicrin (CAS 76-06-2).

1A004 (*continued*)

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

Technical Note:

For the purposes of 1A004.d., 'trace detection' is defined as the capability to detect less than 1 ppm vapour, or 1 mg solid or liquid.

Note 1: *1A004.d. does not control equipment specially designed for laboratory use.*

Note 2: *1A004.d. does not control non-contact walk-through security portals.*

Note: *1A004 does not control:*

a. *Personal radiation monitoring dosimeters;*

b. *Occupational health or safety equipment limited by design or function to protect against hazards specific to residential safety or civil industries, including:*

1. *mining;*

2. *quarrying;*

3. *agriculture;*

4. *pharmaceutical;*

5. *medical;*

6. *veterinary;*

7. *environmental;*

8. *waste management;*

9. *food industry.*

Technical Notes:

1. *1A004 includes equipment and components that have been identified, successfully tested to national standards or otherwise proven effective, for the detection of or defence against 'radioactive materials', "biological agents", Chemical Warfare (CW) agents, 'simulants' or "Riot Control Agents" ("RCAs"), even if such equipment or components are used in civil industries such as mining, quarrying, agriculture, pharmaceuticals, medical, veterinary, environmental, waste management, or the food industry.*

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

3. *For the purposes of 1A004, 'radioactive materials' are those selected or modified to increase their effectiveness in producing casualties in humans or animals, degrading equipment or damaging crops or the environment.*

1A005 Body armour and components therefor, as follows:

NB: *SEE ALSO MILITARY GOODS CONTROLS.*

a. Soft body armour not manufactured to military standards or specifications, or to their equivalents, and specially designed components therefor;

b. Hard body armour plates providing ballistic protection equal to or less than level IIIA (NIJ 0101.06, July 2008), or "equivalent standards".

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

Note 1: *1A005 does not control body armour when accompanying its user for the user's own personal protection.*

1A005 (*continued*)

Note 2: *1A005 does not control body armour designed to provide frontal protection only from both fragment and blast from non-military explosive devices.*

Note 3: *1A005 does not control body armour designed to provide protection only from knife, spike, needle or blunt trauma.*

1A006 Equipment, specially designed or modified for the disposal of Improvised Explosive Devices (IEDs), as follows, and specially designed components and accessories therefor:

NB: *SEE ALSO MILITARY GOODS CONTROLS.*

a. Remotely operated vehicles;

b. 'Disruptors'.

Technical Note:

For the purposes of 1A006.b. 'disruptors' are devices specially designed for the purpose of preventing the operation of an explosive device by projecting a liquid, solid or frangible projectile.

Note: *1A006 does not control equipment when accompanying its operator.*

1A007 Equipment and devices, specially designed to initiate charges and devices containing "energetic materials", by electrical means, as follows:

NB: *SEE ALSO MILITARY GOODS CONTROLS, 3A229 AND 3A232.*

Technical Note:

For the purposes of 1A007, the word initiator or igniter is sometimes used in place of the word detonator.

a. Explosive detonator firing sets designed to drive explosive detonators specified in 1A007.b.;

b. Electrically driven explosive detonators as follows:

1. Exploding Bridge (EB);

2. Exploding Bridge Wire (EBW);

3. Slapper;

4. Exploding Foil Initiators (EFI).

Technical Note:

For the purposes of 1A007.b., the detonators of concern all utilise a small electrical conductor (bridge, bridge wire or foil) that explosively vaporises when a fast, high-current electrical pulse is passed through it. In non-slapper types, the exploding conductor starts a chemical detonation in a contacting high explosive material such as PETN (pentaerythritoltetranitrate). In slapper detonators, the explosive vaporisation of the electrical conductor drives a flyer or slapper across a gap, and the impact of the slapper on an explosive starts a chemical detonation. The slapper in some designs is driven by magnetic force. The term exploding foil detonator may refer to either an EB or a slapper-type detonator.

1A008 Charges, devices and components, as follows:

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

1. Net Explosive Quantity (NEQ) greater than 90 g; and

2. Outer casing diameter equal to or greater than 75 mm;

Technical Note:

For the purposes of 1A008.a., 'shaped charges' are explosive charges shaped to focus the effects of the explosive blast.

1A008 (*continued*)

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

1. An explosive load greater than 40 g/m; and

2. A width of 10 mm or more;

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

d. Cutters, other than those specified in 1A008.b., and severing tools, having a Net Explosive Quantity (NEQ) greater than 3,5 kg.

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

1A202 Composite structures, other than those specified in 1A002, in the form of thin-walled tubes and having all of the following characteristics:

NB: SEE ALSO 9A010 AND 9A110.

a. An inside diameter of between 75 mm and 650 mm;

b. A thickness of 12 mm or less; and

c. 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 Wet-proofed platinised catalysts specially designed or prepared for promoting the hydrogen isotope exchange reaction between hydrogen and water for the recovery of tritium from water or for the production or upgrading of heavy water.

Technical Note:

In heavy water moderated reactors, upgraders maintain the heavy water concentration in the reactor core. Wet-proofed platinised catalysts can also be used to upgrade heavy water.

1A226 Specialised packings which may be used in separating heavy water from ordinary water, having both of the following characteristics:

a. Made of phosphor bronze mesh chemically treated to improve wettability; and

b. Designed to be used in vacuum distillation towers.

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

a. A 'cold area' greater than 0,09 m^2;

b. A density greater than 3 g/cm^3; and

c. A thickness of 100 mm or greater.

Technical Note:

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

1B Test, Inspection and Production Equipment

1B001 Equipment designed for the "production" of "composite" structures or laminates or "fibrous or filamentary materials", as follows, and specially designed components and accessories therefor:

NB: SEE ALSO 1B101, 1B201 AND 1B501.

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

1B001 (*continued*)

b. 'Tape-laying machines', of which the motions for positioning and laying tape are coordinated and programmed in five or more 'primary servo positioning' 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.*

Technical Note:

For the purposes of 1B001.b., 'tape-laying machines' have the ability to lay one or more 'filament bands' limited to widths greater than 25,4 mm and less than or equal to 304,8 mm, and to cut and restart individual 'filament band' courses during the laying process.

c. Multidirectional, multidimensional weaving machines or interlacing machines, including adapters and modification kits, specially designed or modified for weaving, interlacing or braiding fibres, for "composite" structures;

Technical Note:

For the purposes of 1B001.c., the technique of interlacing includes knitting.

d. Equipment specially designed or modified for the "production" of "fibrous or filamentary materials" specified in 1C010, 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 (CVD) 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 specially designed or modified for the "production" of prepregs by the 'hot melt method';

Technical Note

For the purposes of 1B001.e., the 'hot melt method' is the process of applying pressure and heat to impregnate "fibrous or filamentary materials" with resin that has been pre-laminated onto a carrier substrate, such as film or paper.

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

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

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

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

Technical Note:

For the purposes of 1B001.g., 'tow-placement machines' have the ability to place one or more 'filament bands' having widths less than or equal to 25,4 mm, and to cut and restart individual 'filament band' courses during the placement process.

1B001 (*continued*)

Technical Notes:

For the purpose of 1B001:

1. *'Primary servo positioning' is the positioning, under computer "program" direction, of the end effector (i.e., head) in space relative to the work piece at the correct orientation and direction to achieve the desired process.*

2. *A 'filament band' is a single continuous width of fully or partially resin-impregnated tape, tow or fibre. Fully or partially resin-impregnated 'filament bands' include those coated with dry powder that tacks upon heating.*

1B002 Equipment designed to produce metal alloy powder or particulate materials, and having all of the following:

a. Specially designed to avoid contamination; and

b. Specially designed for use in one of the processes specified in 1C002.c.2.

NB: SEE ALSO 1B102.

1B003 Tools, dies, moulds or fixtures, for "superplastic forming" or "diffusion bonding" titanium, aluminium or their alloys, specially designed for the manufacture of any of the following:

a. Airframe or aerospace structures;

b. "Aircraft" or aerospace engines; or

c. Specially designed components for structures specified in 1B003.a. or for engines specified in 1B003.b.

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

NB: 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 or fibre placement 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:

NB: SEE ALSO 1B115.b.

a. Metal powder "production equipment" usable for the "production", in a controlled environment, of spherical, spheroidal or atomised materials specified in 1C011.a., 1C011.b., 1C111.a.1., 1C111.a.2. or in the Military Goods Controls.

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. Electroburst equipment usable for obtaining sputtered or spherical metallic powders with organization of the process in an argon-water environment;

c. Equipment usable for the "production" of spherical aluminium powders by powdering a melt in an inert medium (e.g. nitrogen).

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

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

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

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

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

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

1B116 Specially designed nozzles for producing pyrolitically derived materials formed on a mould, mandrel or other substrate from precursor gases which decompose in the 1 573 K (1 300°C) to 3 173 K (2 900°C) temperature range at pressures of 130 Pa to 20 kPa.

1B117 Batch mixers having all of the following, and specially designed components therefor:

a. Designed or modified for mixing under vacuum in the range of zero to 13,326 kPa:

b. Capable of controlling the temperature of the mixing chamber;

c. A total volumetric capacity of 110 litres or more; and

d. At least one 'mixing/kneading shaft' mounted off centre.

Note: In 1B117.d. the term 'mixing/kneading shaft' does not refer to deagglomerators or knife-spindles.

1B118 Continuous mixers having all of the following, and specially designed components therefor:

a. Designed or modified for mixing under vacuum in the range of zero to 13,326 kPa;

b. Capable of controlling the temperature of the mixing chamber;

1B118 (*continued*)

c. any of the following:

1. Two or more mixing/kneading shafts; or

2. All of the following:

a. A single rotating and oscillating shaft with kneading teeth/pins; and

b. Kneading teeth/pins 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 Military Goods Controls, and specially designed components therefor.

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

a. Filament winding machines having all of the following characteristics:

1. Having motions for positioning, wrapping, and winding fibres coordinated and programmed in two or more axes;

2. Specially designed to fabricate composite structures or laminates from "fibrous or filamentary materials"; and

3. Capable of winding cylindrical tubes with an internal diameter between 75 and 650 mm and lengths of 300 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.

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

a. Designed for operation with internal temperatures in the range of 15 K (– 258 °C) to 35 K (– 238 °C);

b. Designed for operation at internal pressures in the range of 0,1 MPa to 1 MPa;

c. Constructed of either:

1. Austenitic stainless steel; or

2. Equivalent materials which are both cryogenic and hydrogen (H_2)-compatible between 15 K (– 258 °C) and 35 K (– 238 °C); and

d. With internal diameters of 30 cm or greater and 'effective lengths' of 4 m or greater.

Technical Note 1:

In 1B228 'effective length' means the active height of packing material in a packed-type column, or the active height of internal contactor plates in a plate-type column.

1B228 (*continued*)

Technical Note 2:

Equivalent materials could include, but are not limited to the following materials:

a. aluminium,

b. aluminium alloys,

c. copper alloys,

d. nickel alloys, and

e. titanium alloys.

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

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

b. A capacity greater than 8,5 m^3/h; and

c. Either of the following characteristics:

1. For concentrated potassium amide solutions (1 % or greater), an operating pressure of 1,5 to 60 MPa; or

2. For dilute potassium amide solutions (less than 1 %), an operating pressure of 20 to 60 MPa.

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

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

b. Equipment for tritium facilities or plants, as follows:

1. Hydrogen or helium refrigeration units capable of cooling to 23 K (– 250 °C) or less, with heat removal capacity greater than 150 W;

2. Hydrogen isotope storage or hydrogen isotope 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 in the range 15 K (– 258 °C) to 35 K (– 238 °C); and

b. Designed for a throughput of hydrogen or helium gas of 1 000 kg/h or greater.

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

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

b. Equipment for the separation of lithium isotopes based on the lithium-mercury amalgam process, 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;

c. Ion exchange systems specially designed for lithium isotope separation, and specially designed components therefor;

d. Chemical exchange systems (employing crown ethers, cryptands, or lariat ethers), specially designed for lithium isotope separation, and specially designed components therefor.

1B234 High explosive containment vessels, chambers, containers and other similar containment devices designed for the testing of high explosives or explosive devices and having both of the following characteristics:

NB: SEE ALSO MILITARY GOODS CONTROLS.

a. Designed to fully contain an explosion equivalent to 2 kg of trinitrotoluene (TNT) or greater; and

b. Having design elements or features enabling real time or delayed transfer of diagnostic or measurement information.

1B235 Target assemblies and components for the production of tritium as follows:

a. Target assemblies made of or containing lithium enriched in the lithium-6 isotope specially designed for the production of tritium through irradiation, including insertion in a nuclear reactor;

b. Components specially designed for the target assemblies specified in 1B235.a.

Technical Note:

Components specially designed for target assemblies for the production of tritium may include lithium pellets, tritium getters, and specially-coated cladding.

1B501 Equipment designed for the "production" of "composite" structures or laminates or "fibrous or filamentary materials", as follows, and specially designed components and accessories therefor:

d. Equipment specially designed or modified for the "production" of "fibrous or filamentary materials" specified in 1C010, as follows:

2. Equipment, not specified in 1B001.d.2., for the "production" of multiple parallel silicon carbide fibres by '"laser"-driven CVD'.

Technical Note

For the purposes of 1B501.d.2., '"laser"-driven CVD' uses a "laser" as the energy source, resulting in the fibre's unsupported growth.

1B504 Additive manufacturing equipment designed or modified to produce explosive, pyrotechnic or propellant devices or shapes from "energetic materials", and having one or more ultrasonic extruders or nozzles.

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 absorbing electromagnetic radiation, or intrinsically conductive polymers, as follows:

NB: SEE ALSO 1C101.

a. Materials for absorbing frequencies exceeding 2 x 10^8 Hz but less than 3 x 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:

1. Made from any of the following:

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

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

Technical Note:

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

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

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

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

1. A specific gravity exceeding 4,4; and

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

e. Planar absorbers having no magnetic loss and fabricated from 'open-cell foam' plastic material with a density of 0,15 g/cm^3 or less.

Technical Note:

For the purposes of 1C001.a. Note 1.e., 'open-cell foams' are flexible and porous materials, having an inner structure open to the atmosphere. 'Open-cell foams' are also known as reticulated foams.

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

b. Materials not transparent to visible light and specially designed for absorbing near-infrared radiation having a wavelength exceeding 810 nm but less than 2 000 nm (frequencies exceeding 150 THz but less than 370 THz);

Note: 1C001.b. does not control materials specially designed or formulated for any of the following applications:

a. "Laser" marking of polymers; or

b. "Laser" welding of polymers.

1C001 (*continued*)

c. Intrinsically conductive polymeric materials with a 'bulk electrical conductivity' exceeding 10 000 S/m (Siemens per metre) or a 'sheet (surface) resistivity' of less than 100 ohms/square, based on any of the following polymers:

1. Polyaniline;

2. Polypyrrole;

3. Polythiophene;

4. Poly phenylene-vinylene; or

5. Poly thienylene-vinylene.

Note: *1C001.c. does not control materials in a liquid form.*

Technical Note:

For the purposes of 1C001.c., '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:

NB: *SEE ALSO 1C202.*

Note: *1C002 does not control metal alloys, metal alloy powder and alloyed materials, specially formulated for coating purposes.*

Technical Note:

For the purposes of 1C002, metal alloys are those containing a higher percentage by weight of the stated metal than of any other element.

a. Aluminides, as follows:

1. Nickel aluminides containing a minimum of 15 % by weight aluminium, a maximum of 38 % by weight aluminium and at least one additional alloying element;

2. Titanium aluminides containing 10 % by weight or more aluminium and at least one additional alloying element;

b. Metal alloys, as follows, made from the powder or particulate material specified in 1C002.c.:

1. Nickel alloys having any of the following:

a. A 'stress-rupture life' of 10 000 hours or longer at 923 K (650 °C) at a stress of 676 MPa; or

b. A 'low cycle fatigue life' of 10 000 cycles or more at 823 K (550 °C) at a maximum stress of 1 095 MPa;

2. Niobium alloys having any of the following:

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

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

3. Titanium alloys having any of the following:

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

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

4. Aluminium alloys having any of the following:

a. A tensile strength of 240 MPa or more at 473 K (200 °C); or

b. A tensile strength of 415 MPa or more at 298 K (25 °C);

1C002 b. (*continued*)

5. Magnesium alloys having all of the following:

a. A tensile strength of 345 MPa or more; and

b. A corrosion rate of less than 1 mm/year in 3 % sodium chloride aqueous solution measured in accordance with ASTM standard G-31 or national equivalents;

Technical Notes:

For the purposes of 1C002.b.:

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

2. *'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 ratio is defined as maximum stress minus minimum stress divided by maximum stress.*

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

1. Made from any of the following composition systems:

Technical Note:

For the purposes of 1C002.c.1., X equals one or more alloying elements.

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

Note: 1C002.c.1.a. includes nickel alloys qualified for aero, aero-derivative, industrial or marine gas turbine engines.

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';

g. 'Mechanical alloying';

h. 'Plasma atomisation'; or

i. 'Ultrasonic atomisation'; and

3. Capable of forming materials specified in 1C002.a. or 1C002.b.;

1C002 (*continued*)

d. Alloyed materials having all of the following:

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'.

Technical Notes:

For the purposes of 1C002:

1. *'Vacuum atomisation' is a process to reduce a molten stream of metal to droplets of a diameter of 500 μm or less by the rapid evolution of a dissolved gas upon exposure to a vacuum.*

2. *'Gas atomisation' is a process to reduce a molten stream of metal alloy to droplets of 500 μm diameter or less by a high pressure gas stream.*

3. *'Rotary atomisation' is a process to reduce a stream or pool of molten metal to droplets to a diameter of 500 μm or less by centrifugal force.*

4. *'Splat quenching' is a process to 'solidify rapidly' a molten metal stream impinging upon a chilled block, forming a flake-like product.*

5. *'Melt spinning' is a process to 'solidify rapidly' a molten metal stream impinging upon a rotating chilled block, forming a flake, ribbon or rod-like product.*

6. *'Comminution' is a process to reduce a material to particles by crushing or grinding.*

7. *'Melt extraction' is 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.*

8. *'Mechanical alloying' is 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.*

9. *'Plasma atomisation' is a process to reduce a molten stream or solid metal to droplets of 500 μm diameter or less, using plasma torches in an inert gas environment.*

10. *'Ultrasonic atomisation' is a process to reduce a molten stream of metal alloy to droplets of 500 μm diameter or less by ultrasonic vibration.*

11. *For the purposes of 1C002 Technical Notes, 'solidify rapidly' is a process involving the solidification of molten material at cooling rates exceeding 1 000 K/s.*

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

a. Initial relative permeability of 120 000 or more and a thickness of 0,05 mm or less;

Technical Note:

For the purposes of 1C003.a., measurement of initial relative permeability must be performed on fully annealed materials.

b. Magnetostrictive alloys having any of the following:

1. A saturation magnetostriction of more than 5×10^{-4}; or

2. A magnetomechanical coupling factor (k) of more than 0,8; or

c. Amorphous or 'nanocrystalline' alloy strips, having all of the following:

1. A composition having a minimum of 75 % by weight of iron, cobalt or nickel;

2. A saturation magnetic induction (B_s) of 1,6 T or more; and

1C003 c. (*continued*)

3. Any of the following:

a. A strip thickness of 0,02 mm or less; or

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

Technical Note:

For the purposes of 1C003.c., 'nanocrystalline' materials are those materials having a crystal grain size of 50 nm or less, as determined by X-ray diffraction.

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

a. A density exceeding 17,5 g/cm^3;

b. An elastic limit exceeding 880 MPa;

c. An ultimate tensile strength exceeding 1 270 MPa; and

d. An elongation exceeding 8 %.

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

a. "Superconductive" "composite" conductors containing one or more niobium-titanium 'filaments', having all of the following:

1. Embedded in a "matrix" other than a copper or copper-based mixed "matrix"; and

2. Having a cross-section area less than 0,28 x 10^{-4} mm^2 (6 μm in diameter for circular 'filaments');

b. "Superconductive" "composite" conductors consisting of one or more "superconductive" 'filaments' other than niobium-titanium, having all of the following:

1. A "critical temperature" at zero magnetic induction exceeding 9,85 K (- 263,3 °C); and

2. Remaining in the "superconductive" state at a temperature of 4,2 K (- 268,95 °C) when exposed to a magnetic field oriented in any direction perpendicular to the longitudinal axis of conductor and corresponding to a magnetic induction of 12 T with critical current density exceeding 1 750 A/mm^2 on overall cross-section of the conductor;

c. "Superconductive" "composite" conductors consisting of one or more "superconductive" 'filaments' which remain "superconductive" above 115 K (- 158,15 °C).

Technical Note:

For the purposes of 1C005 'filaments' may be in wire, cylinder, film, tape or ribbon form.

1C006 Fluids and lubricating materials, as follows:

a. Not used;

b. Lubricating materials containing, as their principal ingredients, phenylene or alkylphenylene ethers or thio-ethers, or their mixtures, containing more than two ether or thio-ether functions or mixtures thereof;

c. Damping or flotation fluids having all of the following:

1. Purity exceeding 99,8 %;

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

3. Made from at least 85 % of any of the following:

a. Dibromotetrafluoroethane (CAS 25497-30-7, 124-73-2, 27336-23-8);

b. Polychlorotrifluoroethylene (oily and waxy modifications only); or

c. Polybromotrifluoroethylene;

1C006 (*continued*)

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

1. Containing 85 % by weight or more of any of the following, or mixtures thereof:

a. Monomeric forms of perfluoropolyalkylether-triazines or perfluoroaliphatic-ethers;

b. Perfluoroalkylamines;

c. Perfluorocycloalkanes; or

d. Perfluoroalkanes;

2. Density at 298 K (25 °C) of 1,5 g/ml or more;

3. In a liquid state at 273 K (0 °C); and

4. Containing 60 % or more by weight of fluorine.

Note: *1C006.d. does not control materials specified and packaged as medical products.*

1C007 Ceramic powders, ceramic-"matrix" "composite" materials and 'precursor materials', as follows:

NB: *SEE ALSO 1C107 AND 1C507.*

a. Ceramic powders of titanium diboride (TiB_2) (CAS 12045-63-5) having total metallic impurities, excluding intentional additions, of less than 5 000 ppm, an average particle size equal to or less than 5 μm and no more than 10 % of the particles larger than 10 μm;

b. Not used;

c. Ceramic-"matrix" "composite" materials as follows:

1. Ceramic-ceramic "composite" materials with a glass or oxide-"matrix" and reinforced with any of the following:

a. Continuous fibres having all of the following:

1. Being made from any of the following materials:

a. Al_2O_3 (CAS 1344-28-1); or

b. Si-C-N; and

2. Having all of the following:

a. Tensile strength equal to or greater than 700 MPa at 1 273 K (1 000 °C); and

b. Tensile creep resistance equal to or less than 1 % creep strain at 100 MPa load and 1 273 K (1 000 °C) for 100 hours.

b. Fibres having all of the following:

1. Being 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;

2. Ceramic "matrix" "composite" materials, with a "matrix" formed of carbides or nitrides of silicon, zirconium or boron;

d. Not used;

1C007 (*continued*)

e. 'Precursor materials' specially designed for the "production" of materials specified in 1C007.c., as follows:

1. Polydiorganosilanes;

2. Polysilazanes;

3. Polycarbosilazanes;

f. Not used.

Technical Note:

For the purposes of 1C007, 'precursor materials' are special purpose polymeric or metallo-organic materials used for the "production" of silicon carbide, silicon nitride, or ceramics with silicon, carbon and nitrogen.

1C008 Non-fluorinated polymeric substances as follows:

a. Imides, as follows:

1. Bismaleimides;

2. Aromatic polyamide-imides (PAI) having a 'glass transition temperature (T_g)' exceeding 563 K (290 °C);

3. Aromatic polyimides having a 'glass transition temperature (T_g)' exceeding 505 K (232 °C);

4. Aromatic polyetherimides having a 'glass transition temperature (T_g)' exceeding 563 K (290 °C);

Note: *1C008.a. controls substances in liquid or solid "fusible" form, including resin, powder, pellet, film, sheet, tape or ribbon.*

NB: *For non-"fusible" aromatic polyimides in film, sheet, tape or ribbon form, see 1A003.*

b. Not used;

c. Not used;

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 563 K (290 °C).

Technical Notes:

1. For the purposes of 1C008.a.2. thermoplastic materials, 1C008.a.4. materials and 1C008.f. materials, the 'glass transition temperature (T_g)' is determined using the method described in ISO 11357-2:1999 or national equivalents

2. For the purposes of 1C008.a.2. thermosetting materials and 1C008.a.3. materials, the 'glass transition temperature (T_g)' is determined using the 3-point bend method described in ASTM D 7028-07 or equivalent national standard. The test is to be performed using a dry test specimen which has attained a minimum of 90 % degree of cure as specified in ASTM E 2160-04 or equivalent national standard, and was cured using the combination of standard- and post-cure processes that yield the highest T_g.

1C009 Unprocessed fluorinated compounds as follows:

a. Not used;

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", as follows:

NB: SEE ALSO 1C210 AND 9C110.

Technical Notes:

1. *For the purposes of calculating "specific tensile strength", "specific modulus" or specific weight of "fibrous or filamentary materials" in 1C010.a., 1C010.b., 1C010.c. or 1C010.e.1.b., the tensile strength and modulus should be determined by using Method A described in ISO 10618:2004 or national equivalents.*

2. *For the purposes of assessing the "specific tensile strength", "specific modulus" or specific weight of non-unidirectional "fibrous or filamentary materials" (e.g., fabrics, random mats or braids) in 1C010, this is to be based on the mechanical properties of the constituent unidirectional monofilaments (e.g., monofilaments, yarns, rovings or tows) prior to processing into the non-unidirectional "fibrous or filamentary materials".*

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

1. "Specific modulus" exceeding $12{,}7 \times 10^6$ m; and

2. "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. "Specific modulus" exceeding $14{,}65 \times 10^6$ m; and

2. "Specific tensile strength" exceeding $26{,}82 \times 10^4$ m;

Note: 1C010.b. does not control:

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

1. An area not exceeding 1 m^2;

2. A length not exceeding 2,5 m; and

3. A width exceeding 15 mm;

b. Mechanically chopped, milled or cut carbon "fibrous or filamentary materials" 25,0 mm or less in length.

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

1. Having any of the following:

a. Composed of 50 % or more by weight silicon dioxide and having a "specific modulus" exceeding $2{,}54 \times 10^6$ m; or

b. Not specified in 1C010.c.1.a. and having a "specific modulus" exceeding $5{,}6 \times 10^6$ m; and

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

Note: 1C010.c. does not control:

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

b. Molybdenum and molybdenum alloy fibres;

c. Boron fibres;

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

1C010 (*continued*)

d. "Fibrous or filamentary materials", having any of the following:

1. Composed of any of the following:

a. Polyetherimides specified in 1C008.a.; or

b. Materials specified in 1C008.d. 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.;

Technical Note:

For the purposes of 1C010.d.2., 'commingled' is filament to filament blending of thermoplastic fibres and reinforcement fibres in order to produce a fibre reinforcement "matrix" mix in total fibre form.

e. Fully or partially resin-impregnated or pitch-impregnated "fibrous or filamentary materials" (prepregs), metal or carbon-coated "fibrous or filamentary materials" (preforms) or 'carbon fibre preforms', having all of the following:

1. Having any of the following:

a. Inorganic "fibrous or filamentary materials" specified in 1C010.c.; or

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

1. "Specific modulus" exceeding 10,15 x 10^6 m; and

2. "Specific tensile strength" exceeding 17,7 x 10^4 m; and

2. Having any of the following:

a. Resin or pitch, specified in 1C008 or 1C009.b.;

b. 'Dynamic Mechanical Analysis glass transition temperature (DMA T_g)' equal to or exceeding 453 K (180 °C) and having a phenolic resin; or

c. 'Dynamic Mechanical Analysis glass transition temperature (DMA T_g)' equal to or exceeding 505 K (232 °C) and having a resin or pitch, not specified in 1C008 or 1C009.b., and not being a phenolic resin.

Note 1: *Metal or carbon-coated "fibrous or filamentary materials" (preforms) or 'carbon fibre preforms', not impregnated with resin or pitch, are specified by "fibrous or filamentary materials" in 1C010.a., 1C010.b. or 1C010.c.*

Note 2: *1C010.e. does not control:*

a. Epoxy resin "matrix" impregnated carbon "fibrous or filamentary materials" (prepregs) for the repair of "civil aircraft" structures or laminates, having all the following:

1. An area not exceeding 1 m^2;

2. A length not exceeding 2,5 m; and

3. A width exceeding 15 mm.

b. Fully or partially resin-impregnated or pitch-impregnated mechanically chopped, milled or cut carbon "fibrous or filamentary materials" 25,0 mm or less in length when using a resin or pitch other than those specified in 1C008 or 1C009.b.

1C010 e. (*continued*)

Technical Notes:

1. For the purposes of 1C010.e. and Note 1, 'carbon fibre preforms' are 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".

2. For the purposes of 1C010.e.2. materials, 'Dynamic Mechanical Analysis glass transition temperature (DMA T_g)' is determined using the method described in ASTM D 7028-07, or equivalent national standard, on a dry test specimen. In the case of thermoset materials, degree of cure of a dry test specimen shall be a minimum of 90 % as defined by ASTM E 2160-04 or equivalent national standard.

1C011 Metals and compounds, as follows:

NB: SEE ALSO MILITARY GOODS CONTROLS AND 1C111.

a. Metals in particle sizes of less than 60 μm whether spherical, atomised, spheroidal, flaked or ground, manufactured from material consisting of 99 % or more of zirconium, magnesium and alloys thereof;

Technical Note:

For the purposes of 1C011.a., the natural content of hafnium in the zirconium (typically 2 % to 7 %) is counted with the zirconium.

Note: The metals or alloys specified in 1C011.a. are controlled whether or not the metals or alloys are encapsulated in aluminium, magnesium, zirconium or beryllium.

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

1. Boron with a purity of 85 % by weight or more;

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

Note: The metals or alloys specified in 1C011.b. are controlled whether or not the metals or alloys are encapsulated in aluminium, magnesium, zirconium or beryllium.

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

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

e. Iodine pentafluoride (CAS 7783-66-6).

NB: For metal powders mixed with other substances to form a mixture formulated for military purposes, see Military Goods Controls.

1C012 Materials as follows:

Technical Note:

For the purposes of 1C012., these materials are typically used for nuclear heat sources.

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

Note: 1C012.a. does not control:

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

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

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

Note: 1C012.b. does not control shipments with a neptunium-237 content of 1 g or less.

1C101 Materials and devices for reduced observables such as radar reflectivity, ultraviolet/infrared signatures and acoustic signatures, other than those specified in 1C001, usable in 'missiles', "missile" subsystems or unmanned aerial vehicles specified in 9A012 or 9A112.a.

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 ultraviolet 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 pyrolised carbon-carbon materials designed for space launch vehicles specified in 9A004 or sounding rockets specified in 9A104.

1C107 Graphite and ceramic materials, other than those specified in 1C007, as follows:

a. Fine grain graphites with a bulk density of 1,72 g/cm^3 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;

NB: See also 0C004.

b. Pyrolytic or fibrous reinforced graphites, usable for rocket nozzles and reentry vehicle nose tips usable in "missiles", space launch vehicles specified in 9A004 or sounding rockets specified in 9A104;

NB: See also 0C004.

c. Ceramic composite materials (dielectric constant less than 6 at any frequency from 100 MHz to 100 GHz) for use in radomes usable in "missiles", space launch vehicles specified in 9A004 or sounding rockets specified in 9A104;

d. Bulk machinable silicon-carbide reinforced unfired ceramic, usable for nose tips usable in "missiles", space launch vehicles specified in 9A004 or sounding rockets specified in 9A104;

e. Reinforced silicon-carbide ceramic composites, usable for nose tips, reentry vehicles and nozzle flaps usable in "missiles", space launch vehicles specified in 9A004 or sounding rockets specified in 9A104;

f. Bulk machinable ceramic composite materials consisting of an 'Ultra High Temperature Ceramic (UHTC)' matrix with a melting point equal to or greater than 3 000 °C and reinforced with fibres or filaments, usable for missile components (such as nose-tips, re-entry vehicles, leading edges, jet vanes, control surfaces or rocket motor throat inserts) in "missiles", space launch vehicles specified in 9A004, sounding rockets specified in 9A104 or 'missiles'.

Note: 1C107.f. does not control 'Ultra High Temperature Ceramic (UHTC)' materials in non-composite form.

1C107 f. (*continued*)

Technical Note 1:

In 1C107.f. 'missile' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.

Technical Note 2:

'Ultra High Temperature Ceramics (UHTC)' includes:

1. *Titanium diboride (TiB_2);*
2. *Zirconium diboride (ZrB_2);*
3. *Niobium diboride (NbB_2);*
4. *Hafnium diboride (HfB_2);*
5. *Tantalum diboride (TaB_2);*
6. *Titanium carbide (TiC);*
7. *Zirconium carbide (ZrC);*
8. *Niobium carbide (NbC);*
9. *Hafnium carbide (HfC);*
10. *Tantalum carbide (TaC).*

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

a. Propulsive substances:

1. Spherical or spheroidal aluminium powder other than that specified in the Military Goods Controls, in particle size 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 2591-1:1988 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 powders, other than that specified in the Military Goods Controls, as follows:

a. Metal powders of zirconium, beryllium or magnesium, or alloys of these metals, if at least 90 % of the total particles by particle volume or weight are made up of particles of less than 60 μm (determined by measurement techniques such as using a sieve, laser diffraction or optical scanning), whether spherical, atomised, spheroidal, flaked or ground, consisting 97 % by weight or more of any of the following:

1. Zirconium;
2. Beryllium; or
3. Magnesium;

Technical Note:

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

1C111 a. 2. (*continued*)

b. Metal powders of either boron or boron alloys with a boron content of 85 % or more by weight, if at least 90 % of the total particles by particle volume or weight are made up of particles of less than 60 μm (determined by measurement techniques such as using a sieve, laser diffraction or optical scanning), whether spherical, atomised, spheroidal, flaked or ground;

Note: *1C111a.2.a. and 1C111a.2.b. controls powder mixtures with a multimodal particle distribution (e.g. mixtures of different grain sizes) if one or more modes are controlled.*

3. Oxidiser substances usable in liquid propellant rocket engines as follows:

a. Dinitrogen trioxide (CAS 10544-73-7);

b. Nitrogen dioxide (CAS 10102-44-0)/dinitrogen tetroxide (CAS 10544-72-6);

c. Dinitrogen pentoxide (CAS 10102-03-1);

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_2O_4/NO_2) that can be used in missile systems. There are a range of compositions that can be denoted as MONi or MONij, where i and j are integers representing the percentage of Nitric Oxide in the mixture (e.g., MON3 contains 3 % Nitric Oxide, MON25 25 % Nitric Oxide. An upper limit is MON40, 40 % by weight).

e. SEE MILITARY GOODS CONTROLS FOR Inhibited Red Fuming Nitric Acid (IRFNA);

f. SEE MILITARY GOODS CONTROLS AND 1C238 FOR compounds composed of fluorine and one or more of other halogens, oxygen or nitrogen.

4. Hydrazine derivatives as follows:

NB: *SEE ALSO MILITARY GOODS CONTROLS.*

a. Trimethylhydrazine (CAS 1741-01-1);

b. Tetramethylhydrazine (CAS 6415-12-9);

c. N,N-Diallylhydrazine (CAS 5164-11-4);

d. Allylhydrazine (CAS 7422-78-8);

e. Ethylene dihydrazine (CAS 6068-98-0);

f. Monomethylhydrazine dinitrate;

g. Unsymmetrical dimethylhydrazine nitrate;

h. Hydrazinium azide (CAS 14546-44-2);

i. 1,1-Dimethylhydrazinium azide (CAS 227955-52-4) / 1,2-Dimethylhydrazinium azide (CAS 299177-50-7);

j. Hydrazinium dinitrate (CAS 13464-98-7);

k. Diimido oxalic acid dihydrazine (CAS 3457-37-2);

l. 2-hydroxyethylhydrazine nitrate (HEHN);

m. See Military Goods Controls for Hydrazinium perchlorate;

n. Hydrazinium diperchlorate (CAS 13812-39-0);

1C111 a. 4. NB: (*continued*)

o. Methylhydrazine nitrate (MHN) (CAS 29674-96-2);

p. 1,1-Diethylhydrazine nitrate (DEHN) / 1,2-Diethylhydrazine nitrate (DEHN) (CAS 363453-17-2);

q. 3,6-Dihydrazino tetrazine nitrate (1,4-dihydrazine nitrate) (DHTN);

5. High energy density materials, other than that specified in the Military Goods Controls, usable in 'missiles' or unmanned aerial vehicles specified in 9A012 or 9A112.a.;

a. Mixed fuel that incorporate both solid and liquid fuels, such as boron slurry, having a mass-based energy density of 40 x 10^6 J/kg or greater;

b. Other high energy density fuels and fuel additives (e.g., cubane, ionic solutions, JP-10) having a volume-based energy density of 37,5 x 10^9 J/m^3 or greater, measured at 20 °C and one atmosphere (101,325 kPa) pressure;

Note: 1C111.a.5.b. does not control fossil refined fuels and biofuels produced from vegetables, including fuels for engines certified for use in civil aviation, unless specially formulated for 'missiles' or unmanned aerial vehicles specified in 9A012 or 9A112.a..

Technical Note:

In 1C111.a.5. 'missile' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.

6. Hydrazine replacement fuels as follows:

a. 2-Dimethylaminoethylazide (DMAZ) (CAS 86147-04-8);

b. Polymeric substances:

1. Carboxy-terminated polybutadiene (including carboxyl-terminated polybutadiene) (CTPB);

2. Hydroxy-terminated polybutadiene (including hydroxyl-terminated polybutadiene) (HTPB) (CAS 69102-90-5), other than that specified in the Military Goods Controls;

3. Polybutadiene-acrylic acid (PBAA);

4. Polybutadiene-acrylic acid-acrylonitrile (PBAN) (CAS 25265-19-4 / CAS 68891-50-9);

5. Polytetrahydrofuran polyethylene glycol (TPEG);

Technical Note:

Polytetrahydrofuran polyethylene glycol (TPEG) is a block co-polymer of poly 1,4-Butanediol (CAS 110-63-4) and polyethylene glycol (PEG) (CAS 25322-68-3).

6. SEE MILITARY GOODS CONTROLS FOR polyglycidyl nitrate (PGN or poly-GLYN) (CAS 27814-48- 8).

c. Other propellant additives and agents:

1. SEE MILITARY GOODS CONTROLS FOR Carboranes, decaboranes, pentaboranes and derivatives thereof;

2. Triethylene glycol dinitrate (TEGDN) (CAS 111-22-8);

3. 2-Nitrodiphenylamine (CAS 119-75-5);

1C111 c. (*continued*)

4. SEE MILITARY GOODS CONTROLS FOR trimethylolethane trinitrate (TMETN) (CAS 3032-55-1);

5. Diethylene glycol dinitrate (DEGDN) (CAS 693-21-0);

6. Ferrocene derivatives as follows:

a. SEE MILITARY GOODS CONTROLS FOR catocene (CAS 37206-42-1);

b. SEE MILITARY GOODS CONTROLS FOR Ethyl ferrocene (CAS 1273-89-8);

c. SEE MILITARY GOODS CONTROLS FOR n-Propyl ferrocene (CAS 1273-92-3)/iso-propyl ferrocene (CAS 12126-81-7);

d. SEE MILITARY GOODS CONTROLS FOR n-butyl ferrocene (CAS 31904-29-7);

e. SEE MILITARY GOODS CONTROLS FOR Pentyl ferrocene (CAS 1274-00-6);

f. SEE MILITARY GOODS CONTROLS FOR Dicyclopentyl ferrocene (CAS 125861-17-8);

g. SEE MILITARY GOODS CONTROLS FOR Dicyclohexyl ferrocene;

h. SEE MILITARY GOODS CONTROLS FOR Diethyl ferrocene (CAS 1273-97-8);

i. SEE MILITARY GOODS CONTROLS FOR Dipropyl ferrocene;

j. SEE MILITARY GOODS CONTROLS FOR Dibutyl ferrocene (CAS 1274-08-4);

k. SEE MILITARY GOODS CONTROLS FOR Dihexyl ferrocene (CAS 93894-59-8);

l. SEE MILITARY GOODS CONTROLS FOR Acetyl ferrocene (CAS 1271-55-2) / 1,1'-diacetyl ferrocene (CAS 1273-94-5);

m. SEE MILITARY GOODS CONTROLS FOR Ferrocene carboxylic acid (CAS 1271-42-7) / 1,1'-Ferrocenedicarboxylic acid (CAS 1293-87-4);

n. SEE MILITARY GOODS CONTROLS FOR butacene (CAS 125856-62-4);

o. Other ferrocene derivatives usable as rocket propellant burning rate modifiers, other than those specified in the Military Goods Controls.

Note: 1C111.c.6.o. does not control ferrocene derivatives that contain a six carbon aromatic functional group attached to the ferrocene molecule.

7. 4,5-Diazidomethyl-2-methyl-1,2,3-triazole (iso-DAMTR), other than that specified in the Military Goods Controls.

d. 'Gel propellants', other than that specified in the Military Goods Controls, specifically formulated for use in 'missiles'.

Technical Notes:

1. In 1C111.d. a 'gel propellant' is a fuel or oxidiser formulation using a gellant such as silicates, kaolin (clay), carbon or any polymeric gellant.

2. In 1C111.d. a 'missile' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.

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

1C116 Maraging steels, useable in 'missiles', having all of the following:

NB: SEE ALSO 1C216.

a. Having an ultimate tensile strength, measured at 293 K (20 °C), equal to or greater than:

1. 0,9 GPa in the solution annealed stage; or

2. 1,5 GPa in the precipitation hardened stage; and

b. Any of the following forms:

1. Sheet, plate or tubing with a wall or plate thickness equal to or less than 5,0 mm;

2. Tubular forms with a wall thickness equal to or less than 50 mm and having an inner diameter equal to or greater than 270 mm.

Technical Note 1:

Maraging steels are iron alloys:

1. Generally characterised by high nickel content, carbon content of less than or equal to 0,03 % by weight, and the use of substitutional elements or precipitates to produce strengthening and age-hardening of the alloy; and

2. Subjected to heat treatment cycles to facilitate the martensitic transformation process (solution annealed stage) and subsequently age hardened (precipitation hardened stage).

Technical Note 2:

In 1C116 'missile' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.

1C117 Materials for the fabrication of 'missiles' components as follows:

a. Tungsten and alloys in particulate form with a tungsten content of 97 % by weight or more and a particle size of 50 x 10^{-6} m (50 μm) or less;

b. Molybdenum and alloys in particulate form with a molybdenum content of 97 % by weight or more and a particle size of 50 x 10^{-6} m (50 μm) or less;

c. Tungsten materials in solid form having all of the following:

1. Any of the following material compositions:

a. Tungsten and alloys containing 97 % by weight or more of tungsten;

b. Copper infiltrated tungsten containing 80 % by weight or more of tungsten; or

c. Silver infiltrated tungsten containing 80 % by weight or more of tungsten; and

2. Able to be machined to any of the following products:

a. Cylinders having a diameter of 120 mm or greater and a length of 50 mm or greater;

b. 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

c. Blocks having a size of 120 mm by 120 mm by 50 mm or greater.

Technical Note:

In 1C117 'missile' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.

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 % by weight of chromium and 4,5 – 7,0 % by weight of nickel;

2. Having a titanium content of greater than 0,10 % by weight; and

3. A ferritic-austenitic microstructure (also referred to as a two-phase microstructure) of which at least 10 % by volume (according to ASTM E-1181-87 or national equivalents) is austenite; and

b. Having any of the following forms:

1. Ingots or bars having a size of 100 mm or more in each dimension;

2. Sheets having a width of 600 mm or more and a thickness of 3 mm or less; or

3. Tubes having an outer diameter of 600 mm or more and a wall thickness of 3 mm or less.

1C202 Alloys, other than those specified in 1C002.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;

b. Titanium alloys having both of the following characteristics:

1. 'Capable of' an ultimate tensile strength of 900 MPa or more at 293 K (20 °C); and

2. In the form of tubes or cylindrical solid forms (including forgings) with an outside diameter of more than 75 mm.

Technical Note:

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

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

a. Carbon or aramid 'fibrous or filamentary materials' having either of the following characteristics:

1. A "specific modulus" of $12,7 \times 10^6$ m or greater; or

2. A "specific tensile strength" of $23,5 \times 10^4$ m or greater;

Note: 1C210.a. does not control aramid 'fibrous or filamentary materials' having 0,25 % by weight or more 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 $7,62 \times 10^4$ 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 1 950 MPa or more, at 293 K (20°C).

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

Technical Note:

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

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

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

Technical Note:

The natural isotopic abundance of boron-10 is approximately 18,5 weight per cent (20 atom per cent).

1C226 Tungsten, tungsten carbide, and alloys containing more than 90 % tungsten by weight, other than that specified in 1C117, 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 ppm by weight of metallic impurities other than magnesium; and

b. Containing less than 10 ppm by weight of boron.

1C228 Magnesium having both of the following characteristics:

a. Containing less than 200 ppm by weight of metallic impurities other than calcium; and

b. Containing less than 10 ppm 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 ppm 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, other than that specified in the Military Goods Controls.

NB: *SEE ALSO MILITARY GOODS CONTROLS.*

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

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

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

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

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

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

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

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

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

Technical Note:

The natural isotopic abundance of lithium-6 is approximately 6,5 weight per cent (7,5 atom per cent).

1C234 Zirconium with a hafnium content of less than 1 part hafnium to 500 parts zirconium by weight, as follows: metal, alloys containing more than 50 % zirconium by weight, compounds, manufactures thereof, waste or scrap of any of the foregoing, other than those specified in 0A001.f.

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 1 000, and products or devices containing any of the foregoing.

Note: *1C235 does not control a product or device containing less than 1,48 x 10^{3} GBq (40 Ci) of tritium.*

1C236 'Radionuclides' appropriate for making neutron sources based on alpha-n reaction, other than those specified in 0C001 and 1C012.a., in the following forms:

a. Elemental;

b. Compounds having a total activity of 37 GBq/kg (1 Ci/kg) or greater;

c. Mixtures having a total 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 activity.*

Technical Note:

In 1C236 'radionuclides' are any of the following:

— *Actinium-225 (^{225}Ac)*

— *Actinium-227 (^{227}Ac)*

— *Californium-253 (^{253}Cf)*

— *Curium-240 (^{240}Cm)*

— *Curium-241 (^{241}Cm)*

1C236 (*continued*)

— *Curium-242 (^{242}Cm)*

— *Curium-243 (^{243}Cm)*

— *Curium-244 (^{244}Cm)*

— *Einsteinium-253 (^{253}Es)*

— *Einsteinium-254 (^{254}Es)*

— *Gadolinium-148 (^{148}Gd)*

— *Plutonium-236 (^{236}Pu)*

— *Plutonium-238 (^{238}Pu)*

— *Polonium-208 (^{208}Po)*

— *Polonium-209 (^{209}Po)*

— *Polonium-210 (^{210}Po)*

— *Radium-223 (^{223}Ra)*

— *Thorium-227 (^{227}Th)*

— *Thorium-228 (^{228}Th)*

— *Uranium-230 (^{230}U)*

— *Uranium-232 (^{232}U)*

1C237 Radium-226 (^{226}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_3).

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

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

a. Nickel powder having both of the following characteristics:

1. A nickel purity content of 99,0 % or greater by weight; and

2. A mean particle size of less than 10 μm measured by American Society for Testing and Materials (ASTM) B330 standard;

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

Note: *1C240 does not control the following:*

a. Filamentary nickel powders;

b. Single porous nickel sheets with an area of 1 000 cm^2 per sheet or less.

1C240 (*continued*)

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.

1C241 Rhenium, and alloys containing 90 % by weight or more rhenium; and alloys of rhenium and tungsten containing 90 % by weight or more of any combination of rhenium and tungsten, other than those specified in 1C226, having both of the following characteristics:

a. In forms with a hollow cylindrical symmetry (including cylinder segments) with an inside diameter between 100 and 300 mm; and

b. A mass greater than 20 kg.

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

NB: SEE ALSO MILITARY GOODS CONTROLS AND 1C450.

1. Thiodiglycol (CAS 111-48-8);
2. Phosphorus oxychloride (CAS 10025-87-3);
3. Dimethyl methylphosphonate (CAS 756-79-6);
4. SEE MILITARY GOODS CONTROLS for Methyl phosphonyl difluoride (CAS 676-99-3);
5. Methyl phosphonyl dichloride (CAS 676-97-1);
6. Dimethyl phosphite (DMP) (CAS 868-85-9);
7. Phosphorus trichloride (CAS 7719-12-2);
8. Trimethyl phosphite (TMP) (CAS 121-45-9);
9. Thionyl chloride (CAS 7719-09-7);
10. 3-Hydroxy-1-methylpiperidine (CAS 3554-74-3);
11. N,N-Diisopropyl-(beta)-aminoethyl chloride (CAS 96-79-7);
12. N,N-Diisopropyl-(beta)-aminoethane thiol (CAS 5842-07-9);
13. 3-Quinuclidinol (CAS 1619-34-7);
14. Potassium fluoride (CAS 7789-23-3);
15. 2-Chloroethanol (CAS 107-07-3);
16. Dimethylamine (CAS 124-40-3);
17. Diethyl ethylphosphonate (CAS 78-38-6);
18. Diethyl N,N-dimethylphosphoramidate (CAS 2404-03-7);
19. Diethyl phosphite (CAS 762-04-9);
20. Dimethylamine hydrochloride (CAS 506-59-2);
21. Ethyl phosphinyl dichloride (CAS 1498-40-4);

1C350 (*continued*)

22. Ethyl phosphonyl dichloride (CAS 1066-50-8);
23. SEE MILITARY GOODS CONTROLS for Ethyl phosphonyl difluoride (CAS 753-98-0);
24. Hydrogen fluoride (CAS 7664-39-3);
25. Methyl benzilate (CAS 76-89-1);
26. Methyl phosphinyl dichloride (CAS 676-83-5);
27. N,N-Diisopropyl-(beta)-amino ethanol (CAS 96-80-0);
28. Pinacolyl alcohol (CAS 464-07-3);
29. SEE MILITARY GOODS CONTROLS for O-Ethyl O-2-diisopropylaminoethyl methylphosphonite (QL) (CAS 57856-11-8);
30. Triethyl phosphite (CAS 122-52-1);
31. Arsenic trichloride (CAS 7784-34-1);
32. Benzilic acid (CAS 76-93-7);
33. Diethyl methylphosphonite (CAS 15715-41-0);
34. Dimethyl ethylphosphonate (CAS 6163-75-3);
35. Ethyl phosphinyl difluoride (CAS 430-78-4);
36. Methyl phosphinyl difluoride (CAS 753-59-3);
37. 3-Quinuclidone (CAS 3731-38-2);
38. Phosphorus pentachloride (CAS 10026-13-8);
39. Pinacolone (CAS 75-97-8);
40. Potassium cyanide (CAS 151-50-8);
41. Potassium bifluoride (CAS 7789-29-9);
42. Ammonium hydrogen fluoride or ammonium bifluoride (CAS 1341-49-7);
43. Sodium fluoride (CAS 7681-49-4);
44. Sodium bifluoride (CAS 1333-83-1);
45. Sodium cyanide (CAS 143-33-9);
46. Triethanolamine (CAS 102-71-6);
47. Phosphorus pentasulphide (CAS 1314-80-3);
48. Di-isopropylamine (CAS 108-18-9);
49. Diethylaminoethanol (CAS 100-37-8);
50. Sodium sulphide (CAS 1313-82-2);
51. Sulphur monochloride (CAS 10025-67-9);
52. Sulphur dichloride (CAS 10545-99-0);
53. Triethanolamine hydrochloride (CAS 637-39-8);
54. N,N-Diisopropyl-(beta)-aminoethyl chloride hydrochloride (CAS 4261-68-1);
55. Methylphosphonic acid (CAS 993-13-5);
56. Diethyl methylphosphonate (CAS 683-08-9);
57. N,N-Dimethylaminophosphoryl dichloride (CAS 677-43-0);
58. Triisopropyl phosphite (CAS 116-17-6);

1C350 (*continued*)

59. Ethyldiethanolamine (CAS 139-87-7);
60. O,O-Diethyl phosphorothioate (CAS 2465-65-8);
61. O,O-Diethyl phosphorodithioate (CAS 298-06-6);
62. Sodium hexafluorosilicate (CAS 16893-85-9);
63. Methylphosphonothioic dichloride (CAS 676-98-2);
64. Diethylamine (CAS 109-89-7);
65. N,N-Diisopropylaminoethanethiol hydrochloride (CAS 41480-75-5);
66. Methyl dichlorophosphate (CAS 677-24-7);
67. Ethyl dichlorophosphate (CAS 1498-51-7);
68. Methyl difluorophosphate (CAS 22382-13-4);
69. Ethyl difluorophosphate (CAS 460-52-6);
70. Diethyl chlorophosphite (CAS 589-57-1);
71. Methyl chlorofluorophosphate (CAS 754-01-8);
72. Ethyl chlorofluorophosphate (CAS 762-77-6);
73. N,N-Dimethylformamidine (CAS 44205-42-7);
74. N,N-Diethylformamidine (CAS 90324-67-7);
75. N,N-Dipropylformamidine (CAS 48044-20-8);
76. N,N-Diisopropylformamidine (CAS 857522-08-8);
77. N,N-Dimethylacetamidine (CAS 2909-14-0);
78. N,N-Diethylacetamidine (CAS 14277-06-6);
79. N,N-Dipropylacetamidine (CAS 1339586-99-0);
80. N,N-Dimethylpropanamidine (CAS 56776-14-8);
81. N,N-Diethylpropanamidine (CAS 84764-73-8);
82. N,N-Dipropylpropanamidine (CAS 1341496-89-6);
83. N,N-Dimethylbutanamidine (CAS 1340437-35-5);
84. N,N-Diethylbutanamidine (CAS 53510-30-8);
85. N,N-Dipropylbutanamidine (CAS 1342422-35-8);
86. N,N-Diisopropylbutanamidine (CAS 1315467-17-4);
87. N,N-Dimethylisobutanamidine (CAS 321881-25-8);
88. N,N-Diethylisobutanamidine (CAS 1342789-47-2);
89. N,N-Dipropylisobutanamidine (CAS 1342700-45-1);
90. Dipropylamine (CAS 142-84-7);
91. 1,1,3,3-Tetraethylguanidine (CAS 13439-87-7).

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,.63 and.65 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,.63 and.65 in which no individually specified chemical constitutes more than 30 % by the weight of the mixture.*

1C350 (*continued*)

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,.66,.67,.68,.69,.70,.71,.72,.73,.74,.75,.76,.77,.78,.79,.80,.81,.82,.83,.84,. 85,.86,.87,.88,.89 and.90 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.

1C351 Human and animal pathogens 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. African horse sickness virus;

2. African swine fever virus;

3. Andes virus;

4. Avian influenza virus, which are:

a. Uncharacterised; or

b. Defined in Annex I(2) EC Directive 2005/94/EC (OJ L 10, 14.1.2006 p. 16) 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 of the subtypes H5 or H7 with genome sequences codified for multiple basic amino acids at the cleavage site of the haemagglutinin molecule similar to that observed for other HPAI viruses, indicating that the haemagglutinin molecule can be cleaved by a host ubiquitous protease;

5. Bluetongue virus;

6. Chapare virus;

7. Chikungunya virus;

8. Choclo virus;

9. Crimean-Congo hemorrhagic fever virus;

10. Not used;

11. Dobrava-Belgrade virus;

12. Eastern equine encephalitis virus;

13. Ebolavirus: all members of the Ebolavirus genus;

14. Foot-and-mouth disease virus;

15. Goatpox virus;

16. Guanarito virus;

17. Hantaan virus;

18. Hendra virus (Equine morbillivirus);

19. Suid herpesvirus 1 (Pseudorabies virus; Aujeszky's disease);

20. Classical swine fever virus (Hog cholera virus);

21. Japanese encephalitis virus;

1C351 a. (*continued*)

22. Junin virus;
23. Kyasanur Forest disease virus;
24. Laguna Negra virus;
25. Lassa virus;
26. Louping ill virus;
27. Lujo virus;
28. Lumpy skin disease virus;
29. Lymphocytic choriomeningitis virus;
30. Machupo virus;
31. Marburgvirus: all members of the Marburgvirus genus;
32. Monkeypox virus;
33. Murray Valley encephalitis virus;
34. Newcastle disease virus;
35. Nipah virus;
36. Omsk hemorrhagic fever virus;
37. Oropouche virus;
38. Peste-des-petits-ruminants virus;
39. Swine vesicular disease virus;
40. Powassan virus;
41. Rabies virus and all other members of the Lyssavirus genus;
42. Rift Valley fever virus;
43. Rinderpest virus;
44. Rocio virus;
45. Sabia virus;
46. Seoul virus;
47. Sheeppox virus;
48. Sin Nombre virus;
49. St. Louis encephalitis virus;
50. Porcine Teschovirus;
51. Tick-borne encephalitis virus (Far Eastern subtype);
52. Variola virus;
53. Venezuelan equine encephalitis virus;
54. Vesicular stomatitis virus;
55. Western equine encephalitis virus;
56. Yellow fever virus;
57. Severe acute respiratory syndrome-related coronavirus (SARS-related coronavirus);
58. Reconstructed 1918 influenza virus;
59. Middle East respiratory syndrome-related coronavirus (MERS-related coronavirus);

1C351 (*continued*)

b. Not used;

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. Burkholderia mallei (Pseudomonas mallei);

6. Burkholderia pseudomallei (Pseudomonas pseudomallei);

7. Chlamydia psittaci (Chlamydophila psittaci);

8. Clostridium argentinense (formerly known as Clostridium botulinum Type G), botulinum neurotoxin producing strains;

9. Clostridium baratii, botulinum neurotoxin producing strains;

10. Clostridium botulinum;

11. Clostridium butyricum, botulinum neurotoxin producing strains;

12. Clostridium perfringens epsilon toxin producing types;

13. Coxiella burnetii;

14. Francisella tularensis;

15. Mycoplasma capricolum subspecies capripneumoniae (strain F38);

16. Mycoplasma mycoides subspecies mycoides SC (small colony);

17. Rickettsia prowazekii;

18. Salmonella enterica subspecies enterica serovar Typhi (Salmonella typhi);

19. Shiga toxin producing Escherichia coli (STEC) of serogroups O26, O45, O103, O104, O111, O121, O145, O157, and other shiga toxin producing serogroups;

Note:

Shiga toxin producing Escherichia coli (STEC) includes, inter alia, enterohaemorrhagic E. coli (EHEC), verotoxin producing E. coli (VTEC) or verocytotoxin producing E. coli (VTEC).

20. Shigella dysenteriae;

21. Vibrio cholerae;

22. Yersinia pestis;

d. "Toxins", as follows, and "sub-unit of toxins" thereof:

1. Botulinum neurotoxins;

2. Clostridium perfringens alpha, beta 1, beta 2, epsilon and iota toxins;

3. Conotoxins;

4. Ricin;

5. Saxitoxin;

6. Shiga toxins (shiga-like toxins, verotoxins and verocytotoxins)

7. Staphylococcus aureus enterotoxins, hemolysin alpha toxin, and toxic shock syndrome toxin (formerly known as Staphylococcus enterotoxin F);

1C351 d. (*continued*)

8. Tetrodotoxin;

9. Not used;

10. Microcystins (Cyanginosins);

11. Aflatoxins;

12. Abrin;

13. Not used;

14. Diacetoxyscirpenol;

15. T-2 toxin;

16. HT-2 toxin;

17. Modeccin;

18. Volkensin;

19. Viscumin (Viscum Album Lectin 1);

20. Brevetoxins;

21. Gonyautoxins;

22. Nodularins;

23. Palytoxin;

24. Neosaxitoxin (NEO).

Note: *1C351.d. does not control botulinum neurotoxins 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.

e. 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, as follows:

1. Coccidioides immitis;

2. Coccidioides posadasii.

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

1C353 'Genetic elements' and 'genetically-modified organisms', as follows:

a. Any 'genetically-modified organism' which contains, or 'genetic element' that codes for, any of the following:

1. Any gene, genes, translated product or translated products, specific to any virus specified in 1C351.a. or 1C354.a.;

2. Any gene or genes specific to any bacterium specified in 1C351.c. or 1C354.b. or fungus specified in 1C351.e. or 1C354.c., and which is any of the following:

a. In itself or through its transcribed or translated products represents a significant hazard to human, animal or plant health; or

b. Could 'endow or enhance pathogenicity'; or

3. Any "toxins" specified in 1C351.d. or "sub-units of toxins" therefor;

b. Not used.

1C353 (*continued*)

Technical Notes:

1. *'Genetically-modified organisms' include organisms in which the nucleic acid sequences have been created or altered by deliberate molecular manipulation.*

2. *'Genetic elements' include, inter alia, chromosomes, genomes, plasmids, transposons, vectors and inactivated organisms containing recoverable nucleic acid fragments, whether genetically modified or unmodified, or chemically synthesised in whole or in part. For the purposes of the genetic elements control, nucleic acids from an inactivated organism, virus, or sample are considered recoverable if the inactivation and preparation of the material is intended or known to facilitate isolation, purification, amplification, detection, or identification of nucleic acids.*

3. *'Endow or enhance pathogenicity' is defined as when the insertion or integration of the nucleic acid sequence or sequences is/are likely to enable or increase a recipient organism's ability to be used to deliberately cause disease or death. This might include alterations to,* inter alia: *virulence, transmissibility, stability, route of infection, host range, reproducibility, ability to evade or suppress host immunity, resistance to medical countermeasures, or detectability.*

Note 1: 1C353 does not control nucleic acid sequences of shiga toxin producing Escherichia coli of serogroups O26, O45, O103, O104, O111, O121, O145, O157, and other shiga toxin producing serogroups, other than those genetic elements coding for shiga toxin, or for its subunits.

Note 2: 1C353 does not control "vaccines".

1C354 Plant 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. Andean potato latent virus (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 citri pv. citri (Xanthomonas axonopodis pv. citri, Xanthomonas campestris pv. citri);

3. Xanthomonas oryzae pv. oryzae (Pseudomonas campestris pv. oryzae);

4. Clavibacter michiganensis subsp. sepedonicus (Clavibacter sepedonicus, Clavibacter michiganense subsp. sepedonicus, Corynebacterium michiganensis subsp. sepedonicum or Corynebacterium sepedonicum);

5. Ralstonia solanacearum, race 3, biovar 2;

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 kahawae (Colletotrichum coffeanum var. virulans);

2. Bipolaris oryzae (Cochliobolus miyabeanus, Helminthosporium oryzae);

3. Pseudocercospora ulei (Microcyclus ulei, Dothidella ulei);

4. Puccinia graminis ssp. graminis var. graminis / Puccinia graminis ssp. graminis var. stakmanii (Puccinia graminis [syn. Puccinia graminis f. sp. tritici]);

1C354 c. (*continued*)

5. Puccinia striiformis (syn. Puccinia glumarum);

6. Magnaporthe oryzae (Pyricularia oryzae);

7. Peronosclerospora philippinensis (Peronosclerospora sacchari);

8. Sclerophthora rayssiae var. zeae;

9. Synchytrium endobioticium;

10. Tilletia indica;

11. Thecaphora solani.

1C450 Toxic chemicals and toxic chemical precursors, as follows, and "chemical mixtures" containing one or more thereof:

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

a. Toxic chemicals, as follows:

1. Amiton: O,O-Diethyl S-[2-(diethylamino)ethyl] phosphorothiolate (CAS 78-53-5) and corresponding alkylated or protonated salts;

2. PFIB: 1,1,3,3,3-Pentafluoro-2-(trifluoromethyl)-1-propene (CAS 382-21-8);

3. SEE MILITARY GOODS CONTROLS FOR BZ: 3-Quinuclidinyl benzilate (CAS 6581-06-2);

4. Phosgene: Carbonyl dichloride (CAS 75-44-5);

5. Cyanogen chloride (CAS 506-77-4);

6. Hydrogen cyanide (CAS 74-90-8);

7. Chloropicrin: Trichloronitromethane (CAS 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.

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

b. Toxic chemical precursors, as follows:

1. Chemicals, other than those specified in the Military Goods Controls or in 1C350, containing a phosphorus atom to which is bonded one methyl, ethyl or propyl (normal or iso) group but not further carbon atoms;

Note: 1C450.b.1. does not control Fonofos: O-Ethyl S-phenyl ethylphosphonothiolothionate (CAS 944-22-9);

1C450 b. (*continued*)

2. N,N-Dialkyl [methyl, ethyl or propyl (normal or iso)] phosphoramidic dihalides, other than N,N-Dimethylaminophosphoryl dichloride;

NB: See 1C350.57. for N,N-Dimethylaminophosphoryl dichloride.

3. Dialkyl [methyl, ethyl or propyl (normal or iso)] N,N-dialkyl [methyl, ethyl or propyl (normal or iso)]-phosphoramidates, other than Diethyl-N,N-dimethylphosphoramidate which is specified in 1C350;

4. N,N-Dialkyl [methyl, ethyl or propyl (normal or iso)] aminoethyl-2-chlorides and corresponding protonated salts, other than N,N-Diisopropyl-(beta)-aminoethyl chloride or N,N-Diisopropyl-(beta)-aminoethyl chloride hydrochloride which are specified in 1C350;

5. N,N-Dialkyl [methyl, ethyl or propyl (normal or iso)] aminoethane-2-ols and corresponding protonated salts, other than N,N-Diisopropyl-(beta)-aminoethanol (CAS 96-80-0) and N,N-Diethylaminoethanol (CAS 100-37-8) which are specified in 1C350;

Note: 1C450.b.5. does not control the following:

a. N,N-Dimethylaminoethanol (CAS 108-01-0) and corresponding protonated salts;

b. Protonated salts of N,N-Diethylaminoethanol (CAS 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 (CAS 5842-07-9) and N,N-Diisopropylaminoethanethiol hydrochloride (CAS 41480-75-5) which are specified in 1C350;

7. See 1C350 for ethyldiethanolamine (CAS 139-87-7);

8. Methyldiethanolamine (CAS 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.

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 one or more of the chemicals specified in entry 1C450.b.8. in which no individually specified chemical constitutes 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.

1C507 Ceramic powders, ceramic-"matrix" "composite" materials and 'precursor materials', as follows:

c. Ceramic-"matrix" "composite" materials as follows:

1. Ceramic-ceramic "composite" materials with a glass or oxide-"matrix" and reinforced with:

a. Continuous fibres, not specified in 1C007.c.1.a., having all of the following:

1. Being made from any of the following Al_2O_3-based materials or a combination thereof:

a. Al_2O_3; or

b. Mullite ($3Al_2O_3.2SiO_2$); and

1C507 c. 1. a. (*continued*)

2. Having all of the following:

a. Tensile strength equal to or greater than 700 MPa at 1 273 K (1 000 °C); and

b. Tensile creep resistance equal to or less than 1 % creep strain at 100 MPa load and 1 273 K (1 000 °C) for 100 hours.

1C513 'High-entropy alloy' or "refractory metal and alloy" powders, not specified in 1C002, having a surface modified with 'inoculants'.

Technical Notes:

For the purposes of 1C513.:

1. *'High-entropy alloys' are alloys having at least 5 principal metallic elements, each having concentration within the range of 5 to 35 atomic percent, from the following list: Al, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zr, Nb, Mo, Hf, Ta or W.*

2. *'Inoculants' are additives that promote grain nucleation and increase the total area of grain boundaries to inhibit solidification defects.*

1D Software

1D001 "Software" specially designed or modified for the "development", "production" or "use" of equipment specified in 1B001 to 1B003, 1B501 or 1B504.

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

1D003 "Software" specially designed or modified to enable equipment to perform the functions of equipment specified in 1A004.c. or 1A004.d.

1D101 "Software" specially designed or modified for the operation or maintenance 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 1A002 to 1A005, 1A006.b., 1A007, 1B or 1C.

1E002 Other "technology" as follows:

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

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

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

1. Ceramic powders having all of the following:

a. Any of the following compositions:

1. Single or complex oxides of zirconium and complex oxides of silicon or aluminium;

2. Single nitrides of boron (cubic crystalline forms);

3. Single or complex carbides of silicon or boron; or

4. Single or complex nitrides of silicon;

1E002 c. 1. (*continued*)

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

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

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

c. Being any of the following:

1. Zirconia (CAS 1314-23-4) with an average particle size equal to or less than 1 μm and no more than 10 % of the particles larger than 5 μm; or

2. Other ceramic powders with an average particle size equal to or less than 5 μm and no more than 10 % of the particles larger than 10 μm;

2. Non-"composite" ceramic materials composed of the materials specified in 1E002.c.1.;

Note: *1E002.c.2. does not control "technology" for abrasives.*

d. Not used;

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 1C507.c.;

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.*

g. "Libraries" specially designed or modified to enable equipment to perform the functions of equipment specified in 1A004.c. or 1A004.d.

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 1C118, 1D101 or 1D103.

1E102 "Technology" according to the General Technology Note for the "development" of "software" specified in 1D001, 1D101 or 1D103.

1E103 "Technology" for the regulation of temperature, pressure or atmosphere in autoclaves or hydroclaves, when used for the "production" of "composites" or partially processed "composites".

1E104 "Technology" for 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, 1A007, 1A202, 1A225 to 1A227, 1B201, 1B225 to 1B235, 1C002.b.3. or.b.4., 1C010.b., 1C202, 1C210, 1C216, 1C225 to 1C241 or 1D201.

1E202 "Technology" according to the General Technology Note for the "development" or "production" of goods specified in 1A007, 1A202 or 1A225 to 1A227.

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

PART IV

Category 2

CATEGORY 2 – MATERIALS PROCESSING

2A Systems, Equipment and Components

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

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

NB: SEE ALSO 2A101.

a. Ball bearings and solid roller bearings, having all tolerances specified by the manufacturer in accordance with ISO 492 Tolerance Class 4 or Class 2 (or national equivalents), or better, and having both 'rings' and 'rolling elements', made from monel or beryllium;

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

Technical Notes:

For the purposes of 2A001.a.:

1. *'Ring' is a annular part of a radial rolling bearing incorporating one or more raceways (ISO 5593:1997).*
2. *'Rolling element' is a ball or roller which rolls between raceways (ISO 5593:1997).*

b. Not used;

c. Active magnetic bearing systems using any of the following, and specially designed components therefor:

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.

2A101 Radial ball bearings, other than those specified in 2A001, having all tolerances specified in accordance with ISO 492 Tolerance Class 2 (or ANSI/ABMA Std 20 Tolerance Class ABEC-9 or other national equivalents), or better and having all of the following characteristics:

a. An inner ring bore diameter between 12 mm and 50 mm;

b. An outer ring outside diameter between 25 mm and 100 mm; and

c. A width between 10 mm and 20 mm.

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

a. Crucibles having both of the following characteristics:

1. A volume of between 150 cm^3 and 8 000 cm^3; and
2. Made of or coated with any of the following materials, or combination of the following materials, having an overall impurity level of 2 % or less by weight:

a. Calcium fluoride (CaF_2);

b. Calcium zirconate (metazirconate) ($CaZrO_3$);

c. Cerium sulphide (Ce_2S_3);

d. Erbium oxide (erbia) (Er_2O_3);

e. Hafnium oxide (hafnia) (HfO_2);

f. Magnesium oxide (MgO);

2A225 a. 2. (*continued*)

g. Nitrided niobium-titanium-tungsten alloy (approximately 50 % Nb, 30 % Ti, 20 % W);

h. Yttrium oxide (yttria) (Y_2O_3); or

i. Zirconium oxide (zirconia) (ZrO_2);

b. Crucibles having both of the following characteristics:

1. A volume of between 50 cm^3 and 2 000 cm^3; and

2. Made of or lined with tantalum, having a purity of 99,9 % or greater by weight;

c. Crucibles having all of the following characteristics:

1. A volume of between 50 cm^3 and 2 000 cm^3;

2. Made of or lined with tantalum, having a purity of 98 % or greater by weight; and

3. Coated with tantalum carbide, nitride, boride, or any combination thereof.

2A226 Valves having all of the following characteristics:

a. A 'nominal size' of 5 mm or greater;

b. Having a bellows seal; and

c. Wholly made of or lined with aluminium, aluminium alloy, nickel, or nickel alloy containing more than 60 % nickel by weight.

Technical Note:

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

2B Test, Inspection and Production Equipment

Technical Notes:

1. For the purposes of 2B, 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 coordinated 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 movement 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. For the purposes of 2B, axis nomenclature shall be in accordance with ISO 841:2001, Industrial automation systems and integration – Numerical control of machines – Coordinate system and motion nomenclature.

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

5. For the purposes of 2B, 'stated "unidirectional positioning repeatability"' may be used for each machine tool model as an alternative to individual machine tests and is determined as follows:

a. Select five machines of a model to be evaluated;

5. (continued)

b. Measure the linear axis repeatability (R ↑ ,R ↓) according to ISO 230-2:2014 and evaluate "unidirectional positioning repeatability" for each axis of each of the five machines;

c. Determine the arithmetic mean value of the "unidirectional positioning repeatability"-values for each axis of all five machines together. These arithmetic mean values of "unidirectional positioning repeatability" ($\overline{UPR}$) become the stated value of each axis for the model ($\overline{UPR}_x$,$\overline{UPR}_y$, …);

d. Since the Category 2 list refers to each linear axis there will be as many 'stated "unidirectional positioning repeatability" values as there are linear axes;

e. If any axis of a machine model not specified in 2B001.a. to 2B001.c. has a 'stated "unidirectional positioning repeatability" equal to or less than the specified "unidirectional positioning repeatability" of each machine tool model plus 0,7 μm, the builder should be required to reaffirm the accuracy level once every eighteen months.

6. For the purposes of 2B001.a. to 2B001.c., measurement uncertainty for the "unidirectional positioning repeatability" of machine tools, as defined in the ISO 230-2:2014 or national equivalents, shall not be considered.

7. For the purposes of 2B001.a. to 2B001.c., the measurement of axes shall be made according to test procedures in 5.3.2. of ISO 230-2:2014. Tests for axes longer than 2 meters shall be made over 2 m segments. Axes longer than 4 m require multiple tests (e.g., two tests for axes longer than 4 m and up to 8 m, three tests for axes longer than 8 m and up to 12 m), each over 2 m segments and distributed in equal intervals over the axis length. Test segments are equally spaced along the full axis length, with any excess length equally divided at the beginning, in between, and at the end of the test segments. The smallest "unidirectional positioning repeatability"-value of all test segments is to be reported.

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", as follows:

NB: 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:

a. Crankshafts or camshafts;

b. Tools or cutters;

c. Extruder worms;

d. Engraved or facetted jewellery parts; or

e. Dental prostheses.

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.

Note 4: A machine tool having an additive manufacturing capability in addition to a turning, milling or grinding capability must be evaluated against each applicable entry 2B001.a.,.b. or.c.

NB: For optical finishing machines, see 2B002.

a. Machine tools for turning having two or more axes which can be coordinated simultaneously for "contouring control" having any of the following:

1. "Unidirectional positioning repeatability" equal to or less (better) than 0,9 μm along one or more linear axis with a travel length less than 1,0 m; or

2B001 a. (*continued*)

2. "Unidirectional positioning repeatability" equal to or less (better) than 1,1 μm along one or more linear axis with a travel length equal to or greater than 1,0 m;

Note 1: *2B001.a. does not control turning machines specially designed for producing contact lenses, having all of the following:*

a. Machine controller limited to using ophthalmic based software for part programming data input; and

b. No vacuum chucking.

Note 2: *2B001.a. does not control bar machines (Swissturn), limited to machining only bar feed thru, if maximum bar diameter is equal to or less than 42 mm and there is no capability of mounting chucks. Machines may have drilling or milling capabilities for machining parts with diameters less than 42 mm.*

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

1. Three linear axes plus one rotary axis which can be coordinated simultaneously for "contouring control" having any of the following:

a. "Unidirectional positioning repeatability" equal to or less (better) than 0,9 μm along one or more linear axis with a travel length less than 1,0 m; or

b. "Unidirectional positioning repeatability" equal to or less (better) than 1,1 μm along one or more linear axis with a travel length equal to or greater than 1,0 m;

2. Five or more axes which can be coordinated simultaneously for "contouring control" having any of the following;

a. "Unidirectional positioning repeatability" equal to or less (better) than 0,9 μm along one or more linear axis with a travel length less than 1,0 m;

b. "Unidirectional positioning repeatability" equal to or less (better) than 1,4 μm along one or more linear axis with a travel length equal to or greater than 1 m and less than 4 m; or

c. "Unidirectional positioning repeatability" equal to or less (better) than 6,0 μm (along one or more linear axis with a travel length equal to or greater than 4 m;

3. A "unidirectional positioning repeatability" for jig boring machines, equal to or less (better) than 1,1 μm along one or more linear axis; or

4. Fly cutting machines having all of the following:

a. Spindle 'run-out' and 'camming' less (better) than 0,0004 mm Total Indicated Reading (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;

Technical Notes:

For the purposes of 2B001.b.4.a.:

1. 'Run-out' (out-of-true running) is the 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 (ISO 230-1:2012).

2. 'Camming' (axial displacement) is 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 (ISO 230-1:2012).

2B001 (*continued*)

c. Machine tools for grinding having any of the following:

1. Having all of the following:

a. "Unidirectional positioning repeatability" equal to or less (better) than 1,1 µm along one or more linear axis; and

b. Three or four axes which can be coordinated simultaneously for "contouring control"; or

2. Five or more axes which can be coordinated simultaneously for "contouring control" having any of the following:

a. "Unidirectional positioning repeatability" equal to or less (better) than 1,1 µm along one or more linear axis with a travel length less than 1 m;

b. "Unidirectional positioning repeatability" equal to or less (better) than 1,4 µm along one or more linear axis with a travel length equal to or greater than 1 m and less than 4 m; or

c. "Unidirectional positioning repeatability" equal to or less (better) than 6,0 µm along one or more linear axis with a travel length equal to or greater than 4 m;

Note: *2B001.c. does not control grinding machine as follows:*

a. Cylindrical external, internal, and external-internal grinding machines, having all of the following:

1. Limited to cylindrical grinding; and

2. Limited to a maximum workpiece capacity of 150 mm outside diameter or length;

b. Machines designed specifically as jig grinders that do not have a z-axis or a w-axis, with a "unidirectional positioning repeatability" less (better) than 1,1 µm;

c. Surface grinders.

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

e. Machine tools for removing metals, ceramics or "composites", having all of the following:

1. Removing material by means of any of the following:

a. Water or other liquid jets, including those employing abrasive additives;

b. Electron beam; or

c. "Laser" beam; and

2. At least two rotary axes having all of the following:

a. Can be coordinated simultaneously for "contouring control"; and

b. A positioning "accuracy" of less (better) than 0,003°;

f. Deep-hole-drilling machines and turning machines modified for deep-hole-drilling, having a maximum depth-of-bore capability exceeding 5m.

2B002 Numerically controlled optical finishing machine tools equipped for selective material removal to produce non-spherical optical surfaces having all of the following characteristics:

a. Finishing the form to less (better) than 1,0 µm;

b. Finishing to a roughness less (better) than 100 nm rms.

c. Four or more axes which can be coordinated simultaneously for "contouring control"; and

2B002 (*continued*)

d. Using any of the following processes:

1. 'Magnetorheological Finishing' ('MRF');

2. 'Electrorheological Finishing' ('ERF');

3. 'Energetic particle beam finishing';

4. 'Inflatable membrane tool finishing'; or

5. 'Fluid jet finishing'.

Technical Notes:

For the purposes of 2B002:

1. *'MRF' is a material removal process using an abrasive magnetic fluid whose viscosity is controlled by a magnetic field.*

2. *'ERF' is a removal process using an abrasive fluid whose viscosity is controlled by an electric field.*

3. *'Energetic particle beam finishing' uses Reactive Atom Plasmas (RAP) or ion-beams to selectively remove material.*

4. *'Inflatable membrane tool finishing' is a process that uses a pressurized membrane that deforms to contact the workpiece over a small area.*

5. *'Fluid jet finishing' makes use of a fluid stream for material removal.*

2B003 "Numerically controlled" machine tools, specially designed for the shaving, finishing, grinding or honing of hardened (Rc = 40 or more) spur, helical and double-helical gears having all of the following:

a. A pitch diameter exceeding 1 250 mm;

b. A face width of 15 % of pitch diameter or larger; and

c. A finished quality of American Gear Manufacturers Association (AGMA) 14 or better (equivalent to ISO 1328 class 3).

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

NB: 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. Having any of the following:

1. A maximum working pressure exceeding 207 MPa;

2. A controlled thermal environment exceeding 1 773 K (1 500 °C); or

3. A facility for hydrocarbon impregnation and removal of resultant gaseous degradation products.

Technical Note:

For the purposes of 2B004, 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.

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

2B005 Equipment specially designed for the deposition, processing and in-process control of inorganic overlays, coatings and surface modifications, as follows, for substrates specified in column 2, by processes shown in column 1 in the Table following 2E503, and specially designed automated handling, positioning, manipulation and control components therefor:

a. Chemical Vapour Deposition (CVD) production equipment having all of the following:

NB: SEE ALSO 2B105.

1. A process modified for one of the following:

a. Pulsating CVD;

b. Controlled Nucleation Thermal Deposition (CNTD); or

c. Plasma enhanced or plasma assisted CVD; and

2. Having any of the following:

a. Incorporating high vacuum (equal to or less than 0,01 Pa) rotating seals; or

b. Incorporating *in situ* coating thickness control;

b. Ion implantation production equipment having beam currents of 5 mA or more;

c. Electron Beam Physical Vapour Deposition (EB-PVD) production equipment incorporating power systems rated for over 80 kW and having any of the following:

1. A liquid pool level "laser" control system which regulates precisely the ingots feed rate; or

2. A computer controlled rate monitor operating on the principle of photo-luminescence of the ionised atoms in the evaporant stream to control the deposition rate of a coating containing two or more elements;

d. Plasma spraying production equipment having any of the following:

1. Operating at reduced pressure controlled atmosphere (equal to or less than 10 kPa measured above and within 300 mm of the gun nozzle exit) in a vacuum chamber capable of evacuation down to 0,01 Pa prior to the spraying process; or

2. Incorporating *in situ* coating thickness control;

e. Sputter deposition production equipment capable of current densities of 0,1 mA/mm^2 or higher at a deposition rate of 15 µm/h or more;

f. Cathodic arc deposition production equipment incorporating a grid of electromagnets for steering control of the arc spot on the cathode;

g. Ion plating production equipment capable of 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 (CVD), cathodic arc, sputter deposition, ion plating or ion implantation equipment, specially designed for cutting or machining tools.

2B006 Dimensional inspection or measuring systems, equipment, position feedback units and "electronic assemblies", as follows:

a. Computer controlled or "numerical controlled" Coordinate Measuring Machines (CMM), having a three dimensional (volumetric) maximum permissible error of length measurement ($E_{0,MPE}$) at any point within the operating range of the machine (i.e., within the length of axes) equal to or less (better) than (1,7 + L/1 000) µm (L is the measured length in mm), according to ISO 10360-2:2009;

2B006 a. (*continued*)

Technical Note:

For the purposes of 2B006.a., the $E_{0,MPE}$ of the most accurate configuration of the CMM specified by the manufacturer (e.g., best of the following: probe, stylus length, motion parameters, environment) and with "all compensations available" shall be compared to the 1,7+L/1 000 µm threshold.

NB: SEE ALSO 2B206.

b. Linear displacement measuring instruments or systems, linear position feedback units, and "electronic assemblies", as follows:

Note: Interferometer and optical-encoder measuring systems containing a "laser" are only specified in 2B006.b.3 and 2B206.c.

1. 'Non-contact type measuring systems' with a 'resolution' equal to or less (better) than 0,2 µm within 0 to 0,2 mm of the 'measuring range';

Technical Notes:

For the purposes of 2B006.b.1.:

1. 'Non -contact type measuring systems' are designed to measure the distance between the probe and measured object along a single vector, where the probe or measured object is in motion.

2. 'Measuring range' means the distance between the minimum and maximum working distance.

2. Linear position feedback units specially designed for machine tools and having an overall "accuracy" less (better) than (800 + (600 x L/1 000)) nm (L equals effective length in mm);

3. Measuring systems having all of the following:

a. Containing a "laser";

b. A 'resolution' over their full scale of 0,200 nm or less (better); and

c. Capable of achieving a "measurement uncertainty" equal to or less (better) than (1,6 + L/2 000) nm (L is the measured length in mm) at any point within a measuring range, when compensated for the refractive index of air and measured over a period of 30 seconds at a temperature of 20 ± 0,01 °C;

4. "Electronic assemblies" specially designed to provide feedback capability in systems specified in 2B006.b.3.;

Technical Note:

For the purposes of 2B006.b., 'resolution' is the least increment of a measuring device; on digital instruments, the least significant bit.

c. Rotary position feedback units specially designed for machine tools or angular displacement measuring instruments, having an angular position "accuracy" equal to or less (better) than 0,9 second of arc;

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

d. Equipment for measuring surface roughness (including surface defects), by measuring optical scatter with a sensitivity of 0,5 nm or less (better).

Note: 2B006 includes machine tools, other than those specified in 2B001, that can be used as measuring machines if they meet or exceed the criteria specified for the measuring machine function.

2B007 "Robots" having any of the following characteristics and specially designed controllers and "end-effectors" therefor:

NB: SEE ALSO 2B207.

a. Not used;

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

Note: 2B007.b. does not control "robots" specially designed for paint-spraying booths.

c. Specially designed or rated as radiation-hardened to withstand a total radiation dose greater than 5×10^3 Gy (silicon) without operational degradation; or

Technical Note:

The term Gy (silicon) refers to the energy in Joules per kilogram absorbed by an unshielded silicon sample when exposed to ionising radiation.

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

2B008 'Compound rotary tables' and "tilting spindles", specially designed for machine tools, as follows:

a. Not used;

b. Not used;

c. 'Compound rotary tables' having all of the following:

1. Designed for machine tools for turning, milling or grinding; and

2. Two rotary axes designed to be coordinated simultaneously for "contouring control";

Technical Note:

For the purposes of 2B008.c., a 'compound rotary table' is a table allowing the workpiece to rotate and tilt about two non-parallel axes.

d. "Tilting spindles" having all of the following:

1. Designed for machine tools for turning, milling or grinding; and

2. Designed to be coordinated simultaneously for "contouring control".

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:

NB: SEE ALSO 2B109 AND 2B209.

a. Three or more axes which can be coordinated simultaneously for "contouring control"; and

b. A roller force more than 60 kN.

Technical Note:

For the purposes of 2B009, machines combining the function of spin-forming and flow-forming are regarded as flow-forming machines.

2B104 "Isostatic presses", other than those specified in 2B004, having all of the following:

NB: SEE ALSO 2B204.

a. Maximum working pressure of 69 MPa or greater;

2B104 (*continued*)

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

2B109 Flow-forming machines, other than those specified in 2B009, usable in the "production" of propulsion components and equipment (e.g. motor cases and interstages) for "missiles", and specially designed components as follows:

NB: *SEE ALSO 2B209.*

a. Flow-forming machines having all of the following:

1. Equipped with, or, according to the manufacturer's technical specification, are capable of being equipped with "numerical control" units or computer control; and

2. 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.

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 incorporating a digital controller' and employing feedback or closed loop techniques, capable of vibrating a system at an acceleration equal to or greater than 10 g rms between 20 Hz and 2 kHz while imparting forces equal to or greater than 50 kN, measured 'bare table';

Technical Note:

In 2B116.a., 'vibration test systems incorporating a digital controller' are those systems, the functions of which are, partly or entirely, automatically controlled by stored and digitally coded electrical signals.

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

Technical Note:

In 2B116.b., 'real-time control bandwidth' means the maximum rate at which a controller can execute complete cycles of sampling, processing data and transmitting control signals.

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 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 equal to or greater than 50 kN, measured 'bare table', and usable in systems specified in 2B116.a.

Technical Note:

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

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

2B119 Balancing machines and related equipment, as follows:

NB: SEE ALSO 2B219.

a. Balancing machines having all of 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 or more axes;

b. Designed or modified to incorporate slip rings or integrated non-contact devices capable of transferring electrical power, signal information, or both; and

c. Having any of the following characteristics:

1. For any single axis having all of the following:

a. Capable of rates of 400 degrees/s or more, or 30 degrees/s or less; and

b. A rate resolution equal to or less than 6 degrees/s and an accuracy equal to or less than 0,6 degrees/s;

2. Having a worst-case rate stability equal to or better (less) than plus or minus 0,05 % averaged over 10 degrees or more; or

3. A positioning "accuracy" equal to or less (better) than 5 arc second.

Note 1: 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.

Note 2: Motion simulators or rate tables specified in 2B120 remain controlled whether or not slip rings or integrated non-contact devices are fitted at time of export.

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

a. Two or more axes; and

b. A positioning "accuracy" equal to or less (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 greater than 100 g and designed or modified to incorporate slip rings or integrated non-contact devices capable of transferring electrical power, signal information, or both.

Note: *Centrifuges specified in 2B122 remain controlled whether or not slip rings or integrated non-contact devices are fitted at time of export.*

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

Technical Note:

Stated positioning accuracy levels derived under the following procedures from measurements made according to ISO 230-2:1988 ([7]) or national equivalents may be used for each machine tool model if provided to, and accepted by, national authorities instead of individual machine tests. Determination of stated positioning accuracy:

a. Select five machines of a model to be evaluated;

b. Measure the linear axis accuracies according to ISO 230-2:1988[7];

c. Determine the accuracy values (A) for each axis of each machine. The method of calculating the accuracy value is described in the ISO 230-2:1988[7] standard;

d. Determine the average accuracy value of each axis. This average value becomes the stated positioning accuracy of each axis for the model (Âx Ây...);

e. Since item 2B201 refers to each linear axis, there will be as many stated positioning accuracy values as there are linear axes;

f. If any axis of a machine tool not specified in 2B201.a., 2B201.b. or 2B201.c. has a stated positioning accuracy of 6 µm or better (less) for grinding machines, and 8 µm or better (less) for milling and turning machines, both according to ISO 230-2:1988[6], then the builder should be required to reaffirm the accuracy level once every eighteen months.

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[6] or national equivalents along any linear axis;

2. Two or more contouring rotary axes; or

3. Five or more axes which can be coordinated simultaneously for "contouring control";

Note: *2B201.a. does not control milling machines having the following characteristics:*

a. X-axis travel greater than 2 m; and

b. Overall positioning accuracy on the x-axis more (worse) than 30 µm.

b. Machine tools for grinding, having any of the following characteristics:

1. Positioning accuracies with "all compensations available" equal to or less (better) than 4 µm according to ISO 230-2:1988[6] or national equivalents along any linear axis;

2. Two or more contouring rotary axes; or

3. Five or more axes which can be coordinated simultaneously for "contouring control";

([7]) Manufacturers calculating positioning accuracy in accordance with ISO 230-2:1997 or 2006 should consult the competent authorities of the Member State in which they are established.

2B201 b. (*continued*)

Note: 2B201.b. does not control grinding machines as follows:

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 outside diameter 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[6] or national equivalents.

c. Machine tools for turning, that have positioning accuracies with "all compensations available" better (less) than 6 µm according to ISO 230-2:1988[6] along any linear axis (overall positioning) for machines capable of machining diameters greater than 35 mm;

Note: 2B201.c. does not control bar machines (Swissturn), limited to machining only bar feed thru, if maximum bar diameter is equal to or less than 42 mm and there is no capability of mounting chucks. Machines may have drilling and/or milling capabilities for machining parts with diameters less than 42 mm.

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 2B201.a.,.b. or.c.

Note 3: 2B201.a.3. and 2B201.b.3. include machines based on a parallel linear kinematic design (e.g., hexapods) that have 5 or more axes none of which is a rotary axis.

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

a. "Isostatic presses" having both of the following characteristics:

1. Capable of achieving a maximum working pressure of 69 MPa or greater; and

2. A chamber cavity with an inside diameter in excess of 152 mm;

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

Technical Note:

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

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

a. Computer controlled or numerically controlled coordinate measuring machines (CMM) having either of the following characteristics:

1. Having only two axes and having a maximum permissible error of length measurement along any axis (one dimensional), identified as any combination of $E_{0x,MPE}$, $E_{0y,MPE}$, or $E_{0z,MPE}$, equal to or less (better) than (1,25 + L/1 000) µm (where L is the measured length in mm) at any point within the operating range of the machine (i.e., within the length of the axis), according to ISO 10360-2:2009; or

2. Three or more axes and having a three dimensional (volumetric) maximum permissible error of length measurement ($E_{0,MPE}$) equal to or less (better) than (1,7 + L/800) µm (where L is the measured length in mm) at any point within the operating range of the machine (i.e., within the length of the axis), according to ISO 10360-2:2009;

Technical Note:

The $E_{0,MPE}$ of the most accurate configuration of the CMM specified according to ISO 10360-2:2009 by the manufacturer (e.g., best of the following: probe, stylus, length, motion parameters, environments) and with all compensations available shall be compared to the (1,7 + L/800) µm threshold.

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 µm per 5 mm; and

2. "Angular position deviation" equal to or less than 0,02°;

c. 'Linear displacement' measuring systems having all of the following characteristics:

Technical Note:

For the purpose of 2B206.c. 'linear displacement' means the change of distance between the measuring probe and the measured object.

1. Containing a "laser"; and

2. Capable of maintaining, for at least 12 hours, over a temperature range of ± 1 K (± 1 °C); around a standard temperature and standard pressure, all of the following:

a. A 'resolution' over their full scale of 0,1 µm or better; and

Technical Note:

For the purpose of 2B206.c.2.a. 'resolution' is the least increment of a measuring device; on digital instruments, the least significant bit.

b. With a "measurement uncertainty" equal to or better (less) than (0,2 + L/2 000) µm (L is the measured length in mm).

Note: 2B206.c. does not control measuring interferometer systems, without closed or open loop feedback, containing a laser to measure slide movement errors of machine tools, dimensional inspection machines, or similar equipment.

d. Linear variable differential transformer (LVDT) systems having both of the following characteristics:

Technical Note:

For the purpose of 2B206.d. 'linear displacement' means the change of distance between the measuring probe and the measured object.

2B206 d. (*continued*)

1. Having any of the following:

a. "Linearity" equal to or less (better) than 0,1 % measured from 0 to the full operating range, for LVDTs with an operating range up to 5 mm; or

b. "Linearity" equal to or less (better) than 0,1 % measured from 0 to 5 mm for LVDTs with an operating range greater than 5 mm; and

2. Drift equal to or better (less) than 0,1 % per day at a standard ambient test room temperature ± 1 K (± 1 °C).

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:

All parameters of measurement values in 2B206 represent plus/minus i.e., not total band.

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

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

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

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

a. Machines having both of the following characteristics:

1. Three or more rollers (active or guiding); and

2. Which, according to the manufacturer's technical specification, can be equipped with "numerical control" units or a computer control;

b. Rotor-forming mandrels designed to form cylindrical rotors of inside diameter between 75 mm and 650 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. A minimum achievable residual specific unbalance equal to or less than 10 g mm/kg per plane; and

4. Belt drive type.

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

a. A capability of penetrating 0,6 m or more of hot cell wall (through-the-wall operation); or

b. A capability of bridging over the top of a hot cell wall with a thickness of 0,6 m or more (over-the-wall operation).

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, other than those specified in 3B001 and 9B001, and power supplies therefor, as follows:

NB: SEE ALSO 3B001 and 9B001.

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;

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

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

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

a. Arc remelt furnaces, arc melt furnaces and arc melt and casting furnaces having both of the following characteristics:

1. Consumable electrode capacities between 1 000 cm^3 and 20 000 cm^3; and

2. Capable of operating with melting temperatures above 1 973 K (1 700°C);

b. Electron beam melting furnaces, plasma atomisation furnaces and plasma 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 2B227.b.;

d. Plasma torches specially designed for furnaces specified in 2B227.b. having both of the following characteristics:

1. Operating at a power greater than 50 kW; and

2. Capable of operating above 1 473 K (1 200°C);

e. Electron beam guns specially designed for the furnaces specified in 2B227.b. operating at a power greater than 50 kW.

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.

2B228 (*continued*)

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 650 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 All types of 'pressure transducers' capable of measuring absolute pressures and having all of the following:

a. Pressure sensing elements made of or protected by aluminium, aluminium alloy, aluminium oxide (alumina or sapphire), nickel, nickel alloy with more than 60 % nickel by weight, or fully fluorinated hydrocarbon polymers;

b. Seals, if any, essential for sealing the pressure sensing element, and in direct contact with the process medium, made of or protected by aluminium, aluminium alloy, aluminium oxide (alumina or sapphire), nickel, nickel alloy with more than 60 % nickel by weight, or fully fluorinated hydrocarbon polymers; and

c. Having either of the following characteristics:

1. A full scale of less than 13 kPa and an 'accuracy' of better than 1 % of full-scale; or
2. A full scale of 13 kPa or greater and an 'accuracy' of better than 130 Pa when measured at 13 kPa.

Technical Notes:

1. *In 2B230 'pressure transducer' means a device that converts a pressure measurement into a signal.*
2. *For the purposes of 2B230, 'accuracy' includes non-linearity, hysteresis and repeatability at ambient temperature.*

2B231 Vacuum pumps having all of the following characteristics:

a. Input throat size equal to or greater than 380 mm;

b. Pumping speed equal to or greater than 15 m^3/s; and

c. Capable of producing an ultimate vacuum better than 13 mPa.

Technical Notes:

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

2B232 High-velocity gun systems (propellant, gas, coil, electromagnetic, and electrothermal types, and other advanced systems) capable of accelerating projectiles to 1,5 km/s or greater.

NB: SEE ALSO MILTARY GOODS CONTROLS.

2B233 Bellows-sealed scroll-type compressors and bellows-sealed scroll-type vacuum pumps having all of the following:

NB: SEE ALSO 2B350.i.

a. Capable of an inlet volume flow rate of 50 m^3/h or greater;

b. Capable of a pressure ratio of 2:1 or greater; and

c. Having all surfaces that come in contact with the process gas made from any of the following materials:

1. Aluminium or aluminium alloy;

2. Aluminium oxide;

3. Stainless steel;

4. Nickel or nickel alloy;

5. Phosphor bronze; or

6. Fluoropolymers.

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^3 (100 litres) and less than 20 m^3 (20 000 litres), where all surfaces that come in direct contact with the chemical(s) being processed or contained are made from any of the following materials:

NB: For prefabricated repair assemblies, see 2B350.k.

1. 'Alloys' with more than 25 % nickel and 20 % chromium by weight;

2. Fluoropolymers (polymeric or elastomeric materials with more than 35 % fluorine by weight);

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';

7. Zirconium or zirconium 'alloys'; or

8. Niobium (columbium) or niobium 'alloys';

b. Agitators designed 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 (polymeric or elastomeric materials with more than 35 % fluorine by weight);

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';

7. Zirconium or zirconium 'alloys'; or

8. Niobium (columbium) or niobium 'alloys';

c. Storage tanks, containers or receivers with a total internal (geometric) volume greater than 0,1 m^3 (100 litres) where all surfaces that come in direct contact with the chemical(s) being processed or contained are made from any of the following materials:

NB: For prefabricated repair assemblies, see 2B350.k.

1. 'Alloys' with more than 25 % nickel and 20 % chromium by weight;

2B350 c. (*continued*)

2. Fluoropolymers (polymeric or elastomeric materials with more than 35 % fluorine by weight);

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';

7. Zirconium or zirconium 'alloys'; or

8. Niobium (columbium) or niobium 'alloys';

d. Heat exchangers or condensers with a heat transfer surface area greater than 0,15 m^2, and less than 20 m^2; 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 (polymeric or elastomeric materials with more than 35 % fluorine by weight);

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;

10. Titanium carbide; or

11. Niobium (columbium) or niobium 'alloys';

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 (polymeric or elastomeric materials with more than 35 % fluorine by weight);

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'; or

9. Niobium (columbium) or niobium 'alloys';

f. Remotely operated filling equipment in which all surfaces that come in direct contact with the chemical(s) being processed are made from any of the following materials:

1. 'Alloys' with more than 25 % nickel and 20 % chromium by weight; or

2. Nickel or 'alloys' with more than 40 % nickel by weight;

2B350 (*continued*)

g. Valves and components, as follows:

1. Valves, having both of the following:

a. A 'nominal size' greater than DN 10 or NPS 3/8; and

b. All surfaces that come in direct contact with the chemical(s) being produced, processed, or contained are made from 'corrosion resistant materials';

2. Valves, other than those specified in 2B350.g.1., having all of the following;

a. A 'nominal size' equal to or greater than DN 25 or NPS 1 and equal to or less than DN 100 or NPS 4;

b. Casings (valve bodies) or preformed casing liners;

c. A closure element designed to be interchangeable; and

d. All surfaces of the casing (valve body) or preformed case liner that come in direct contact with the chemical(s) being produced, processed, or contained are made from 'corrosion resistant materials';

3. Components, designed for valves specified in 2B350.g.1. or 2B350.g.2., in which all surfaces that come in direct contact with the chemical(s) being produced, processed, or contained are made from 'corrosion resistant materials', as follows:

a. Casings (valve bodies);

b. Preformed casing liners;

Technical Notes:

1. For the purposes of 2B350.g., 'corrosion resistant materials' means any of the following materials:

a. Nickel or alloys with more than 40 % nickel by weight;

b. Alloys with more than 25 % nickel and 20 % chromium by weight;

c. Fluoropolymers (polymeric or elastomeric materials with more than 35 % fluorine by weight);

d. Glass or glass-lined (including vitrified or enamelled coating);

e. Tantalum or tantalum alloys;

f. Titanium or titanium alloys;

g. Zirconium or zirconium alloys;

h. Niobium (columbium) or niobium alloys; or

i. Ceramic materials as follows:

1. Silicon carbide with a purity of 80 % or more by weight;

2. Aluminium oxide (alumina) with a purity of 99,9 % or more by weight;

3. Zirconium oxide (zirconia).

2. The 'nominal size' is defined as the smaller of the inlet and outlet diameters.

3. Nominal sizes (DN) of valves are in accordance with ISO 6708:1995. Nominal Pipe Sizes (NPS) are in accordance with ASME B36.10 or B36.19 or national equivalents.

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 (polymeric or elastomeric materials with more than 35 % fluorine by weight);

2B350 h. (*continued*)

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'; or

9. Niobium (columbium) or niobium 'alloys';

i. Multiple-seal and seal-less pumps, with manufacturer's specified maximum flow-rate greater than 0,6 m^3/hour, or vacuum pumps with manufacturer's specified maximum flow-rate greater than 5 m^3/hour (under standard temperature (273 K (0°C)) and pressure (101,3 kPa) conditions), other than those specified in 2B233; 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 (high silicon iron alloys);

4. Fluoropolymers (polymeric or elastomeric materials with more than 35 % fluorine by weight);

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';

10. Zirconium or zirconium 'alloys'; or

11. Niobium (columbium) or niobium 'alloys';

Technical Note:

In 2B350.i., the term seal refers to only those seals that come into direct contact with the chemical(s) being processed (or are designed to), and provide a sealing function where a rotary or reciprocating drive shaft passes through a pump body.

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;

k. Prefabricated repair assemblies having metallic surfaces that come in direct contact with the chemical(s) being processed which are made from tantalum or tantalum alloys as follows, and specially designed components therefor:

1. Designed for mechanical attachment to glass-lined reaction vessels or reactors specified in 2B350.a.; or

2B350 k. (*continued*)

2. Designed for mechanical attachment to glass-lined storage tanks, containers or receivers specified in 2B350.c.

Note 1: *For the purposes of 2B350, the materials used for gaskets, packing, seals, screws, washers or other materials performing a sealing function do not determine the status of control, provided that such components are designed to be interchangeable.*

Note 2: *For the purposes of 2B350.a to 2B350.i and 2B350.k, the phrase «where all surfaces that come in (or into) direct contact with the chemical(s) are made from» is understood to include all operations with the chemical(s), which are wetting the surfaces concerned: inter alia producing, processing, consuming, containing, storing, and/or transferring.*

Technical Notes:

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

2. *For the listed materials in the above entries, the term 'alloy' when not accompanied by a specific elemental concentration is understood as identifying those alloys where the identified metal is present in a higher percentage by weight than any other element.*

2B351 Toxic gas monitors and monitoring systems and their dedicated detecting components, other than those specified in 1A004, as follows; and detectors; sensor devices; and replaceable sensor cartridges therefor:

a. Designed for continuous operation and usable for the detection of chemical warfare agents or chemicals specified in 1C350 with a 'minimum detection limit' of less than 0,3 mg/m^3; or

Technical Note:

The 'minimum detection limit' of toxic gas monitors or monitoring systems is the lowest detectable concentration of the analyte required to produce a signal greater than three times the standard deviation of the toxic gas monitor's or monitoring system's signal when measuring a blank sample.

In the case of toxic gas monitors or monitoring systems having a deadband or programmed zero suppression, the 'minimum detection limit' is the lowest detectable concentration required to produce a reading.

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

2B352 Biological manufacturing and handling equipment, as follows:

a. Containment facilities and related equipment as follows:

1. Complete containment facilities that meet the criteria for P3 or P4 (BL3, BL4, L3, L4) containment as specified in the WHO Laboratory Biosafety Manual (3rd edition, Geneva, 2004);

2. Equipment designed for fixed installation in containment facilities specified in 2B352.a., as follows:

a. Double-door pass-through decontamination autoclaves;

b. Breathing air suit decontamination showers;

c. Mechanical-seal or inflatable-seal walkthrough doors;

b. Fermenters and components as follows:

1. Fermenters capable of cultivation of "microorganisms" or of live cells for the production of viruses or toxins, without the propagation of aerosols, having a total internal volume of 20 litres or more;

2B352 b. (*continued*)

2. Components designed for fermenters specified in 2B352.b.1. as follows:

a. Cultivation chambers designed to be sterilised or disinfected in situ;

b. Cultivation chamber holding devices;

c. Process control units capable of simultaneously monitoring and controlling two or more fermentation system parameters (e.g., temperature, pH, nutrients, agitation, dissolved oxygen, air flow, foam control);

Technical Notes:

1. For the purposes of 2B352.b. fermenters include bioreactors, single-use (disposable) bioreactors, chemostats and continuous-flow systems.

2. For the purposes of 2B352.b. cultivation chamber holding devices include single-use cultivation chambers with rigid walls.

c. Centrifugal separators capable of continuous separation, without the propagation of aerosols, having a flow rate greater than 100 litres per hour, as follows:

1. Centrifugal separators having all of the following characteristics:

a. One or more sealing joints within the steam containment area;

b. Components of polished stainless steel or titanium;

c. Capable of in-situ steam sterilisation in a closed state.

2. Single-use centrifugal separators, in which all components that come in direct contact with the substances being processed are disposable or single-use.

Technical Note:

Centrifugal separators and single-use centrifugal separators include decanters.

d. Cross (tangential) flow filtration equipment and components as follows:

1. Cross (tangential) flow filtration equipment capable of separation of "microorganisms", viruses, toxins or cell cultures having all of the following characteristics:

a. A total filtration area equal to or greater than 1 m^2; and

b. Having any of the following characteristics:

1. Capable of being 'sterilised' or 'disinfected' in-situ; or

2. Using disposable or single-use filtration components;

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 a process to reduce the number of microorganisms but not usually of bacterial spores, through the use of chemical agents, without necessarily killing or removing all organisms.

Note: 2B352.d. does not control equipment designed for reverse osmosis or for filtration of blood for medical applications (e.g. hemodialysis or plasmapheresis), as specified by the manufacturer.

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^2 for each component and designed for use in cross (tangential) flow filtration equipment specified in 2B352.d.;

e. Steam, gas or vapour sterilisable freeze-drying equipment with a condenser capacity of 10 kg of ice or more in 24 hours and less than 1 000 kg of ice in 24 hours;

2B352 (*continued*)

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. Biocontainment chambers, isolators, or biological safety cabinets having all of the following characteristics, for normal operation:

a. Fully enclosed workspace where the operator is separated from the work by a physical barrier;

b. Able to operate at negative pressure;

c. Means to safely manipulate items in the workspace;

d. Supply and exhaust air to and from the workspace is HEPA filtered;

Note 1: *2B352.f.2. includes Class III biosafety cabinets, as described in the latest edition of the WHO Laboratory Biosafety Manual or constructed in accordance with national standards, regulations or guidance.*

Note 2: *2B352.f.2. includes any isolator meeting all of the above mentioned characteristics, regardless of its intended use and its designation, except for medical isolators specially designed for barrier nursing or transportation of infected patients.*

g. Aerosol inhalation equipment designed for aerosol challenge testing with "microorganisms", viruses or "toxins" as follows:

1. Whole-body exposure chambers having a capacity of 1 m^3 or more;

2. Nose-only exposure apparatus utilising directed aerosol flow and having capacity for exposure of any of the following:

a. 12 or more rodents; or

b. 2 or more animals other than rodents;

3. Closed animal restraint tubes designed for use with nose-only exposure apparatus utilising directed aerosol flow;

h. Spray drying equipment capable of drying toxins or pathogenic "microorganisms" having all of the following:

1. A water evaporation capacity of ≥ 0,4 kg/h and ≤ 400 kg/h;

2. The ability to generate a typical mean product particle size of ≤ 10 μm with existing fittings or by minimal modification of the spray-dryer with atomisation nozzles enabling generation of the required particle size; and

3. Capable of being sterilised or disinfected in situ;

i. Nucleic acid synthesisers or synthesisers and assemblers, which are partly or entirely automated, and designed to generate continuous nucleic acids greater than 0,5 kilobases in length.

j. Peptide synthesizers that are partly or entirely automated and capable of generating peptides at a 'system synthesis scale' of 1 mmol or greater.

Technical Note:

'System synthesis scale' denotes the maximum amount of peptide (mmol) that can be produced by the instrument using the largest compatible reaction vessels (L). For multiple peptides produced in parallel, this is the sum of the largest compatible reaction vessels (L).

NB: *For chemical reaction vessels or reactors, see 2B350.a.*

2B510 Additive manufacturing equipment, designed to produce metal or metal alloy components, having all of the following, and specially designed components therefor:

a. Having at least one of the following consolidation sources:

1. "Laser";

2. Electron beam; or

3. Electric arc;

b. Having a controlled process atmosphere of any of the following:

1. Inert gas; or

2. Vacuum (equal to or less than 100 Pa);

c. Having any of the following 'in-process monitoring' equipment in a 'co-axial configuration' or 'paraxial configuration':

1. Imaging camera with a peak response in the wavelength range exceeding 380 nm but not exceeding 14 000 nm;

2. Pyrometer designed to measure temperatures greater than 1 273,15 K (1 000 °C); or

3. Radiometer or spectrometer with a peak response in the wavelength range exceeding 380 nm but not exceeding 3 000 nm; and

d. A closed loop control system designed to modify the consolidation source parameters, build path, or equipment settings during the build cycle in response to feedback from 'in-process monitoring' equipment specified in 2B510.c.

Technical Notes:

For the purposes of 2B510:

1. *'In-process monitoring', also known as in-situ process monitoring, pertains to the observation and measurement of the additive manufacturing process including electromagnetic, or thermal, emissions from the melt pool.*

2. *'Co-axial configuration', also known as on-axis or inline configuration, pertains to one or more sensors that are mounted in an optical path shared by the "laser" consolidation source.*

3. *'Paraxial configuration' pertains to one or more sensors that are physically mounted onto or integrated into the "laser", electron beam, or electric arc consolidation source component.*

4. *For both 'co-axial configuration' and 'paraxial configuration', the field of view of the sensor(s) is fixed to the moving reference frame of the consolidation source and moves in the same scan trajectories of the consolidation source throughout the build process.*

2C Materials

None.

2D Software

2D001 "Software", other than that specified in 2D002, as follows:

a. "Software" specially designed or modified for the "development" or "production" of equipment specified in 2A001, 2B001 to 2B009 or 2B510

b. "Software" specially designed or modified for the "use" of equipment specified in 2A001.c., 2B001 or 2B003 to 2B009.

Note: *2D001 does not control part programming "software" that generates "numerical control" codes for machining various parts.*

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 coordinating simultaneously more than four axes for "contouring control".

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

Note 2: *2D002 does not control "software" for items specified in 2B002. For "software" for items specified in 2B002, see 2D001 and 2D003.*

Note 3: *2D002 does not control "software" that is exported with, and the minimum necessary for the operation of, items not specified in Category 2.*

2D003 "Software", designed or modified for the operation of equipment specified in 2B002, that converts optical design, workpiece measurements and material removal functions into "numerical control" commands to achieve the desired workpiece form.

2D101 "Software" specially designed or modified for the "use" of equipment specified in 2B104, 2B105, 2B109, 2B116, 2B117 or 2B119 to 2B122.

NB: *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.

Note: *2D202 does not control part programming "software" that generates "numerical control" command codes but does not allow direct use of equipment for machining various parts.*

2D351 "Software", other than that specified in 1D003, specially designed for "use" of equipment specified in 2B351.

2D352 "Software" specially designed for nucleic acid assemblers and synthesisers specified in 2B352.i., that is capable of designing and building functional genetic elements from digital sequence data.

2E Technology

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

Note: *2E001 includes "technology" for the integration of probe systems into Coordinate Measuring Machines (CMM) specified in 2B006.a.*

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

2E003 Other "technology", as follows:

a. Not used;

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';

Technical Note:

For the purposes of 2E003.b.1.c., 'direct-acting hydraulic pressing' is a deformation process which uses a fluid-filled flexible bladder in direct contact with the workpiece.

2E003 b. (*continued*)

2. Not used;

NB: *For "technology" for metal-working manufacturing processes for gas turbine engines and components, see 9E003 and the Military Goods Controls.*

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

d. Not used;

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 2E503.*

NB: *This table should be read to specify the "technology" for a particular Coating Process only when the Resultant Coating in column 3 is in a paragraph directly across from the relevant Substrate under column 2. For example, Chemical Vapour Deposition (CVD) coating process technical data are included for the application of silicides to carbon-carbon, ceramic and metal "matrix" "composites" substrates, but are not included for the application of silicides to 'cemented tungsten carbide' (16), 'silicon carbide' (18) substrates. In the second case, the resultant coating is not listed in the paragraph under column 3 directly across from the paragraph under column 2 listing 'cemented tungsten carbide' (16), 'silicon carbide' (18).*

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 2B233, 2D201 or 2D202.

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

2E503 Other "technology", as follows:

g. "Technology", not specified elsewhere, for the "development" or "production" of 'coating systems' having all of the following:

1. Designed to protect ceramic "matrix" "composite" materials specified in 1C007 from corrosion; and

2. Designed to operate at temperatures exceeding 1 373,15 K (1 100 °C).

Technical Note:

For the purposes of 2E503.g, 'coating systems' consist of one or more layers (e.g., bond, interlayer, top coat) of material deposited on the substrate.

Table

Deposition techniques

1. Coating Process (1) ([1])	2. Substrate	3. Resultant Coating
A. Chemical Vapour Deposition (CVD)	"Superalloys"	Aluminides for internal passages
	Ceramics (19) and Low expansion glasses (14)	Silicides Carbides Dielectric layers (15) Diamond Diamond-like carbon (17)
	Carbon-carbon, Ceramic and Metal "matrix" "composites"	Silicides Carbides Refractory metals Mixtures thereof (4) Dielectric layers (15) Aluminides Alloyed aluminides (2) Boron nitride
	Cemented tungsten carbide (16), Silicon carbide (18)	Carbides Tungsten Mixtures thereof (4) Dielectric layers (15)
	Molybdenum and Molybdenum alloys	Dielectric layers (15)
	Beryllium and Beryllium alloys	Dielectric layers (15) Diamond Diamond-like carbon (17)
	Sensor window materials (9)	Dielectric layers (15) Diamond Diamond-like carbon (17)
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)

1. Coating Process (1) ([1])	2. Substrate	3. Resultant Coating
	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
B.2. Ion assisted resistive heating Physical Vapour Deposition (PVD) (Ion Plating)	Ceramics (19) and Low-expansion glasses	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)

1. Coating Process (1) ([1])	2. Substrate	3. Resultant Coating
	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.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"	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"	Aluminides Silicides Carbides
	Corrosion resistant steel (7)	MCrAlX (5) Modified zirconia (12) Mixtures thereof (4)

1. Coating Process (1) ([1])	2. Substrate	3. Resultant Coating
	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"	Fused silicides Fused aluminides except for resistance heating elements
	Carbon-carbon, Ceramic and Metal "matrix" "composites"	Silicides Carbides Mixtures thereof (4)
F. Sputter Deposition	"Superalloys"	Alloyed silicides Alloyed aluminides (2) Noble metal modified aluminides (3) MCrAlX (5) Modified zirconia (12) Platinum Mixtures thereof (4)
	Ceramics and Low- expansion glasses (14)	Silicides Platinum Mixtures thereof (4) Dielectic layers (15) Diamond-like carbon (17)
	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)

1. Coating Process (1) ([1])	2. Substrate	3. Resultant Coating
	Beryllium and Beryllium alloys	Borides Dielectric layers (15) Beryllium
	Sensor window materials (9)	Dielectric layers (15) Diamond-like carbon (17)
	"Refractory metals and alloys"	Aluminides Silicides Oxides Carbides
G. Ion Implantation	High temperature bearing steels	Additions of Chromium Tantalum or Niobium (Columbium)
	Titanium alloys (13)	Borides Nitrides
	Beryllium and Beryllium alloys	Borides
	Cemented tungsten carbide (16)	Carbides Nitrides

([1]) The numbers in parenthesis refer to the Notes following this Table.

TABLE – DEPOSITION TECHNIQUES – NOTES

1. The term 'coating process' includes coating repair and refurbishing as well as original coating.

2. The term 'alloyed aluminide coating' includes single or multiple-step coatings in which an element or elements are deposited prior to or during application of the aluminide coating, even if these elements are deposited by another coating process. It does not, however, include the multiple use of single-step pack cementation processes to achieve alloyed aluminides.

3. The term 'noble metal modified aluminide' coating includes multiple-step coatings in which the noble metal or noble metals are laid down by some other coating process prior to application of the aluminide coating.

4. The term 'mixtures thereof' includes infiltrated material, graded compositions, co-deposits and multilayer deposits and are obtained by one or more of the coating processes specified in the Table.

5. 'MCrAlX' refers to a coating alloy where M equals cobalt, iron, nickel or combinations thereof and X equals hafnium, yttrium, silicon, tantalum in any amount or other intentional additions over 0,01 % by weight in various proportions and combinations, except:

   a. CoCrAlY coatings which contain less than 22 % by weight of chromium, less than 7 % by weight of aluminium and less than 2 % by weight of yttrium;

   b. CoCrAlY coatings which contain 22 to 24 % by weight of chromium, 10 to 12 % by weight of aluminium and 0,5 to 0,7 % by weight of yttrium; or

   c. NiCrAlY coatings which contain 21 to 23 % by weight of chromium, 10 to 12 % by weight of aluminium and 0,9 to 1,1 % by weight of yttrium.

6. The term 'aluminium alloys' refers to alloys having an ultimate tensile strength of 190 MPa or more measured at 293 K (20 °C).

7. The term ‘corrosion resistant steel’ refers to AISI (American Iron and Steel Institute) 300 series or equivalent national standard steels.

8. Not used.

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. Category 2 does not include "technology" for single-step pack cementation of solid aerofoils.

11. ‘Polymers’, as follows: polyimide, polyester, polysulphide, polycarbonates and polyurethanes.

12. ‘Modified zirconia’ refers to additions of other metal oxides (e.g., calcia, magnesia, yttria, hafnia, rare earth oxides) to zirconia in order to stabilise certain crystallographic phases and phase compositions. Thermal barrier coatings made of zirconia, modified with calcia or magnesia by mixing or fusion, are not controlled.

13. ‘Titanium alloys’ refers only to aerospace alloys having an ultimate tensile strength of 900 MPa or more measured at 293 K (20 °C).

14. ‘Low-expansion glasses’ refers to glasses which have a coefficient of thermal expansion of 1×10^{-7} K^{-1} or less measured at 293 K (20 °C).

15. ‘Dielectric layers’ are coatings constructed of multi-layers of insulator materials in which the interference properties of a design composed of materials of various refractive indices are used to reflect, transmit or absorb various wavelength bands. Dielectric layers refers to more than four dielectric layers or dielectric/metal "composite" layers.

16. ‘Cemented tungsten carbide’ does not include cutting and forming tool materials consisting of tungsten carbide/(cobalt, nickel), titanium carbide/(cobalt, nickel), chromium carbide/nickel-chromium and chromium carbide/nickel.

17. "Technology" for depositing 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.

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.

a. (*continued*)

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 vaporise 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 synthesise 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 Physical Vapour Deposition (EB-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" Vaporisation uses either pulsed or continuous wave "laser" beams to vaporise 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 ionised 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;

NB: 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 ionise 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.

d. (*continued*)

N.B.2. High velocity refers to nozzle-exit gas velocity exceeding 750 m/s calculated at 293 K (20 °C) at 0,1 MPa.

e. Slurry Deposition is a surface modification coating or overlay coating process wherein a metallic or ceramic powder with an organic binder is suspended in a liquid and is applied to a substrate by either spraying, dipping or painting, subsequent air or oven drying, and heat treatment to obtain the desired coating.

f. Sputter Deposition is an overlay coating process based on a momentum transfer phenomenon, wherein positive ions are accelerated by an electric field towards the surface of a target (coating material). The kinetic energy of the impacting ions is sufficient to cause target surface atoms to be released and deposited on an appropriately positioned substrate.

N.B.1. The Table refers only to triode, magnetron or reactive sputter deposition which is used to increase adhesion of the coating and rate of deposition and to radio frequency (RF) augmented sputter deposition used to permit vaporisation of non-metallic coating materials.

N.B.2. Low-energy ion beams (less than 5 keV) can be used to activate the deposition.

g. Ion Implantation is a surface modification coating process in which the element to be alloyed is ionised, 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 (EB-PVD) or sputter deposition.

PART V

Category 3

CATEGORY 3 – ELECTRONICS

3A Systems, Equipment and Components

Note 1: The control status of equipment and components described in 3A001, 3A002 or 3A501, other than those described in 3A001.a.3. to 3A001.a.10., 3A001.a.12. to 3A001.a.14., 3A001.b.12. or 3A501.a.15. 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. to 3A001.a.14., which are unalterably programmed or designed for a specific function for another equipment is determined by the control status of the other equipment.

NB: 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. to 3A001.a.14.

Note 3: The status of wafers (finished or unfinished), in which the function has been determined, is to be evaluated against the parameters of 3A001.a., 3A001.b., 3A001.d., 3A001.e.4., 3A001.g., 3A001.h., or 3A001.i.

3A001 Electronic items as follows:

a. General purpose integrated circuits, as follows:

Note: Integrated circuits include the following types:

— *"Monolithic integrated circuits";*

— *"Hybrid integrated circuits";*

— *"Multichip integrated circuits";*

3A001 a. Note: (*continued*)

— *'Film type integrated circuit', including silicon-on-sapphire integrated circuits;*

— *"Optical integrated circuits";*

— *'Three dimensional integrated circuit';*

— *"Monolithic Microwave Integrated Circuits" ("MMICs").*

Technical Notes:

For the purposes of 3A001.a.:

1. *'Film type integrated circuit' is an array of "circuit elements" and metallic interconnections formed by deposition of a thick or thin film on an insulating "substrate".*

2. *'Three dimensional integrated circuit' is a collection of semiconductor dies or active device layers, integrated together, and having through semiconductor via connections passing completely through an interposer, substrate, die or layer to establish interconnections between the device layers. An interposer is an interface that enables electrical connections.*

1. Integrated circuits designed or rated as radiation hardened to withstand any of the following:

   a. A total dose of 5×10^3 Gy (silicon) or higher;

   b. A dose rate upset of 5×10^6 Gy (silicon)/s or higher; or

   c. A fluence (integrated flux) of neutrons (1 MeV equivalent) of 5×10^{13} n/cm^2 or higher on silicon, or its equivalent for other materials;

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

2. "Microprocessor microcircuits", "microcomputer microcircuits", microcontroller microcircuits, storage integrated circuits manufactured from a compound semiconductor, Analogue-to-Digital Converters (ADCs), integrated circuits that contain ADCs and store or process the digitised data, Digital-to-Analogue Converters (DACs), electro-optical or "optical integrated circuits" designed for "signal processing", field programmable logic devices, custom integrated circuits for which either the function is unknown or the control status of the equipment in which the integrated circuit will be used is unknown, Fast Fourier Transform (FFT) processors, Static Random Access Memories (SRAMs), or 'non-volatile memories', 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 control integrated circuits designed for civil automobiles or railway train applications.*

   Technical Note:

   For the purposes of 3A001.a.2., 'non-volatile memories' are memories with data retention over a period of time after a power shutdown.

   NB: *For cryogenic CMOS integrated circuits not specified in 3A001.a.2., see 3A501.a.15.*

3A001 a. (*continued*)

3. "Microprocessor microcircuits", "microcomputer 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. Not used;

5. Analogue-to-Digital Converter (ADC) and Digital-to-Analogue Converter (DAC) integrated circuits, as follows:

a. ADCs having any of the following:

NB: *SEE ALSO 3A101*

1. Not used;

2. A resolution of 10 bit or more, but less than 12 bit, with a "sample rate" greater than 600 Mega Samples Per Second (MSPS);

3. A resolution of 12 bit or more, but less than 14 bit, with a "sample rate" greater than 400 MSPS;

4. A resolution of 14 bit or more, but less than 16 bit, with a "sample rate" greater than 250 MSPS; or

5. A resolution of 16 bit or more with a "sample rate" greater than 65 MSPS;

NB: *For integrated circuits that contain ADCsand store or process the digitised data, see 3A001.a.14.*

Technical Notes:

For the purposes of 3A001.a.5.a.:

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

2. *The resolution of the ADC is the number of bits of the digital output that represents the measured analogue input. Effective Number of Bits (ENOB) is not used to determine the resolution of the ADC.*

3. *For "multiple channel ADCs", the "sample rate" is not aggregated and the "sample rate" is the maximum rate of any single channel.*

4. *For "interleaved ADCs" or for "multiple channel ADCs" that are specified to have an interleaved mode of operation, the "sample rates" are aggregated and the "sample rate" is the maximum combined total rate of all of the interleaved channels.*

b. DACs having any of the following:

1. A resolution of 10 bit or more, but less than 12 bit, with an 'adjusted update rate' exceeding 3 500 MSPS; or

2. A resolution of 12 bit or more and having any of the following:

a. An 'adjusted update rate' exceeding 1 250 MSPS but not exceeding 3 500 MSPS, and having any of the following:

1. A settling time less than 9 ns to arrive at or within 0,024 % of full scale from a full scale step; or

2. A 'Spurious Free Dynamic Range' (SFDR) greater than 68 dBc (carrier) when synthesising a full scale analogue signal of 100 MHz or the highest full scale analogue signal frequency specified below 100 MHz; or

b. An 'adjusted update rate' exceeding 3 500 MSPS;

3A001 a. 5. (*continued*)

Technical Notes:

For the purposes of 3A001.a.5.b.:

1. *'Spurious Free Dynamic Range' (SFDR) is defined as the ratio of the RMS value of the carrier frequency (maximum signal component) at the input of the DAC to the RMS value of the next largest noise or harmonic distortion component at its output.*

2. *SFDR is determined directly from the specification table or from the characterisation plots of SFDR versus frequency.*

3. *A signal is defined to be full scale when its amplitude is greater than -3 dBfs (full scale).*

4. *'Adjusted update rate' for DACs:*

   a. *For conventional (non-interpolating) DACs, the 'adjusted update rate' is the rate at which the digital signal is converted to an analogue signal and the output analogue values are changed by the DAC. For DACs where the interpolation mode may be bypassed (interpolation factor of one), the DAC should be considered as a conventional (non-interpolating) DAC.*

   b. *For interpolating DACs (oversampling DACs), the 'adjusted update rate' is defined as the DAC update rate divided by the smallest interpolating factor. For interpolating DACs, the 'adjusted update rate' may be referred to by different terms including:*

      — *input data rate*

      — *input word rate*

      — *input sample rate*

      — *maximum total input bus rate*

      — *maximum DAC clock rate for DAC clock input.*

6. Electro-optical and "optical integrated circuits", designed for "signal processing" and having all of the following:

   a. One or more than one internal "laser" diode;

   b. One or more than one internal light detecting element; and

   c. Optical waveguides;

7. Field programmable logic devices having any of the following:

   a. A maximum number of single-ended digital input/outputs of greater than 700; or

   b. An 'aggregate one-way peak serial transceiver data rate' of 500 Gb/s or greater;

   Note: *3A001.a.7. includes:*

      — *Complex Programmable Logic Devices (CPLDs);*

      — *Field Programmable Gate Arrays (FPGAs);*

      — *Field Programmable Logic Arrays (FPLAs);*

      — *Field Programmable Interconnects (FPICs).*

   N.B.1 *For integrated circuits having field programmable logic devices that are combined with an ADC, see 3A001.a.14.*

   N.B.2 *For "electronic assemblies", modules or equipment, containing one or more 'user configurable' Field Programmable Logic Devices (FPLDs), see 3A502.i.*

3A001 a. 7. (*continued*)

Technical Notes:

For the purposes of 3A001.a.7.:

1. *Maximum number of digital input/outputs in 3A001.a.7.a. is also referred to as the maximum user input/outputs or maximum available input/outputs, whether the integrated circuit is packaged or bare die.*

2. *'Aggregate one-way peak serial transceiver data rate' is the product of the peak serial one-way transceiver data rate times the number of transceivers on the FPGA.*

8. Not used;

9. Neural network integrated circuits;

NB: For integrated circuits, having one or more digital processing units having a 'Total Processing Performance' ('TPP') of 6 000 or more, see 3A501.a.16.

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 1 500 terminals;

b. A typical 'basic gate propagation delay time' of less than 0,02 ns; or

c. An operating frequency exceeding 3 GHz;

Technical Notes:

For the purposes of 3A001.a.10.b.:

1. *'Basic gate propagation delay time' is 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'.*

2. *'Basic gate propagation delay time' is not to be confused with the input/output delay time of a complex "monolithic integrated circuit".*

3. *'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.

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 3 000 (2 input gates); or

b. A toggle frequency exceeding 1,2 GHz;

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

Technical Note:

For the purposes of 3A001.a.12., when N is equal to 1 024 points, the formula gives an execution time of 500 μs.

3A001 a. (*continued*)

13. Direct Digital Synthesizer (DDS) integrated circuits having any of the following:

    a. A Digital-to-Analogue Converter (DAC) clock frequency of 3,5 GHz or more and a DAC resolution of 10 bit or more, but less than 12 bit; or

    b. A DAC clock frequency of 1,25 GHz or more and a DAC resolution of 12 bit or more;

    Technical Note:

    For the purposes of 3A001.a.13., the DAC clock frequency may be specified as the master clock frequency or the input clock frequency.

14. Integrated circuits that perform or are programmable to perform all of the following:

    a. Analogue-to-digital conversions meeting any of the following:

        1. Not used;

        2. A resolution of 10 bit or more, but less than 12 bit, with a "sample rate" greater than 1,0 GSPS;

        3. A resolution of 12 bit or more, but less than 14 bit, with a "sample rate" greater than 1,0 GSPS;

        4. A resolution of 14 bit or more, but less than 16 bit, with a "sample rate" greater than 400 Mega Samples Per Second (MSPS); or

        5. A resolution of 16 bit or more with a "sample rate" greater than 180 MSPS; and

    b. Any of the following:

        1. Storage of digitised data; or

        2. Processing of digitised data;

    N.B.1. For ADC integrated circuits, see 3A001.a.5.a.

    N.B.2. For field programmable logic devices, see 3A001.a.7.

    Technical Notes:

    For the purposes of 3A001.a.14.:

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

    2. The resolution of the ADC is the number of bits of the digital output of the ADC that represents the measured analogue input. Effective Number of Bits (ENOB) is not used to determine the resolution of the ADC.

    3. For integrated circuits with non-interleaving "multiple channel ADCs", the "sample rate" is not aggregated and the "sample rate" is the maximum rate of any single channel.

    4. For integrated circuits with "interleaved ADCs"or with "multiple channel ADCs" that are specified to have an interleaved mode of operation, the "sample rates" are aggregated and the "sample rate" is the maximum combined total rate of all of the interleaved channels.

3A001 (*continued*)

b. Microwave or millimetre wave items as follows:

Technical Note:

For the purposes of 3A001.b., the parameter peak saturated power output may also be referred to on product data sheets as output power, saturated power output, maximum power output, peak power output, or peak envelope power output.

1. "Vacuum electronic devices" and cathodes, as follows:

Note 1: 3A001.b.1. does not control "vacuum electronic devices" designed or rated for operation in any frequency band and having all of the following:

a. Does not exceed 31,8 GHz; and

b. Is "allocated by the International Telecommunication Union (ITU)" for radio-communications services, but not for radio-determination.

Note 2: 3A001.b.1. does not control non-"space-qualified" "vacuum electronic devices" having all of the following:

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

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

1. Exceeds 31,8 GHz but does not exceed 43,5 GHz; and

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

a. Travelling-wave "vacuum electronic devices", pulsed or continuous wave, as follows:

1. Devices operating at frequencies exceeding 31,8 GHz;

2. Devices having a cathode heater with a turn on time to rated Radio Frequency (RF) power of less than 3 seconds;

3. Coupled cavity devices, or derivatives thereof, with a "fractional bandwidth" of more than 7 % or a peak power exceeding 2,5 kW;

4. Devices based on helix, folded waveguide, or serpentine waveguide circuits, or derivatives thereof, having any of the following:

a. An "instantaneous bandwidth" of more than one octave, and average power (expressed in kW) times frequency (expressed in GHz) of more than 0,5;

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

c. Being "space-qualified"; or

d. Having a gridded electron gun;

5. Devices with a "fractional bandwidth" greater than or equal to 10 %, with any of the following:

a. An annular electron beam;

b. A non-axisymmetric electron beam; or

c. Multiple electron beams;

b. Crossed-field amplifier "vacuum electronic devices" with a gain of more than 17 dB;

c. Thermionic cathodes designed for "vacuum electronic devices" producing an emission current density at rated operating conditions exceeding 5 A/cm^2 or a pulsed (non-continuous) current density at rated operating conditions exceeding 10 A/cm^2;

3A001 b. 1. (*continued*)

d. "Vacuum electronic devices" with the capability to operate in a 'dual mode';

Technical Note:

For the purposes of 3A001.b.1.d., 'dual mode' means the "vacuum electronic device" beam current can be intentionally changed between continuous-wave and pulsed mode operation by use of a grid and produces a peak pulse output power greater than the continuous-wave output power.

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

NB: For "MMIC" amplifiers that have an integrated phase shifter, see 3A001.b.12.

a. Rated for operation at frequencies exceeding 2,7 GHz up to and including 6,8 GHz with a "fractional bandwidth" greater than 15 %, and having any of the following:

1. A peak saturated power output greater than 75 W (48,75 dBm) at any frequency exceeding 2,7 GHz up to and including 2,9 GHz;

2. A peak saturated power output greater than 55 W (47,4 dBm) at any frequency exceeding 2,9 GHz up to and including 3,2 GHz;

3. A peak saturated power output greater than 40 W (46 dBm) at any frequency exceeding 3,2 GHz up to and including 3,7 GHz; or

4. A peak saturated power output greater than 20 W (43 dBm) at any frequency exceeding 3,7 GHz up to and including 6,8 GHz;

b. Rated for operation at frequencies exceeding 6,8 GHz up to and including 16 GHz with a "fractional bandwidth" greater than 10 %, and having any of the following:

1. A peak saturated power output greater than 10 W (40 dBm) at any frequency exceeding 6,8 GHz up to and including 8,5 GHz; or

2. A peak saturated power output greater than 5 W (37 dBm) at any frequency exceeding 8,5 GHz up to and including 16 GHz;

c. Rated for operation with a peak saturated power output greater than 3 W (34,77 dBm) at any frequency exceeding 16 GHz up to and including 31,8 GHz, and with a "fractional bandwidth" of greater than 10 %;

d. Rated for operation with a peak saturated power output greater than 0,1 nW (-70 dBm) at any frequency exceeding 31,8 GHz up to and including 37 GHz;

e. Rated for operation with a peak saturated power output greater than 1 W (30 dBm) at any frequency exceeding 37 GHz up to and including 43,5 GHz, and with a "fractional bandwidth" of greater than 10 %;

f. Rated for operation with a peak saturated power output greater than 31,62 mW (15 dBm) at any frequency exceeding 43,5 GHz up to and including 75 GHz, and with a "fractional bandwidth" of greater than 10 %;

g. Rated for operation with a peak saturated power output greater than 10 mW (10 dBm) at any frequency exceeding 75 GHz up to and including 90 GHz, and with a "fractional bandwidth" of greater than 5 %; or

h. Rated for operation with a peak saturated power output greater than 0,1 nW (-70 dBm) at any frequency exceeding 90 GHz;

3A001 b. 2. (*continued*)

Note 1: *Not used.*

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.h., is determined by the lowest peak saturated power output threshold.*

Note 3: *Notes 1 and 2 in 3A 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 that are any of the following:

a. Rated for operation at frequencies exceeding 2,7 GHz up to and including 6,8 GHz and having any of the following:

1. A peak saturated power output greater than 400 W (56 dBm) at any frequency exceeding 2,7 GHz up to and including 2,9 GHz;

2. A peak saturated power output greater than 205 W (53,12 dBm) at any frequency exceeding 2,9 GHz up to and including 3,2 GHz;

3. A peak saturated power output greater than 115 W (50,61 dBm) at any frequency exceeding 3,2 GHz up to and including 3,7 GHz; or

4. A peak saturated power output greater than 60 W (47,78 dBm) at any frequency exceeding 3,7 GHz up to and including 6,8 GHz;

b. Rated for operation at frequencies exceeding 6,8 GHz up to and including 31,8 GHz and having any of the following:

1. A peak saturated power output greater than 50 W (47 dBm) at any frequency exceeding 6,8 GHz up to and including 8,5 GHz;

2. A peak saturated power output greater than 15 W (41,76 dBm) at any frequency exceeding 8,5 GHz up to and including 12 GHz;

3. A peak saturated power output greater than 40 W (46 dBm) at any frequency exceeding 12 GHz up to and including 16 GHz; or

4. A peak saturated power output greater than 7 W (38,45 dBm) at any frequency exceeding 16 GHz up to and including 31,8 GHz;

c. Rated for operation with a peak saturated power output greater than 0,5 W (27 dBm) at any frequency exceeding 31,8 GHz up to and including 37 GHz;

d. Rated for operation with a peak saturated power output greater than 1 W (30 dBm) at any frequency exceeding 37 GHz up to and including 43,5 GHz;

e. Rated for operation with a peak saturated power output greater than 0,1 nW (-70 dBm) at any frequency exceeding 43,5 GHz; or

f. Other than those specified in 3A001.b.3.a. to 3A001.b.3.e and rated for operation with a peak saturated power output greater than 5 W (37,0 dBm) at all frequencies exceeding 8,5 GHz up to and including 31,8 GHz;

Note 1: *The control status of a transistor in 3A001.b.3.a. to 3A001.b.3.e. whose rated operating frequency includes frequencies listed in more than one frequency range, as defined by 3A001.b.3.a. to 3A001.b.3.e., is determined by the lowest peak saturated power output threshold.*

Note 2: *3A001.b.3. includes bare dice, dice mounted on carriers, or dice mounted in packages. Some discrete transistors may also be referred to as power amplifiers, but the status of these discrete transistors is determined by 3A001.b.3.*

3A001 b. (*continued*)

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

a. Rated for operation at frequencies exceeding 2,7 GHz up to and including 6,8 GHz with a "fractional bandwidth" greater than 15 %, and having any of the following:

1. A peak saturated power output greater than 500 W (57 dBm) at any frequency exceeding 2,7 GHz up to and including 2,9 GHz;

2. A peak saturated power output greater than 270 W (54,3 dBm) at any frequency exceeding 2,9 GHz up to and including 3,2 GHz;

3. A peak saturated power output greater than 200 W (53 dBm) at any frequency exceeding 3,2 GHz up to and including 3,7 GHz; or

4. A peak saturated power output greater than 90 W (49,54 dBm) at any frequency exceeding 3,7 GHz up to and including 6,8 GHz;

b. Rated for operation at frequencies exceeding 6,8 GHz up to and including 31,8 GHz with a "fractional bandwidth" greater than 10 %, and having any of the following:

1. A peak saturated power output greater than 70 W (48,45 dBm) at any frequency exceeding 6,8 GHz up to and including 8,5 GHz;

2. A peak saturated power output greater than 50 W (47 dBm) at any frequency exceeding 8,5 GHz up to and including 12 GHz;

3. A peak saturated power output greater than 30 W (44,77 dBm) at any frequency exceeding 12 GHz up to and including 16 GHz; or

4. A peak saturated power output greater than 20 W (43 dBm) at any frequency exceeding 16 GHz up to and including 31,8 GHz;

c. Rated for operation with a peak saturated power output greater than 0,5 W (27 dBm) at any frequency exceeding 31,8 GHz up to and including 37 GHz;

d. Rated for operation with a peak saturated power output greater than 2 W (33 dBm) at any frequency exceeding 37 GHz up to and including 43,5 GHz, and with a "fractional bandwidth" of greater than 10 %;

e. Rated for operation at frequencies exceeding 43,5 GHz and having any of the following:

1. A peak saturated power output greater than 0,2 W (23 dBm) at any frequency exceeding 43,5 GHz up to and including 75 GHz, and with a "fractional bandwidth" of greater than 10 %;

2. A peak saturated power output greater than 20 mW (13 dBm) at any frequency exceeding 75 GHz up to and including 90 GHz, and with a "fractional bandwidth" of greater than 5 %; or

3. A peak saturated power output greater than 0,1 nW (-70 dBm) at any frequency exceeding 90 GHz;

f. Not used;

N.B.1. *For "MMIC" amplifiers, see 3A001.b.2.*

N.B.2. *For 'transmit/receive modules' and 'transmit modules', see 3A001.b.12.*

N.B.3. *For converters and harmonic mixers, designed to extend the operating or frequency range of signal analysers, signal generators, network analysers or microwave test receivers, see 3A001.b.7.*

3A001 b. 4. (*continued*)

Note 1: *Not used.*

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 peak saturated power output threshold.*

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

   a. A band-pass bandwidth of more than 0,5 % of centre frequency; or

   b. A band-stop bandwidth of less than 0,5 % of centre frequency;

6. Not used;

7. Converters and harmonic mixers that are any of the following:

   a. Designed to extend the frequency range of "signal analysers" beyond 110 GHz;

   b. Designed to extend the operating range of signal generators as follows:

      1. Beyond 110 GHz;

      2. To an output power greater than 100 mW (20 dBm) anywhere within the frequency range exceeding 43,5 GHz but not exceeding 110 GHz;

   c. Designed to extend the operating range of network analysers as follows:

      1. Beyond 110 GHz;

      2. To an output power greater than 100 mW (20 dBm) anywhere within the frequency range exceeding 43,5 GHz but not exceeding 110 GHz;

      3. Not used;

   d. Designed to extend the frequency range of microwave test receivers beyond 110 GHz;

8. Microwave power amplifiers containing "vacuum electronic devices" specified in 3A001.b.1. and having all of the following:

   a. Operating frequencies above 3 GHz;

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

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

   Note: *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.*

9. Microwave power modules (MPM) consisting of, at least, a travelling wave "vacuum electronic device", a "monolithic microwave integrated circuit" ("MMIC") and an integrated electronic power conditioner and having all of the following:

   a. A 'turn-on time' from off to fully operational in less than 10 seconds;

   b. A volume less than the maximum rated power in Watts multiplied by 10 cm^3/W; and

   c. An "instantaneous bandwidth" greater than 1 octave ($f_{max} > 2f_{min}$) and having any of the following:

      1. For frequencies equal to or less than 18 GHz, an RF output power greater than 100 W; or

      2. A frequency greater than 18 GHz;

3A001 b. 9. (*continued*)

Technical Notes:

1. For the purposes of 3A001.b.9.a. the 'turn-on time' refers to the time from fully-off to fully operational, i.e., it includes the warm-up time of the MPM.

2. For the purposes of 3A001.b.9.b., the following example is provided to calculate the volume: for a maximum rated power of 20 W, the volume would be: 20 W x 10 cm^3/W = 200 cm^3.

10. Oscillators or oscillator assemblies, specified to operate with a Single Sideband (SSB) phase noise, in dBc/Hz, less (better) than $-(126 + 20\log_{10}F - 20\log_{10}f)$ anywhere within the range of 10 Hz ≤ F ≤ 10 kHz;

Technical Note:

For the purposes of 3A001.b.10., F is the offset from the operating frequency in Hz and f is the operating frequency in MHz.

11. 'Frequency synthesizer' "electronic assemblies" having a "frequency switching time" as specified in any of the following:

a. Less than 143 ps;

b. Less than 100 μs for any frequency change exceeding 2,2 GHz within the synthesised frequency range exceeding 4,8 GHz but not exceeding 31,8 GHz;

c. Not used;

d. Less than 500 μs for any frequency change exceeding 550 MHz within the synthesised frequency range exceeding 31,8 GHz but not exceeding 37 GHz;

e. Less than 100 μs for any frequency change exceeding 2,2 GHz within the synthesised frequency range exceeding 37 GHz but not exceeding 75 GHz;

f. Less than 100 μs for any frequency change exceeding 5,0 GHz within the synthesised frequency range exceeding 75 GHz but not exceeding 90 GHz; or

g. Less than 1 ms within the synthesised frequency range exceeding 90 GHz;

Technical Note:

For the purposes of 3A001.b.11., a 'frequency synthesizer' is any kind of frequency source, regardless of the actual technique used, providing a multiplicity of simultaneous or alternative output frequencies, from one or more outputs, controlled by, derived from or disciplined by a lesser number of standard (or master) frequencies.

NB: For general purpose "signal analysers", signal generators, network analysers and microwave test receivers, see 3A002.c., 3A002.d., 3A002.e. and 3A002.f., respectively.

12. 'Transmit/receive modules', 'transmit/receive MMICs', 'transmit modules', and 'transmit MMICs', rated for operation at frequencies above 2,7 GHz and having all of the following:

a. A peak saturated power output (in watts), P_{sat}, greater than 505,62 divided by the maximum operating frequency (in GHz) squared [$P_{sat} > 505{,}62$ W x GHz^2/f_{GHz}^2] for any channel;

b. A "fractional bandwidth" of 5 % or greater for any channel;

c. Any planar side with length d (in cm) equal to or less than 15 divided by the lowest operating frequency in GHz [$d \leq 15$cm x GHz x N/f_{GHz}] where N is the number of transmit or transmit/receive channels; and

d. An electronically variable phase shifter per channel.

3A001 b. 12. (*continued*)

Technical Notes:

For the purposes of 3A001.b.12.:

1. *A 'transmit/receive module' is a multifunction "electronic assembly" that provides bi-directional amplitude and phase control for transmission and reception of signals.*

2. *A 'transmit module' is an "electronic assembly" that provides amplitude and phase control for transmission of signals.*

3. *A 'transmit/receive MMIC': is a multifunction "MMIC" that provides bi-directional amplitude and phase control for transmission and reception of signals.*

4. *A 'transmit MMIC' is a "MMIC" that provides amplitude and phase control for transmission of signals.*

5. *2,7 GHz should be used as the lowest operating frequency (f_{GHz}) in the formula in 3A001.b.12.c. for transmit/receive or transmit modules that have a rated operation range extending downward to 2,7 GHz and below [d≤ 15cm x GHz x N/2,7 GHz].*

6. *3A001.b.12. applies to 'transmit/receive modules' or 'transmit modules' with or without a heat sink. The value of d in 3A001.b.12.c. does not include any portion of the 'transmit/receive module' or 'transmit module' that functions as a heat sink.*

7. *'Transmit/receive modules', or 'transmit modules', or 'transmit/receive MMICs' or 'transmit MMICs' may or may not have N integrated radiating antenna elements where N is the number of transmit or transmit/receive channels.*

c. Acoustic wave devices as follows and specially designed components therefor:

1. Surface acoustic wave and surface skimming (shallow bulk) acoustic wave devices, having any of the following:

a. A carrier frequency exceeding 6 GHz;

b. A carrier frequency exceeding 1 GHz but not exceeding 6 GHz and having any of the following:

1. A 'frequency side-lobe rejection' exceeding 65 dB;

2. A product of the maximum delay time and the bandwidth (time in μs and bandwidth in MHz) of more than 100;

3. A bandwidth greater than 250 MHz; or

4. A dispersive delay of more than 10 μs; or

c. A carrier frequency of 1 GHz or less and having any of the following:

1. A product of the maximum delay time and the bandwidth (time in μs and bandwidth in MHz) of more than 100;

2. A dispersive delay of more than 10 μs; or

3. A 'frequency side-lobe rejection' exceeding 65 dB and a bandwidth greater than 100 MHz;

Technical Note:

For the purposes of 3A001.c.1., 'frequency side-lobe rejection' is the maximum rejection value specified in data sheet.

2. Bulk (volume) acoustic wave devices which permit the direct processing of signals at frequencies exceeding 6 GHz;

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

3A001 c. (*continued*)

Note: *3A001.c. does not control acoustic wave devices that are limited to a single band pass, low pass, high pass or notch filtering, or resonating function.*

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

1. Current switching for digital circuits using "superconductive" gates with a product of delay time per gate (in seconds) and power dissipation per gate (in watts) of less than 10^{-14} J; or

2. Frequency selection at all frequencies using resonant circuits with Q-values exceeding 10 000;

e. High energy devices as follows:

1. 'Cells' as follows:

a. 'Primary cells' having any of the following at 20 °C;

1. 'Energy density' exceeding 550 Wh/kg and a 'continuous power density' exceeding 50 W/kg; or

2. 'Energy density' exceeding 50 Wh/kg and a 'continuous power density' exceeding 350 W/kg; or

b. 'Secondary cells' having an 'energy density' exceeding 500 Wh/kg at 20 °C;

Technical Notes:

1. For the purposes of 3A001.e.1., 'energy density' (Wh/kg) is calculated from the nominal *voltage multiplied by the nominal capacity in ampere-hours (Ah) divided by the mass in kilograms. If the nominal capacity is not stated, energy density is calculated from the nominal voltage squared then multiplied by the discharge duration in hours divided by the discharge load in ohms and the mass in kilograms.*

2. For the purposes of 3A001.e.1., a 'cell' is defined as an electrochemical device, which has positive and negative electrodes, an electrolyte, and is a source of electrical energy. It is the basic building block of a battery.

3. For the purposes of 3A001.e.1.a., a 'primary cell' is a 'cell' that is not designed to be charged by any other source.

4. For the purposes of 3A001.e.1.b., a 'secondary cell' is a 'cell' that is designed to be charged by an external electrical source.

5. For the purposes of 3A001.e.1.a., 'continuous power density' (W/kg) is calculated from the nominal voltage multiplied by the specified maximum continuous discharge current in amperes (A) divided by the mass in kilograms. 'Continuous power density' is also referred to as specific power.

Note: *3A001.e.1. does not control batteries, including single-cell batteries.*

2. High energy storage capacitors as follows:

NB: *SEE ALSO 3A201.a. and the Military Goods Controls.*

a. Capacitors with a repetition rate of less than 10 Hz (single shot capacitors) and having all of the following:

1. A voltage rating equal to or more than 5 kV;

2. An energy density equal to or more than 250 J/kg; and

3. A total energy equal to or more than 25 kJ;

3A001 e. 2. (*continued*)

b. Capacitors with a repetition rate of 10 Hz or more (repetition rated capacitors) and having all of the following:

1. A voltage rating equal to or more than 5 kV;

2. An energy density equal to or more than 50 J/kg;

3. A total energy equal to or more than 100 J; and

4. A charge/discharge cycle life equal to or more than 10 000;

3. "Superconductive" electromagnets and solenoids, specially designed to be fully charged or discharged in less than one second and having all of the following:

NB: *SEE ALSO 3A201.b.*

Note: *3A001.e.3. does not control "superconductive" electromagnets or solenoids specially designed for Magnetic Resonance Imaging (MRI) medical equipment.*

a. Energy delivered during the discharge exceeding 10 kJ in the first second;

b. Inner diameter of the current carrying windings of more than 250 mm; and

c. Rated for a magnetic induction of more than 8 T or 'overall current density' in the winding of more than 300 A/mm^2;

Technical Note:

For the purposes of 3A001.e.3.c., 'overall current density' is 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.).

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

Technical Note:

For the purposes of 3A001.e.4., 'AM0', or 'Air Mass Zero', refers to the spectral irradiance of sun light in the earth's outer atmosphere when the distance between the earth and sun is one astronomical unit (AU).

f. Rotary input type absolute position encoders having an "accuracy" equal to or less (better) than 1,0 second of arc and specially designed encoder rings, discs or scales therefor;

NB: SEE ALSO 3A501.f.

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

1. A maximum turn-on current rate of rise (di/dt) greater than 30 000 A/µs and off-state voltage greater than 1 100 V; or

2. A maximum turn-on current rate of rise (di/dt) greater than 2 000 A/µs and having all of the following:

a. An off-state peak voltage equal to or greater than 3 000 V; and

b. A peak (surge) current equal to or greater than 3 000 A.

3A001 g. (*continued*)

Note 1: *3A001.g. includes:*

— *Silicon Controlled Rectifiers (SCRs);*

— *Electrical Triggering Thyristors (ETTs);*

— *Light Triggering Thyristors (LTTs);*

— *Integrated Gate Commutated Thyristors (IGCTs);*

— *Gate Turn-off Thyristors (GTOs);*

— *Metal Oxide Semiconductor (MOS) Controlled Thyristors (MCTs);*

— *Solidtrons.*

Note 2: *3A001.g. does not control thyristor devices and 'thyristor modules' incorporated into equipment designed for civil railway or "civil aircraft" applications.*

Technical Note:

For the purposes of 3A001.g., a 'thyristor module' contains one or more thyristor devices.

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

1. Rated for a maximum operating junction temperature greater than 488 K (215 °C);

2. Repetitive peak off-state voltage (blocking voltage) exceeding 300 V; and

3. Continuous current greater than 1 A.

Note 1: *Repetitive peak off-state voltage in 3A001.h. includes drain to source voltage, collector to emitter voltage, repetitive peak reverse voltage and peak repetitive off-state blocking voltage.*

Note 2: *3A001.h. includes:*

— *Junction Field Effect Transistors (JFETs);*

— *Vertical Junction Field Effect Transistors (VJFETs);*

— *Metal Oxide Semiconductor Field Effect Transistors (MOSFETs);*

— *Double Diffused Metal Oxide Semiconductor Field Effect Transistor (DMOSFET);*

— *Insulated Gate Bipolar Transistor (IGBT);*

— *High Electron Mobility Transistors (HEMTs);*

— *Bipolar Junction Transistors (BJTs);*

— *Thyristors and Silicon Controlled Rectifiers (SCRs);*

— *Gate Turn-Off Thyristors (GTOs);*

— *Emitter Turn-Off Thyristors (ETOs);*

— *PiN Diodes;*

— *Schottky Diodes.*

3A001 h. (*continued*)

Note 3: *3A001.h. does not control switches, diodes, or 'modules', incorporated into equipment designed for civil automobile, civil railway or "civil aircraft" applications.*

Technical Note:

For the purposes of 3A001.h., 'modules' contain one or more solid-state power semiconductor switches or diodes.

i. Intensity, amplitude, or phase electro-optic modulators, designed for analogue signals and having any of the following:

1. A maximum operating frequency of more than 10 GHz but less than 20 GHz, an optical insertion loss equal to or less than 3 dB and having any of the following:

a. A 'half-wave voltage' ('Vπ') less than 2,7 V when measured at a frequency of 1 GHz or below; or

b. A 'Vπ' of less than 4 V when measured at a frequency of more than 1 GHz; or

2. A maximum operating frequency equal to or greater than 20 GHz, an optical insertion loss equal to or less than 3 dB and having any of the following:

a. A 'Vπ' less than 3,3 V when measured at a frequency of 1 GHz or below; or

b. A 'Vπ' less than 5 V when measured at a frequency of more than 1 GHz.

Note: *3A001.i. includes electro-optic modulators having optical input and output connectors (e.g., fibre-optic pigtails).*

Technical Note:

For the purposes of 3A001.i., a 'half-wave voltage' ('Vπ') is the applied voltage necessary to make a phase change of 180 degrees in the wavelength of light propagating through the optical modulator.

NB: *SEE ALSO 3A501.h.*

3A002 General purpose "electronic assemblies", modules and equipment, as follows:

a. Recording equipment and oscilloscopes as follows:

1. Not used;

2. Not used;

3. Not used;

4. Not used;

5. Not used;

6. Digital data recorders having all of the following:

a. A sustained 'continuous throughput' of more than 6,4 Gbit/s to disk or solid-state drive memory; and

b. "Signal processing" of the radio frequency signal data while it is being recorded;

Technical Notes:

For the purposes of 3A002.a.6.:

1. *For recorders with a parallel bus architecture, the 'continuous throughput' rate is the highest word rate multiplied by the number of bits in a word.*

2. *'Continuous throughput' is the fastest data rate the instrument can record to disk or solid-state drive memory without the loss of any information while sustaining the input digital data rate or digitizer conversion rate.*

3A002 a. (*continued*)

7. Real-time oscilloscopes havingall of the following:

a. A vertical root-mean-square (rms) noise voltage of less than 2 % of full-scale at the vertical scale setting that provides the lowest noise value; and

b. An 'upper 3dB frequency' greater than 90 GHz on any channel.

Note: *3A002.a.7. does not control equivalent-time sampling oscilloscopes.*

Technical Notes:

For the purposes of 3A002.a.7.b.:

1. 'Upper 3dB frequency' is the greater of:

a. The specified 3dB bandwidth of the oscilloscope; or

b. The maximum upper end of the frequency range of any 'movable bandwidth window'.

2. 'Movable bandwidth window' is a bandpass filter with a user-definable centre frequency or span.

b. Not used;

c. "Signal analysers" as follows:

1. "Signal analysers" having a 3 dB resolution bandwidth (RBW) exceeding 40 MHz anywhere within the frequency range exceeding 31,8 GHz but not exceeding 37 GHz;

2. "Signal analysers" having a Displayed Average Noise Level (DANL) less (better) than -160 dBm/Hz anywhere within the frequency range exceeding 43,5 GHz but not exceeding 110 GHz;

3. "Signal analysers" having a frequency exceeding 110 GHz;

4. "Signal analysers" having all of the following:

a. 'Real-time bandwidth' exceeding 520 MHz; and

b. Having any of the following:

1. 100 % probability of discovery with less than a 3 dB reduction from full amplitude due to gaps or windowing effects of signals having a duration of 8 μs or less; or

2. A 'frequency mask trigger' function with 100 % probability of trigger (capture) for signals having a duration of 8 μs or less;

Technical Notes:

1. For the purposes of 3A002.c.4.a., 'real-time bandwidth' is the widest frequency range for which the analyser can continuously transform time-domain data entirely into frequency-domain results, using a Fourier or other discrete time transform that processes every incoming time point, without a reduction of measured amplitude of more than 3 dB below the actual signal amplitude caused by gaps or windowing effects, while outputting or displaying the transformed data.

2. For the purposes of 3A002.c.4.b.1., probability of discovery is also referred to as probability of intercept or probability of capture.

3. For the purposes of 3A002.c.4.b.1., the duration for 100 % probability of discovery is equivalent to the minimum signal duration necessary for the specified level measurement uncertainty.

3A002 c. 4. b. (*continued*)

4. *For the purposes of 3A002.c.4.b.2., a 'frequency mask trigger' is a mechanism where the trigger function is able to select a frequency range to be triggered on as a subset of the acquisition bandwidth while ignoring other signals that may also be present within the same acquisition bandwidth. A 'frequency mask trigger' may contain more than one independent set of limits.*

Note: 3A002.c.4. does not control those "signal analysers" using only constant percentage bandwidth filters (also known as octave or fractional octave filters).

5. Not used;

d. Signal generators having any of the following:

1. Specified to generate pulse-modulated signals having all of the following, anywhere within the frequency range exceeding 31,8 GHz but not exceeding 37 GHz:

a. 'Pulse duration' of less than 25 ns; and

b. On/off ratio equal to or exceeding 65 dB;

Technical Note:

For the purposes of 3A002.d.1.a, 'pulse duration' is defined as the time interval from the point on the leading edge that is 50 % of the pulse amplitude to the point on the trailing edge that is 50 % of the pulse amplitude.

2. An output power exceeding 100 mW (20 dBm) anywhere within the frequency range exceeding 43,5 GHz but not exceeding 110 GHz;

3. A "frequency switching time" as specified in any of the following:

a. Not used;

b. Less than 100 μs for any frequency change exceeding 2,2 GHz within the frequency range exceeding 4,8 GHz but not exceeding 31,8 GHz;

c. Not used;

d. Less than 500 μs for any frequency change exceeding 550 MHz within the frequency range exceeding 31,8 GHz but not exceeding 37 GHz;

e. Less than 100 μs for any frequency change exceeding 2,2 GHz within the frequency range exceeding 37 GHz but not exceeding 75 GHz; or

f. Not used;

g. Less than 100 μs for any frequency change exceeding 5,0 GHz within the frequency range exceeding 75 GHz but not exceeding 110 GHz;

4. A Single Sideband (SSB) phase noise, in dBc/Hz, specified as being any of the following:

a. Less (better) than $-(126 + 20\log_{10}F - 20\log_{10}f)$ anywhere within the range of 10 Hz ≤ F ≤ 10 kHz anywhere within the frequency range exceeding 3,2 GHz but not exceeding 110 GHz; or

b. Less (better) than $-(206 - 20\log_{10}f)$ anywhere within the range of 10 kHz< F≤ 100 kHz anywhere within the frequency range exceeding 3,2 GHz but not exceeding 110 GHz;

Technical Note:

For the purposes of 3A002.d.4., F is the offset from the operating frequency in Hz and f is the operating frequency in MHz;

3A002 d. (*continued*)

5. A 'Radio Frequency (RF) modulation bandwidth' of digital baseband signals as specified in any of the following:

a. Exceeding 2,2 GHz within the frequency range exceeding 4,8 GHz but not exceeding 31,8 GHz;

b. Exceeding 550 MHz within the frequency range exceeding 31,8 GHz but not exceeding 37 GHz;

c. Exceeding 2,2 GHz within the frequency range exceeding 37 GHz but not exceeding 75 GHz; or

d. Exceeding 5,0 GHz within the frequency range exceeding 75 GHz but not exceeding 110 GHz; or

Technical Note:

For the purposes of 3A002.d.5., 'RF modulation bandwidth' is the RF bandwidth occupied by a digitally encoded baseband signal modulated onto an RF signal. It is also referred to as information bandwidth or vector modulation bandwidth. I/Q digital modulation is the technical method for producing a vector-modulated RF output signal, and that output signal is typically specified as having an 'RF modulation bandwidth'.

6. A maximum frequency exceeding 110 GHz;

Note 1: *3A002.d.includes arbitrary waveform and function generators.*

Note 2: *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.*

Technical Note:

For the purposes of 3A002.d., the maximum output frequency of an arbitrary waveform or function generator is calculated by dividing the sample rate, in samples/second, by a factor of 2,5.

e. Network analysers having any of the following:

1. An output power exceeding 100 mW (20 dBm) anywhere within the operating frequency range exceeding 43,5 GHz but not exceeding 110 GHz;

2. Not used;

3. 'Nonlinear vector measurement functionality' at frequencies exceeding 50 GHz but not exceeding 110 GHz; or

Technical Note:

For the purposes of 3A002.e.3., 'nonlinear vector measurement functionality' is an instrument's ability to analyse the test results of devices driven into the large-signal domain or the non-linear distortion range.

4. A maximum operating frequency exceeding 110 GHz;

f. Microwave test receivers having all of the following:

1. A maximum operating frequency exceeding 110 GHz; and

2. Being capable of measuring amplitude and phase simultaneously;

g. Atomic frequency standards being any of the following:

1. "Space-qualified";

2. Non-rubidium and having a long-term stability less (better) than 1×10^{-11}/month; or

3A002 g. (*continued*)

3. Non-"space-qualified" and having all of the following:

a. Being a rubidium standard;

b. Long-term stability less (better) than 1 x 10^{-11}/month; and

c. Total power consumption of less than 1 W;

h. "Electronic assemblies", modules, or equipment, specified to perform all of the following:

1. Analogue-to-digital conversions meeting any of the following:

a. Not used;

b. A resolution of 10 bit or more, but less than 12 bit, with a "sample rate" greater than 1,0 GSPS;

c. A resolution of 12 bit or more, but less than 14 bit, with a "sample rate" greater than 1,0 GSPS;

d. A resolution of 14 bit or more, but less than 16 bit, with a "sample rate" greater than 400 Mega Samples Per Second (MSPS); or

e. A resolution of 16 bit or more with a "sample rate" greater than 180 MSPS; and

2. Any of the following:

a. Output of digitised data;

b. Storage of digitised data; or

c. Processing of digitised data.

NB: *Digital data recorders, oscilloscopes, "signal analysers", signal generators, network analysers and microwave test receivers, are specified in 3A002.a.6., 3A002.a.7., 3A002.c., 3A002.d., 3A002.e. and 3A002.f., respectively.*

Technical Notes:

For the purposes of 3A002.h.:

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

2. *The resolution of the ADC is the number of bits of the digital output of the ADC that represents the measured analogue input. Effective Number of Bits (ENOB) is not used to determine the resolution of the ADC.*

3. *For non-interleaved multiple-channel "electronic assemblies", modules, or equipment, the "sample rate" is not aggregated and the "sample rate" is the maximum rate of any single-channel.*

4. *For interleaved channels on multiple-channel "electronic assemblies", modules, or equipment, the "sample rates" are aggregated and the "sample rate" is the maximum combined total rate of all the interleaved channels.*

Note: *3A002.h. includes ADC cards, waveform digitizers, data acquisition cards, signal acquisition boards and transient recorders.*

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.

3A101 Electronic equipment, devices and components, other than those specified in 3A001, as follows:

a. Analogue-to-Digital Converters (ADCs), usable in "missiles", designed to meet military specifications for ruggedized equipment;

3A101 (*continued*)

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. does not specify equipment specially designed for medical purposes.

3A102 'Thermal batteries' designed or modified for 'missiles'.

Technical Notes:

1. In 3A102 'thermal batteries' are single use batteries that contain a solid non-conducting inorganic salt as the electrolyte. These batteries incorporate a pyrolytic material that, when ignited, melts the electrolyte and activates the battery.

2. In 3A102 'missile' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.

3A201 Electronic components, other than those specified in 3A001, as follows;

a. Capacitors having either of the following sets of characteristics:

1. a. Voltage rating greater than 1,4 kV;

b. Energy storage greater than 10 J;

c. Capacitance greater than 0,5 µF; and

d. Series inductance less than 50 nH; or

2. a. Voltage rating greater than 750 V;

b. Capacitance greater than 0,25 µF; and

c. Series inductance less than 10 nH;

b. Superconducting solenoidal electromagnets having all of the following characteristics:

1. Capable of creating magnetic fields greater than 2 T;

2. A ratio of length to inner diameter greater than 2;

3. Inner diameter greater than 300 mm; and

4. Magnetic field uniform to better than 1 % over the central 50 % of the inner volume;

Note: 3A201.b. does not control magnets specially designed for and exported 'as parts of' medical nuclear magnetic resonance (NMR) imaging systems. The phrase 'as part of' does not necessarily mean physical part in the same shipment; separate shipments from different sources are allowed, provided the related export documents clearly specify that the shipments are dispatched 'as part of' the imaging systems.

c. Flash X-ray generators or pulsed electron accelerators having either of the following sets of characteristics:

1. a. An accelerator peak electron energy of 500 keV or greater but less than 25 MeV; and

b. With a 'figure of merit' (K) of 0,25 or greater; or

2. a. An accelerator peak electron energy of 25 MeV or greater; and

b. A 'peak power' greater than 50 MW.

Note: 3A201.c. does not control accelerators that are component parts of devices designed for purposes other than electron beam or X-ray radiation (electron microscopy, for example) nor those designed for medical purposes.

3A201 c. (*continued*)

Technical Notes:

1. *The 'figure of merit' (K) is defined as:*

   $K = 1{,}7 \times 10^3 V^{2{,}65} Q$

   V is the peak electron energy in million electron volts.

   If the accelerator beam pulse duration is less than or equal to 1 μs, then Q is the total accelerated charge in Coulombs. If the accelerator beam pulse duration is greater than 1 μs, then Q is the maximum accelerated charge in 1 μs.

   Q equals the integral of i with respect to t, over the lesser of 1 μs or the time duration of the beam pulse ($Q = \int i\,dt$), where i is beam current in amperes and t is time in seconds.

2. *'Peak power' = (peak potential in volts) x (peak beam current in amperes).*

3. *In machines based on microwave accelerating cavities, the time duration of the beam pulse is the lesser of 1 μs or the duration of the bunched beam packet resulting from one microwave modulator pulse.*

4. *In machines based on microwave accelerating cavities, the peak beam current is the average current in the time duration of a bunched beam packet.*

3A225 Frequency changers or generators, other than those specified in 0B001.b.13., usable as a variable or fixed frequency motor drive, having all of the following characteristics:

N.B.1. *"Software" specially designed to enhance or release the performance of a frequency changer or generator to meet the characteristics of 3A225 is specified in 3D225.*

N.B.2. *"Technology" in the form of codes or keys to enhance or release the performance of a frequency changer or generator to meet the characteristics of 3A225 is specified in 3E225.*

a. Multiphase output providing a power of 40 VA or greater;

b. Operating at a frequency of 600 Hz or more; and

c. Frequency control better (less) than 0,2 %.

Note: *3A225 does not control frequency changers or generators if they have hardware, "software" or "technology" constraints that limit the performance to less than that specified above, provided they meet any of the following:*

1. *They need to be returned to the original manufacturer to make the enhancements or release the constraints;*

2. *They require "software" as specified in 3D225 to enhance or release the performance to meet the characteristics of 3A225; or*

3. *They require "technology" in the form of keys or codes as specified in 3E225 to enhance or release the performance to meet the characteristics of 3A225.*

Technical Notes:

1. *Frequency changers in 3A225 are also known as converters or inverters.*

2. *Frequency changers in 3A225 may be marketed as Generators, Electronic Test Equipment, AC Power Supplies, Variable Speed Motors Drives, Variable Speed Drives (VSDs), Variable Frequency Drives (VFDs), Adjustable Frequency Drives (AFDs), or Adjustable Speed Drives (ASDs).*

3A226 High-power direct current power supplies, other than those specified in 0B001.j.6., having both of the following characteristics:

a. Capable of continuously producing, over a time period of 8 hours, 100 V or greater with current output of 500 A or greater; and

b. Current or voltage stability better than 0,1 % over a time period of 8 hours.

3A227 High-voltage direct current power supplies, other than those specified in 0B001.j.5., having both of the following characteristics:

a. Capable of continuously producing, over a time period of 8 hours, 20 kV or greater with current output of 1 A or greater; and

b. Current or voltage stability better than 0,1 % over a time period of 8 hours.

3A228 Switching devices, as follows:

a. Cold-cathode tubes, whether gas filled or not, operating similarly to a spark gap, having all of the following characteristics:

1. Containing three or more electrodes;

2. Anode peak voltage rating of 2,5 kV or more;

3. Anode peak current rating of 100 A or more; and

4. Anode delay time of 10 μs or less;

Note: *3A228.a. includes gas krytron tubes and vacuum sprytron tubes.*

b. Triggered spark-gaps having both of the following characteristics:

1. An anode delay time of 15 μs or less; and

2. Rated for a peak current of 500 A or more;

c. Modules or assemblies with a fast switching function, other than those specified in 3A001.g. or 3A001.h., having all of the following characteristics:

1. Anode peak voltage rating greater than 2 kV;

2. Anode peak current rating of 500 A or more; and

3. Turn-on time of 1 μs or less.

3A229 High-current pulse generators as follows:

NB: *SEE ALSO MILITARY GOODS CONTROLS.*

a. Detonator firing sets (initiator systems, firesets), including electronically-charged, explosively-driven and optically-driven firing sets, other than those specified in 1A007.a., designed to drive multiple controlled detonators specified in 1A007.b.;

b. Modular electrical pulse generators (pulsers) having all of the following characteristics:

1. Designed for portable, mobile, or ruggedized-use;

2. Capable of delivering their energy in less than 15 μs into loads of less than 40 ohms;

3. Having an output greater than 100 A;

4. No dimension greater than 30 cm;

5. Weight less than 30 kg; and

6. 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.*

3A229 (*continued*)

c. Micro-firing units having all of the following characteristics:

1. No dimension greater than 35 mm;

2. Voltage rating of equal to or greater than 1 kV; and

3. Capacitance of equal to or greater than 100 nF.

3A230 High-speed pulse generators, and 'pulse heads' therefor, 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 Notes:

1. In 3A230, 'pulse transition time' is defined as the time interval between 10 % and 90 % voltage amplitude.

2. 'Pulse heads' are impulse forming networks designed to accept a voltage step function and shape it into a variety of pulse forms that can include rectangular, triangular, step, impulse, exponential, or monocycle types. 'Pulse heads' can be an integral part of the pulse generator, they can be a plug-in module to the device or they can be an externally connected device.

3A231 Neutron generator systems, including tubes, having both of the following characteristics:

a. Designed for operation without an external vacuum system; and

b. Utilising any of the following:

1. Electrostatic acceleration to induce a tritium-deuterium nuclear reaction; or

2. Electrostatic acceleration to induce a deuterium-deuterium nuclear reaction and capable of an output of 3 x 10^9 neutrons/s or greater.

3A232 Multipoint initiation systems, other than those specified in 1A007, as follows:

NB: SEE ALSO MILITARY GOODS CONTROLS.

NB: See 1A007.b. for detonators.

a. Not used;

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

Note: 3A232 does not control detonators using only primary explosives, such as lead azide.

3A233 Mass spectrometers, other than those specified in 0B002.g., capable of measuring ions of 230 u 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 ionisation mass spectrometers (TIMS);

d. Electron bombardment mass spectrometers having both of the following features:

1. A molecular beam inlet system that injects a collimated beam of analyte molecules into a region of the ion source where the molecules are ionised by an electron beam; and

2. One or more 'cold traps' that can be cooled to a temperature of 193 K (– 80 °C);

3A233 (*continued*)

e. Not used;

f. Mass spectrometers equipped with a microfluorination ion source designed for actinides or actinide fluorides.

Technical Notes:

1. Electron bombardment mass spectrometers in 3A233.d. are also known as electron impact mass spectrometers or electron ionisation mass spectrometers.

2. In 3A233.d.2., a 'cold trap' is a device that traps gas molecules by condensing or freezing them on cold surfaces. For the purposes of 3A233.d.2., a closed-loop gaseous helium cryogenic vacuum pump is not a 'cold trap'.

3A234 Striplines to provide low inductance path to detonators with the following characteristics:

a. Voltage rating greater than 2 kV; and

b. Inductance of less than 20 nH.

3A501 Electronic items as follows:

a. General purpose integrated circuits, as follows:

15. Complementary Metal Oxide Semiconductor (CMOS) integrated circuits, not specified in 3A001.a.2., designed to operate at an ambient temperature equal to or less (better) than 4,5 K (- 268,65 °C).

Technical Note:

For the purposes of 3A501.a.15., CMOS integrated circuits are also referred to as cryogenic CMOS or cryoCMOS integrated circuits.

16. Integrated circuits, having one or more digital processing units, having any of the following:

a. A 'Total Processing Performance' ('TPP') greater than or equal to 6 000; or

b. A 'TPP' greater than or equal to 1 600 and less than 6 000 and a 'performance density' greater than or equal to 5,92;

Note: 3A501.a.16.b. does not control items that are not designed for use in 'data centres'.

NB: For computers, "electronic assemblies" and components containing integrated circuits specified in 3A501.a.16., see 4A507.

Technical Notes:

For the purposes of 3A501.a.16.:

1. 'Total Processing Performance' ('TPP') is 2 x 'MacTOPS' x 'bit length of the operation', aggregated over all processing units on the integrated circuit.

a. 'MacTOPS' is the theoretical peak number of Tera (10^{12}) operations per second for multiply-accumulate computation (D = AxB+C).

b. The 2 in the 'TPP' formula is based on industry convention of counting one multiply-accumulate computation, D = AxB+C, as 2 operations for the purpose of datasheets. Therefore, 2 x MacTOPS may correspond to the reported TOPS or FLOPS on a datasheet.

c. 'Bit length of the operation' for a multiply-accumulate computation is the largest bit-length of the inputs to the multiply operation.

d. Aggregate the 'TPPs' for each processing unit on the integrated circuit to arrive at a total. 'TPP' = TPP1 + TPP2 + ... + TPPn (where n is the number of processing units on the integrated circuit).

3A501 a. 16. (*continued*)

2. The rate of 'MacTOPS' is to be calculated at its maximum value theoretically possible. The rate of 'MacTOPS' is assumed to be the highest value the manufacturer claims in a manual or brochure for the integrated circuit. For example, the 'TPP' threshold of 6 000 can be met with 750 tera integer operations (or 2 x 375 'MacTOPS') at 8 bits or 375 tera FLOPS at 16 bits. If the IC is designed for MAC computation with multiple bit lengths that achieve different 'TPP' values, the highest 'TPP' value should be evaluated against parameters in 3A501.a.16.

3. For integrated circuits, specified in 3A501.a.16., that provide processing of both sparse and dense matrices, the 'TPP' values are the values for processing of dense matrices (e.g., without sparsity).

4. 'Performance density' is 'TPP' divided by 'applicable die area'. 'Applicable die area' is measured in millimetres squared and includes all die area of logic dies manufactured with a process node that uses a non-planar transistor architecture.

5. 'Data centre' is a structure, or group of structures, dedicated to the centralised accommodation, interconnection and operation of information technology and network telecommunications equipment providing data storage, processing or transmission services together with all the facilities and infrastructure for power distribution and environmental control.

b. Microwave or millimetre wave items as follows:

13. Parametric signal amplifiers having all of the following:

a. Designed for operation at an ambient temperature below 1 K (- 272,15 °C);

b. Designed for operation at any frequency from 2 GHz up to and including 15 GHz; and

c. A noise figure less (better) than 0,015 dB at any frequency from 2 GHz up to and including 15 GHz at 1 K (- 272,15 °C).

Note: Parametric signal amplifiers include Travelling Wave Parametric Amplifiers (TWPAs).

Technical Note:

For the purposes of 3A501.b.13., parametric signal amplifiers may also be referred to as Quantum-Limited Amplifiers (QLAs).

f. Rotary input type absolute position inductive encoders, not specified in 3A001.f., having all of the following:

1. Digital output;

2. Outer diameter less than or equal to 40 mm; and

3. Resolution equal to or greater than 16 bits;

h. Solid-state power semiconductor switches, diodes, or 'modules', rated for a maximum operating junction temperature less than or equal to 488 K (215 °C) and having all of the following:

1. Repetitive peak off-state voltage (blocking voltage) exceeding 5 000 V;

2. Continuous current greater than 1 A; and

3. Semiconductor material with a bandgap of more than 2.0 eV.

Note 1: Repetitive peak off-state voltage in 3A501.h. includes drain to source voltage, collector to emitter voltage, repetitive peak reverse voltage and peak repetitive off-state blocking voltage.

Note 2: 3A501.h. includes:

— Junction Field Effect Transistors (JFETs)

— Vertical Junction Field Effect Transistors (VJFETs)

3A501 h. *Note 2:* (*continued*)

— Metal Oxide Semiconductor Field Effect Transistors (MOSFETs)

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

— Insulated Gate Bipolar Transistor (IGBT)

— High Electron Mobility Transistors (HEMTs)

— Bipolar Junction Transistors (BJTs)

— Thyristors and Silicon Controlled Rectifiers (SCRs)

— Gate Turn-Off Thyristors (GTOs)

— Emitter Turn-Off Thyristors (ETOs)

— PiN Diodes

— Schottky Diodes

Note 3: *3A501.h. does not apply to switches, diodes, or 'modules', incorporated into equipment designed for civil automobile, civil railway, "civil aircraft", civil power transmission and distribution, or civil 'energy conversion' applications.*

Note 4: *3A501.h. includes silicon carbide, gallium nitride, and gallium oxide semiconductor switches, diodes or 'modules'.*

Technical Notes:

For the purposes of 3A501.h.:

1. 'Modules' contain one or more solid-state power semiconductor switches or diodes.

2. 'Energy conversion' is the process of converting one form of energy into another form of energy.

NB: *SEE ALSO 3A001.h.*

3A502 General purpose "electronic assemblies", modules and equipment, as follows:

i. "Electronic assemblies", modules or equipment, containing one or more 'user configurable' Field Programmable Logic Devices (FPLDs) and having an 'aggregate lookup table input count' of greater than or equal to 1 800 000.

NB: *For items having FPLDs that are combined with an Analogue-to-Digital Converter (ADC), rated for extended operating temperatures or are radiation hardened, or have cryptographic functionality, see 3A002.h., 4A001.a., and 5A002.a. respectively.*

Technical Notes:

For the purposes of 3A502.i.:

1. 'User configurable' means a user can configure or modify the logic cells or interconnects between logic cells within the FPLD logic fabric to prescribe the specific function that the 3A502.i. item performs.

2. 'Aggregate lookup table input count' is the sum of the number of independent inputs available to each programmable Lookup Table (LUT), as accumulated across all physical LUTs contained within a FPLD or other programmable item. An example is: a circuit board containing 2 FPGAs, each having 150 000 programmable LUTs with 6 inputs, would have an 'aggregate lookup table input count' of 2 × 150 000 × 6 = 1 800 000.

3A504 Cryogenic cooling systems and components, as follows:

a. Systems rated to provide a cooling power greater than or equal to 600 μW at or below a temperature of 0,1 K (- 273,05 °C) for a period of greater than 48 hours;

b. Two-stage pulse tube cryocoolers rated to maintain a temperature below 4 K (- 269,15 °C) and provide a cooling power greater than or equal to 1,5 W at or below a temperature of 4,2 K (- 268,95 °C).

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:

NB: SEE ALSO 2B226

a. Equipment designed for epitaxial growth as follows:

1. Equipment designed or modified to produce a layer of any material other than silicon with a thickness uniform to less than ± 2,5 % across a distance of 75 mm or more;

Note: 3B001.a.1. includes Atomic Layer Epitaxy (ALE) equipment.

2. Metal Organic Chemical Vapour Deposition (MOCVD) reactors designed for compound semiconductor epitaxial growth of material having two or more of the following elements: aluminium, gallium, indium, arsenic, phosphorus, antimony, oxygen or nitrogen;

3. Molecular beam epitaxial growth equipment using gas or solid sources;

NB: For equipment designed for epitaxial growth of silicon (Si) or silicon germanium (SiGe), see 3B501.a.4.

b. Equipment designed for ion implantation and having any of the following:

1. Not used;

2. Being designed and optimised to operate at a beam energy of 20 keV or more and a beam current of 10 mA or more for hydrogen, deuterium or helium implant;

3. Direct write capability;

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"; or

5. Being designed and optimised to operate at a beam energy of 20 keV or more and a beam current of 10 mA or more for silicon implant into a semiconductor material "substrate" heated to 600 °C or greater;

c. Not used;

d. Not used;

e. Automatic loading multi-chamber central wafer handling systems having all of the following:

1. Interfaces for wafer input and output, to which more than two functionally different 'semiconductor process tools' specified in 3B001.a.1., 3B001.a.2., 3B001.a.3. or 3B001.b. are designed 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 specially designed for parallel wafer processing.

Technical Notes:

1. For the purposes of 3B001.e.1., 'semiconductor process tools' refers to modular tools that provide physical processes for semiconductor "production" that are functionally different, such as deposition, implant or thermal processing.

3B001 e. (*continued*)

2. For the purposes of 3B001.e.2., 'sequential multiple wafer processing' means the capability to process each wafer in different 'semiconductor process tools', such as by transferring each wafer from one tool to a second tool and on to a third tool with the automatic loading multi-chamber central wafer handling systems.

f. Lithography equipment as follows:

1. Align and expose step and repeat (direct step on wafer) or step and scan (scanner) equipment for wafer processing using photo-optical or X-ray methods and having any of the following:

a. A light source wavelength shorter than 193 nm; or

b. Capable of producing a pattern with a 'Minimum Resolvable Feature size' ('MRF') of 45 nm or less;

Technical Note:

For the purposes of 3B001.f.1.b., the 'Minimum Resolvable Feature size' ('MRF') is calculated by the following formula:

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

where, the K factor = 0,35.

NB: SEE ALSO 3B501.f.

2. Imprint lithography equipment capable of producing features of 45 nm or less;

Note: 3B001.f.2. includes:

— *Micro contact printing tools;*

— *Hot embossing tools;*

— *Nano-imprint lithography tools;*

— *Step and Flash Imprint Lithography (S-FIL) tools.*

3. Equipment specially designed for mask making having all of the following:

a. A deflected focussed electron beam, ion beam or "laser" beam; and

b. Having any of the following:

1. A Full-Width Half-Maximum (FWHM) spot size smaller than 65 nm and an image placement less than 17 nm (mean + 3 sigma); or

2. Not used;

3. A second-layer overlay error of less than 23 nm (mean + 3 sigma) on the mask;

4. Equipment designed for device processing using direct writing methods, having all of the following:

a. A deflected focused electron beam; and

b. Having any of the following:

1. A minimum beam size equal to or smaller than 15 nm; or

2. An overlay error less than 27 nm (mean + 3 sigma);

g. Masks and reticles, designed for integrated circuits specified in 3A001, 3A501.a.15. or 3A501.a.16.;

h. Multi-layer masks with a phase shift layer not specified in 3B001.g. and designed to be used by lithography equipment having a light source wavelength less than 245 nm;

3B001 h. (*continued*)

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

NB: *For masks and reticles, specially designed for optical sensors, see 6B002.*

i. Imprint lithography templates designed for integrated circuits specified in 3A001, 3A501.a.15. or 3A501.a.16.;

j. Mask "substrate blanks" with multilayer reflector structure consisting of molybdenum and silicon, and having all of the following:

1. Specially designed for "Extreme Ultraviolet" ("EUV") lithography; and

2. Compliant with SEMI Standard P37.

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 items specified in 3A001.b.3.;

b. Not used;

c. For testing items specified in 3A001.b.2.

3B501 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:

4. Equipment designed for epitaxial growth of silicon (Si) or silicon germanium (SiGe), and having all of the following:

a. At least one preclean chamber designed to provide a surface preparation means to clean the surface of the wafer; and

b. An epitaxial deposition chamber designed to operate at a temperature below 958 K (685 °C).

Note: *3B501.a.4. includes Atomic Layer Epitaxy (ALE) equipment.*

f. Lithography equipment as follows:

1. Align and expose step and repeat (direct step on wafer) or step and scan (scanner) equipment for wafer processing using photo-optical or X-ray methods and having any of the following:

a. Not used;

b. Having all of the following:

1. A light source wavelength equal to or longer than 193 nm;

2. Capable of producing a pattern with a 'Minimum Resolvable Feature size' ('MRF') of 45 nm or less; and

3. A maximum 'dedicated chuck overlay' value of less than or equal to 1,50 nm;

Technical Notes:

For the purposes of 3B501.f.1.b.:

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

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

where, the K factor = 0,25.

'MRF' is also known as resolution.

3B501 f. 1. b. (*continued*)

2. 'Dedicated chuck overlay' is the alignment accuracy of a new pattern to an existing pattern printed on a wafer by the same lithographic system. 'Dedicated chuck overlay' is also known as single machine overlay.

NB: SEE ALSO 3B001.f.1.

k. Equipment designed for dry etching having any of the following:

1. Equipment designed or modified for isotropic dry etching, having a largest 'silicon germanium-to-silicon (SiGe:Si) etch selectivity' of greater than or equal to 100:1; or

2. Equipment designed or modified for anisotropic dry etching, having all of the following:

a. Radio Frequency (RF) power source(s) with at least one pulsed RF output;

b. One or more fast gas switching valve(s) with switching time less than 300 milliseconds; and

c. Electrostatic chuck with twenty or more individually controllable variable temperature elements;

Note 1: 3B501.k. includes etching by 'radicals', ions, sequential reactions, or non-sequential reaction.

Note 2: 3B501.k.2. includes etching using RF pulse excited plasma, pulsed duty cycle excited plasma, pulsed voltage on electrodes modified plasma, cyclic injection and purging of gases combined with a plasma, plasma atomic layer etching, or plasma quasi-atomic layer etching.

Technical Notes:

For the purposes of 3B501.k.:

1. 'Silicon germanium-to-silicon (SiGe:Si) etch selectivity' is measured for a germanium concentration of greater than or equal to 30 % ($Si_{0,70}$ $Ge_{0,30}$).

2. 'Radical' is defined as an atom, molecule, or ion that has an unpaired electron in an open electron shell configuration.

l. "Extreme Ultraviolet" ("EUV") masks and "EUV" reticles, designed for integrated circuits, not specified in 3B001.g., and having a mask "substrate blank" specified in 3B001.j.;

Technical Note:

For the purposes of 3B501.l., masks or reticles with a mounted pellicle are considered masks and reticles.

m. 'Pellicles' specially designed for "EUV" lithography.

Technical Note:

For the purposes of 3B501.m., a 'pellicle' is a membrane integrated with a frame, designed to protect a mask or reticle from particle contamination.

n. Semiconductor manufacturing deposition equipment as follows:

1. Atomic Layer Deposition (ALD) equipment as follows:

a. Equipment designed for the deposition of tungsten to fill an entire interconnect or in a channel less than 40 nm wide;

b. Equipment designed for 'area selective deposition' of a metal or metal nitride sidewall barrier using an organometallic compound precursor;

3B501 n. 1. b. (*continued*)

Technical Note:

For the purposes of 3B501.n.1.b., 'area selective deposition' refers to the deposition of material on the sidewall but not the bottom of a feature.

c. Equipment designed for the deposition of a 'work function metal' composed of titanium aluminium carbide (TiAlC) and having a work function greater than 4,0 eV, and having all of the following:

1. More than one metal source of which one is functioning as an aluminium precursor source; and

2. A precursor vessel designed to operate at a temperature greater than or equal to 303,15 K (30 °C);

Technical Note:

For the purposes of 3B501.n.1.c., 'work function metal' is a material that controls the threshold voltage of a transistor.

d. Equipment designed or modified for deposition of molybdenum, ruthenium, or combinations thereof, having all of the following:

1. Designed to operate with a metal precursor source designed or modified to operate at a temperature greater than 348 K (75 °C); and

2. A process chamber (module) using a reducing agent containing hydrogen at a pressure equal to or greater than 4 kPa;

Technical Note:

For the purposes of 3B501.n.1.d.1., the metal precursor source need not be integrated with the equipment. The metal precursor could be delivered by an on-tool source or sub-fab metal precursor source.

2. Equipment designed for cobalt electroplating or cobalt electroless-plating deposition processes;

3. Equipment designed for Chemical Vapour Deposition (CVD) of cobalt fill metal;

4. Equipment designed for 'selective bottom-up' Chemical Vapour Deposition (CVD) of tungsten fill metal;

Technical Note:

For the purposes of 3B501.n.4., 'selective bottom-up' refers to the preferential deposition of material on the bottom relative to the sidewall.

5. Equipment designed for void-free plasma enhanced deposition of a layer with a dielectric constant less than 3,3, in 'gaps' having an 'aspect ratio' equal to or greater than 1:1 and a width less than 25 nm;

Technical Notes:

For the purposes of 3B501.n.5.:

1. A 'gap' is the space between metal lines.

2. The 'aspect ratio' (depth: width) is defined as the ratio of the depth to the width of the gap between the metal lines.

6. Equipment designed for the deposition of a ruthenium layer using an organometallic compound precursor, while maintaining the wafer substrate at a temperature greater than 293,15 K (20 °C) and less than 773,15 K (500 °C);

3B501 n. (*continued*)

7. Equipment designed for multistep processing in multiple chambers and maintaining high vacuum or inert environment during transfer between process steps, as follows:

a. Equipment designed to fabricate a metal contact by performing all of the following processes:

1. Surface treatment plasma process using hydrogen, hydrogen and nitrogen, or ammonia (NH_3), while maintaining the wafer substrate at a temperature greater than 373,15 K (100 °C) and less than 773,15 K (500 °C);

2. Surface treatment plasma process using oxygen or ozone, while maintaining the wafer substrate at a temperature greater than 313,15 K (40 °C) and less than 773,15 K (500 °C); and

3. Deposition of a tungsten layer while maintaining the wafer substrate at a temperature greater than 373,15 K (100 °C) and less than 773,15 K (500 °C);

b. Equipment designed to fabricate a metal contact by performing all of the following processes:

1. Surface treatment plasma process using a remote plasma generator and an ion filter; and

2. Deposition of a cobalt layer selectively onto copper using an organometallic compound precursor;

c. Equipment designed to fabricate a metal contact by performing all of the following processes:

1. Deposition of a titanium nitride (TiN) or tungsten carbide (WC) layer, using an organometallic compound precursor, while maintaining the wafer substrate at a temperature greater than 293,15 K (20 °C) and less than 773,15 K (500 °C);

2. Deposition of a cobalt layer using a physical sputter deposition technique and having a process pressure greater than $1{,}33 \times 10^{-1}$ Pa (1 mTorr) and less than $1{,}33 \times 10^{1}$ Pa (100 mTorr), while maintaining the wafer substrate at a temperature less than 773,15 K (500 °C); and

3. Deposition of a cobalt layer using an organometallic compound precursor and having a process pressure greater than $1{,}33 \times 10^{2}$ Pa (1 Torr) and less than $1{,}33 \times 10^{4}$ Pa (100 Torr), while maintaining the wafer substrate at a temperature greater than 293,15 K (20 °C) and less than 773,15 K (500 °C);

d. Equipment designed to fabricate copper interconnects by performing all of the following processes:

1. Deposition of a cobalt or ruthenium layer using an organometallic compound precursor and having a process pressure greater than $1{,}33 \times 10^{2}$ Pa (1 Torr) and less than $1{,}33 \times 10^{4}$ Pa (100 Torr), while maintaining the wafer substrate at a temperature greater than 293,15 K (20 °C) and less than 773,15 K (500 °C); and

2. Deposition of a copper layer using a Physical Vapour Deposition (PVD) technique having a process pressure greater than $1{,}33 \times 10^{-1}$ Pa (1 mTorr) and less than $1{,}33 \times 10^{1}$ Pa (100 mTorr), while maintaining the wafer substrate at a temperature less than 773,15 K (500 °C);

3B501 n. (*continued*)

8. Equipment designed to fabricate a metal contact by multistep processing within a single chamber by performing all of the following:

a. Deposition of a tungsten layer, using an organometallic compound precursor, while maintaining the wafer substrate at a temperature greater than 373,15 K (100 °C) and less than 773,15 K (500 °C); and

b. Surface treatment plasma process using hydrogen, hydrogen and nitrogen, or ammonia (NH_3);

o. Equipment designed for coating, depositing, baking, or developing photoresist formulated for "EUV" lithography;

p. Inspection equipment designed for the detection of defects in, or particles on, "EUV" mask blanks or "EUV" patterned masks;

q. Single wafer wet cleaning equipment with 'surface modification' drying;

Technical Note:

For the purposes of 3B501.q., 'surface modification' refers to silylation of a surface.

r. Equipment designed for single wafer cleaning using supercritical CO_2 or sublimation drying;

s. Equipment designed for "EUV" 'pattern shaping';

Technical Note:

For the purposes of 3B501.s., 'pattern shaping' is a deposition or removal process used to improve overall patterning by reshaping or trimming patterns produced using "EUV" lithography. This process utilises non-vertical directed particles including ions, neutral particles, clusters, radicals, or light.

t. Equipment designed for ion beam deposition or Physical Vapor Deposition (PVD) of a multi-layer reflector for "EUV" masks.

3B503 Scanning Electron Microscope (SEM) equipment designed for imaging semiconductor devices or integrated circuits, having all of the following:

a. Stage placement accuracy less (better) than 30 nm;

b. Stage positioning measurement performed using laser interferometry;

c. Position calibration within a Field of View (FOV) based on laser interferometer length-scale measurement;

d. Collects and stores images having more than 2×10^8 pixels;

e. FOV overlap of less than 5 % in vertical and horizontal directions;

f. Stitching overlap of FOV less than 50 nm; and

g. Accelerating voltage more than 21 kV.

Note 1: *3B503 includes SEM equipment designed for chip design recovery.*

Note 2: *3B503 does not apply to SEM equipment designed to accept a Semiconductor Equipment and Materials International (SEMI) standard wafer carrier, such as a 200 mm or larger Front Opening Unified Pod (FOUP).*

3B504 Cryogenic wafer probing equipment, having all of the following:

a. Designed to test devices at temperatures less than or equal to 4,5 K (- 268,65 °C); and

b. Designed to accommodate wafer diameters greater than or equal to 100 mm.

3C Materials

3C001 Hetero-epitaxial materials, not specified in 3C507, consisting of a "substrate" having stacked epitaxially grown multiple layers of any of the following:

a. Silicon (Si);

b. Germanium (Ge);

c. Silicon carbide (SiC);

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

e. Gallium Oxide (Ga_2O_3); or

f. Diamond.

Note: 3C001.d. does not control a "substrate" having one or more P-type epitaxial layers of GaN, InGaN, AlGaN, InAlN, InAlGaN, GaP, GaAs, AlGaAs, InP, InGaP, AlInP or InGaAlP, independent of the sequence of the elements, except if the P-type epitaxial layer is between N-type layers.

3C002 Resist materials as follows and "substrates" coated with the following resists:

a. Resists designed for semiconductor lithography as follows:

1. Positive resists adjusted (optimised) for use at wavelengths less than 193 nm but equal to or greater than 15 nm;

2. Resists adjusted (optimised) for use at wavelengths less than 15 nm but greater than 1 nm;

b. All resists designed for use with electron beams or ion beams, with a sensitivity of 0,01 μcoulomb/mm^2 or better;

c. Not used;

d. All resists optimised for surface imaging technologies;

e. All resists designed or optimised for use with imprint lithography equipment specified in 3B001.f.2. that use either a thermal or photo-curable process.

3C003 Organo-inorganic compounds as follows:

a. Organo-metallic compounds of aluminium, gallium or indium, having all of the following:

1. A purity (metal basis) greater (better) than 99,999 %; and

2. Aluminium, gallium or indium elements directly linked to carbon in the organic part of the molecule;

b. Organo-arsenic, organo-antimony and organo-phosphorus compounds, having all of the following:

1. A purity (inorganic element basis) greater (better) than 99,999 %; and

2. Arsenic, antimony or phosphorus elements directly linked to carbon in the organic part of the molecule.

3C004 Hydrides of phosphorus, arsenic or antimony, having a purity greater (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.

3C005 High resistivity materials as follows:

a. Silicon carbide (SiC), gallium nitride (GaN), aluminium nitride (AlN), aluminium gallium nitride (AlGaN), gallium oxide (Ga_2O_3) or diamond semiconductor "substrates", or ingots, boules, or other preforms of those materials, having resistivities greater than 10 000 ohm-cm at 20 °C;

3C005 (*continued*)

b. Polycrystalline "substrates" or polycrystalline ceramic "substrates", having resistivities greater than 10 000 ohm-cm at 20 °C and having at least one non-epitaxial single-crystal layer of silicon (Si), silicon carbide (SiC), gallium nitride (GaN), aluminium nitride (AlN), aluminium gallium nitride (AlGaN), gallium oxide (Ga_2O_3) or diamond on the surface of the "substrate".

NB: For materials consisting of a "substrate" specified in 3C005 with at least one epitaxial layer, see 3C001 or 3C006.

3C006 Materials, not specified in 3C001, consisting of a "substrate" specified in 3C005 with at least one epitaxial layer of silicon carbide (SiC), gallium nitride (GaN), aluminium nitride (AlN), aluminium gallium nitride (AlGaN), gallium oxide (Ga_2O_3) or diamond.

3C507 Epitaxial materials consisting of a "substrate" having at least one epitaxially grown layer of any of the following:

a. Silicon having an isotopic impurity less than 0,08 % of silicon isotopes other than silicon-28 or silicon-30; or

b. Germanium having an isotopic impurity less than 0,08 % of germanium isotopes other than germanium-70, germanium-72, germanium-74, or germanium-76.

3C508 Fluorides, hydrides, or chlorides, of silicon or germanium, containing any of the following:

a. Silicon having an isotopic impurity less than 0,08 % of silicon isotopes other than silicon-28 or silicon-30; or

b. Germanium having an isotopic impurity less than 0,08 % of germanium isotopes other than germanium-70, germanium-72, germanium-74, or germanium-76.

3C509 Silicon, silicon oxides, germanium or germanium oxides, containing any of the following:

a. Silicon having an isotopic impurity less than 0,08 % of silicon isotopes other than silicon-28 or silicon-30; or

b. Germanium having an isotopic impurity less than 0,08 % of germanium isotopes other than germanium-70, germanium-72, germanium-74, or germanium-76.

Note: 3C509 includes "substrates", lumps, ingots, boules and preforms.

3D Software

3D001 "Software" specially designed for the "development" or "production" of equipment specified in 3A001.b. to 3A002.h., 3A501.b.13., 3A501.f., 3A501.h. or 3B.

3D002 "Software" specially designed for the "use" of equipment specified in 3A225, 3B001.a. to 3B001.f., 3B002, 3B501.a.4., 3B501.f.1., 3B501.k. or 3B501.n. to 3B501.r.

3D003 'Computational lithography' "software" specially designed for the "development" of patterns on EUV-lithography masks or reticles.

Technical Note:

For the purposes of 3D003, 'computational lithography' is the use of computer modelling to predict, correct, optimise and verify imaging performance of the lithography process over a range of patterns, processes, and system conditions.

3D004 "Software" specially designed for the "development" of equipment specified in 3A003.

3D005 "Software" specially designed to restore normal operation of a microcomputer, "microprocessor microcircuit" or "microcomputer microcircuit" within 1 ms after an Electromagnetic Pulse (EMP) or Electrostatic Discharge (ESD) disruption, without loss of continuation of operation.

3D006 'Electronic Computer-Aided Design' ('ECAD') "software" specially designed for the "development" of integrated circuits having any "Gate-All-Around Field-Effect Transistor" ("GAAFET") structure, and having any of the following:

a. Specially designed for implementing 'Register Transfer Level' ('RTL') to 'Geometrical Database Standard II' ('GDSII') or equivalent standard; or

b. Specially designed for optimisation of power or timing rules.

Technical Notes:

For the purposes of 3D006:

1. *'ECAD' is a category of "software" tools used for designing, analysing, optimising, and validating the performance of integrated circuit or printed circuit board.*

2. *'RTL' is a design abstraction which models a synchronous digital circuit in terms of the flow of digital signals between hardware registers, and the logical operations performed on those signals.*

3. *'GDSII' is a database file format for data exchange of integrated circuit or integrated circuit layout artwork.*

3D101 "Software" specially designed or modified for the "use" of equipment specified in 3A101.b.

3D225 "Software" specially designed to enhance or release the performance of frequency changers or generators to meet the characteristics of 3A225.

3D507 "Software" designed to extract 'GDSII' or equivalent standard layout data and perform layer-to-layer alignment from Scanning Electron Microscope (SEM) images, and generate multi-layer 'GDSII' data or the circuit netlist.

Technical Note:

For the purposes of 3D507, 'GDSII' ('Graphic Design System II') is a database file format for data exchange of integrated circuit artwork or integrated circuit layout artwork.

3E Technology

Note: 3E001 and 3E505 do not control 'Process Design Kits' ('PDKs') unless they include libraries implementing functions or technologies for items specified in 3A001 or 3A501.

Technical Note:

For the purposes of 3E001 and 3E505, a 'Process Design Kit' ('PDK') is a software tool provided by a semiconductor manufacturer to ensure that the required design practices and rules are taken into account in order to successfully produce a specific integrated circuit design in a specific semiconductor process, in accordance with technological and manufacturing constraints (each semiconductor manufacturing process has its particular 'PDK').

3E001 "Technology" according to the General Technology Note for the "development" or "production" of equipment or materials specified in 3A001, 3A002, 3A101, 3A102, 3A201, 3A225 to 3A234, 3A501, 3A502, 3A504, 3B or 3C.

Note 1: Not used.

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

a. Using "technology" at or above 0,130 µm; and

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

Note 3: Not used.

3E002 "Technology" according to the General Technology Note, other than that specified in 3E001, for the "development" or "production" of a "microprocessor microcircuit", "microcomputer microcircuit" or microcontroller microcircuit core, having an Arithmetic Logic Unit (ALU) with an access width of 32 bits or more and any of the following features or characteristics:

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

Technical Note:

For the purposes of 3E002.a., a 'vector processor unit' is a processor element with built-in instructions that perform multiple calculations on 'floating-point' vectors (one-dimensional arrays of 32-bit or larger numbers) simultaneously, having at least one vector ALU and vector registers of at least 32 elements each.

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

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

Technical Notes:

1. For the purposes of 3E002.a. and 3E002.b., 'floating-point' is defined by IEEE-754.

2. For the purposes of 3E002.c., 'fixed-point' refers to a fixed-width real number with both an integer component and a fractional component, and which does not include integer-only formats.

Note 1: 3E002 does not control "technology" for multimedia extensions.

Note 2: 3E002 does not control "technology" for micro-processor cores, having all of the following:

a. Using "technology" at or above 0,130 µm; and

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

Note 3: 3E002 includes "technology" for the "development" or "production" of digital signal processors and digital array processors.

3E003 Other "technology" for the "development" or "production" of the following:

a. Vacuum microelectronic devices;

b. Hetero-structure semiconductor electronic devices such as High Electron Mobility Transistors (HEMTs), Heterojunction Bipolar Transistors (HBTs), quantum well and super lattice devices;

Note: 3E003.b. does not control "technology" for HEMTs operating at frequencies lower than 31,8 GHz and HBTs operating at frequencies lower than 31,8 GHz.

c. "Superconductive" electronic devices;

d. Substrates 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. "Vacuum electronic devices" operating at frequencies of 31,8 GHz or higher;

h. Substrates of gallium oxide for electronic components.

3E004 "Technology" "required" for the slicing, grinding and polishing of 300 mm diameter silicon wafers to achieve a 'Site Front least sQuares Range' ('SFQR') less than or equal to 20 nm at any site of 26 mm x 8 mm on the front surface of the wafer and an edge exclusion less than or equal to 2 mm.

Technical Note:

For the purposes of 3E004 'SFQR' is the range of maximum deviation and minimum deviation from front reference plane, calculated by least square method with all front surface data including site boundary within a site.

3E101 "Technology" according to the General Technology Note for the "use" of equipment or "software" specified in 3A001.a.1., 3A001.a.2., 3A101, 3A102 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., 3A001.g., 3A201, 3A225 to 3A234.

3E225 "Technology", in the form of codes or keys, to enhance or release the performance of frequency changers or generators to meet the characteristics of 3A225.

3E505 "Technology" according to the General Technology Note for the "development" or "production" of integrated circuits or devices, using "Gate-All-Around Field-Effect Transistor" ("GAAFET") structures.

Note 1: *3E505 includes 'process recipes'.*

Note 2: *3E505 does not apply for tool qualification or maintenance.*

Note 3: *Not used.*

Technical Note:

For the purposes of 3E505, a 'process recipe' is a set of conditions and parameters for a particular process step.

PART VI

Category 4

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).*

NB: *For the control status of "software" specially designed for packet switching, see 5D001.*

Technical Note:

For the purposes of Note 2, 'main storage' is 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.

4A Systems, Equipment and Components

4A001 Electronic computers and related equipment, having any of the following and "electronic assemblies" and specially designed components therefor:

NB: SEE ALSO 4A101.

a. Specially designed to have any of the following:

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

Note: 4A001.a.1. does not control computers specially designed for civil automobile, railway train or "civil aircraft" applications.

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

a. Total Dose 5×10^3 Gy (silicon);

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

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

Note: 4A001.a.2. does not control computers specially designed for "civil aircraft" applications.

b. Not used.

4A003 "Digital computers", "electronic assemblies", and related equipment therefor, as follows and specially designed components therefor:

Note 1: 4A003 includes the following:

— *'Vector processors';*

— *Array processors;*

— *Digital signal processors;*

— *Logic processors;*

— *Equipment designed for "image enhancement".*

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. Not used;

b. "Digital computers" having an "Adjusted Peak Performance" ("APP") exceeding 70 Weighted TeraFLOPS (WT);

4A003 (*continued*)

c. "Electronic assemblies" specially designed or modified for enhancing performance by aggregation of processors so that the "APP" of the aggregation exceeds the limit specified in 4A003.b.;

Note 1: *4A003.c. controls only "electronic assemblies" and programmable interconnections not exceeding the limit specified in 4A003.b. when shipped as unintegrated "electronic assemblies".*

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 specified in 4A003.b.*

d. Not used;

e. Not used;

f. Not used;

g. Equipment specially designed for aggregating the performance of "digital computers" by providing external interconnections which allows communications at unidirectional data rates exceeding 2,0 Gbyte/s per link.

Note: *4A003.g. does not control internal interconnection equipment (e.g. backplanes, buses), passive interconnection equipment, 'network access controllers' or 'communications channel controllers'.*

Technical Notes:

For the purposes of 4A003.g. Note:

1. *A 'network access controller' is 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.*

2. *A 'communications channel controller' is 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.*

4A004 Computers as follows and specially designed related equipment, "electronic assemblies" and components therefor:

a. 'Systolic array computers';

b. 'Neural computers';

c. 'Optical computers'.

Technical Notes:

1. *For the purposes of 4A004.a., 'systolic array computers' are computers where the flow and modification of the data is dynamically controllable at the logic gate level by the user.*

2. *For the purposes of 4A004.b., 'neural computers' are computational devices designed or modified to mimic the behaviour of a neuron or a collection of neurons, i.e., computational devices which are distinguished by their hardware capability to modulate the weights and numbers of the interconnections of a multiplicity of computational components based on previous data.*

3. *For the purposes of 4A004.c., 'optical computers' are computers designed or modified to use light to represent data and whose computational logic elements are based on directly coupled optical devices.*

4A005 Systems, equipment, and components therefor, specially designed or modified for the generation, command and control, or delivery of "intrusion software".

4A101 Analogue computers, "digital computers" or digital differential analysers, other than those specified in 4A001.a.1., which are ruggedized and designed or modified for use in space launch vehicles specified in 9A004 or sounding rockets specified in 9A104.

4A102 Hybrid computers specially designed for modelling, simulation or design integration of space launch vehicles specified in 9A004 or sounding rockets specified in 9A104.

Note: *This control only applies when the equipment is supplied with "software" specified in 7D103 or 9D103.*

4A506 Quantum computers and related "electronic assemblies" and components therefor, as follows:

a. Quantum computers, as follows:

1. Quantum computers supporting 34 or more, but fewer than 100, 'fully controlled', 'connected' and 'working' 'physical qubits', and having a 'C-NOT error' of less than or equal to 10^{-4};

2. Quantum computers supporting 100 or more, but fewer than 200, 'fully controlled', 'connected' and 'working' 'physical qubits', and having a 'C-NOT error' of less than or equal to 10^{-3};

3. Quantum computers supporting 200 or more, but fewer than 350, 'fully controlled', 'connected' and 'working' 'physical qubits', and having a 'C-NOT error' of less than or equal to 2×10^{-3};

4. Quantum computers supporting 350 or more, but fewer than 500, 'fully controlled', 'connected' and 'working' 'physical qubits', and having a 'C-NOT error' of less than or equal to 3×10^{-3};

5. Quantum computers supporting 500 or more, but fewer than 700, 'fully controlled', 'connected' and 'working' 'physical qubits', and having a 'C-NOT error' of less than or equal to 4×10^{-3};

6. Quantum computers supporting 700 or more, but fewer than 1 100, 'fully controlled', 'connected' and 'working' 'physical qubits', and having a 'C-NOT error' of less than or equal to 5×10^{-3};

7. Quantum computers supporting 1 100 or more, but fewer than 2 000, 'fully controlled', 'connected' and 'working' 'physical qubits', and having a 'C-NOT error' of less than or equal to 6×10^{-3};

8. Quantum computers supporting 2 000 or more 'fully controlled', 'connected' and 'working' 'physical qubits';

b. Qubit devices and qubit circuits, containing or supporting arrays of 'physical qubits', and specially designed for items specified in 4A506.a.;

c. Quantum control components and quantum measurement devices, specially designed for items specified in 4A506.a.;

Note 1: *4A506 applies to circuit model (or gate-based) and one-way (or measurement-based) quantum computers. This entry does not apply to adiabatic (or annealing) quantum computers.*

Note 2: *Items specified in 4A506 may not necessarily physically contain any qubits. For example, quantum computers based on photonic schemes do not permanently contain a physical item that can be identified as a qubit. Instead, the photonic qubits are generated while the computer is operating and then later discarded.*

Note 3: *Items specified in 4A506.b. include semiconductor, superconducting, and photonic qubit chips and chip arrays; surface ion trap arrays; other qubit confinement technologies; and coherent interconnects between such items.*

Note 4: *4A506.c. applies to items designed for calibrating, initialising, manipulating or measuring the resident qubits of a quantum computer.*

4A506 (*continued*)

Technical Notes:

For the purposes of 4A506:

1. *A 'physical qubit' is a two-level quantum system used to represent the elementary unit of quantum logic by means of manipulations and measurements that are not error corrected. 'Physical qubits' are distinguished from logical qubits, in that logical qubits are error-corrected qubits comprised of many 'physical qubits'.*

2. *'Fully controlled' means the 'physical qubit' can be calibrated, initialised, gated, and read out, as necessary.*

3. *'Connected' means that two-qubit gate operations can be performed between any arbitrary pair of the available 'working' 'physical qubits'. This does not necessarily entail all-to-all connectivity.*

4. *'Working' means that the 'physical qubit' performs universal quantum computational work according to the system specifications for qubit operational fidelity.*

5. *Supporting 34 or more 'fully controlled', 'connected', 'working' 'physical qubits' refers to the capability of a quantum computer to confine, control, measure and process the quantum information embodied in 34 or more 'physical qubits'.*

6. *'C-NOT error' is the average physical gate error for the nearest-neighbour two-'physical qubit' Controlled-NOT (C-NOT) gates.*

4A507 Computers, "electronic assemblies", and components containing one or more integrated circuits, specified in 3A501.a.16.

Technical Note:

For the purposes of 4A507, computers include "digital computers", hybrid computers, and analogue computers.

4B Test, Inspection and Production Equipment

None.

4C Materials

None.

4D Software

Note: The control status of "software" for equipment described in other Categories is dealt with in the appropriate Category.

4D001 "Software" as follows:

a. "Software" specially designed or modified for the "development" or "production" of equipment or "software" specified in 4A001, 4A003 to 4A005, 4A507 or 4D004;

b. "Software", other than that specified in 4D001.a., specially designed or modified for the "development" or "production" of equipment as follows:

1. "Digital computers" having an "Adjusted Peak Performance" ("APP") exceeding 24 Weighted TeraFLOPS (WT);

2. "Electronic assemblies" specially designed or modified for enhancing performance by aggregation of processors so that the "APP" of the aggregation exceeds the limit in 4D001.b.1.;

3. Items specified in 4A506.b. or 4A506.c.

4D002 Not used.

4D003 Not used.

4D004 "Software" specially designed or modified for the generation, command and control, or delivery of "intrusion software".

Note: *4D004 does not control "software" specially designed and limited to provide "software" updates or upgrades meeting all the following:*

a. The update or upgrade operates only with the authorisation of the owner or administrator of the system receiving it; and

b. After the update or upgrade, the "software" updated or upgraded is not any of the following:

1. "Software" specified in 4D004; or

2. "Intrusion software".

4E Technology

4E001 "Technology" as follows:

a. "Technology" according to the General Technology Note, for the "development", "production" or "use" of equipment or "software" specified in 4A001, 4A003 to 4A005, 4A101, 4A102, 4A507 or 4D;

b. "Technology", according to the General Technology Note, other than that specified in 4E001.a., for the "development" or "production" of equipment as follows:

1. "Digital computers" having an "Adjusted Peak Performance" ("APP") exceeding 24 Weighted TeraFLOPS (WT);

2. "Electronic assemblies" specially designed or modified for enhancing performance by aggregation of processors so that the "APP" of the aggregation exceeds the limit in 4E001.b.1.;

3. Items specified in 4A506.b. or 4A506.c.

c. "Technology" for the "development" of "intrusion software".

Note 1: *4E001.a. and 4E001.c. do not control "vulnerability disclosure" or "cyber incident response".*

Note 2: *Note 1 does not diminish the rights of the competent authority of the Member State in which the exporter is established to ascertain compliance with 4E001.a. and 4E001.c.*

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 (FPO) 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 or multiplications. All floating point operations must be expressed in operations per processor cycle; operations requiring multiple cycles may be expressed in fractional results per cycle. For processors not capable of performing calculations on floating point operands of 64-bit or more, the effective calculating rate R is zero.*

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

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

4. For 'vector processors', $W_i = 0{,}9$. For non-'vector processors', $W_i = 0{,}3$.

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

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

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

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

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

Note 6: *"APP" values must be calculated for processor combinations containing processors specially designed to enhance performance by aggregation, operating simultaneously and sharing memory.*

Technical Notes:

1. *Aggregate all processors and accelerators operating simultaneously and located on the same die.*

2. *Processor combinations share memory when any processor is capable of accessing any memory location in the system through the hardware transmission of cache lines or memory words, without the involvement of any software mechanism, which may be achieved using "electronic assemblies" specified in 4A003.c.*

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.*

PART VII

Category 5

CATEGORY 5 – TELECOMMUNICATIONS AND "INFORMATION SECURITY"

Part 1 – **TELECOMMUNICATIONS**

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

Note 1: (*continued*)

NB: *For "lasers" specially designed for telecommunications equipment or systems, see 6A005.*

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 Telecommunications systems, equipment, components and accessories as follows:

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

1. Specially designed to withstand transitory electronic effects or electromagnetic pulse effects, both arising from a nuclear explosion;

2. Specially hardened to withstand gamma, neutron or ion radiation;

3. Specially designed to operate below 218 K (– 55 °C); or

4. Specially designed to operate above 397 K (124 °C);

Note 1: *5A001.a.3. and 5A001.a.4. control only electronic equipment.*

Note 2: *5A001.a.2., 5A001.a.3. and 5A001.a.4. do not control equipment designed or modified for use on board "spacecraft".*

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

1. Being underwater untethered communications systems having any of the following:

a. An acoustic carrier frequency outside the range from 20 kHz to 60 kHz;

b. Using an electromagnetic carrier frequency below 30 kHz;

c. Using electronic beam steering techniques; or

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

2. Being radio equipment operating in the 1,5 MHz to 87,5 MHz band and having all of the following:

a. Automatically predicting and selecting frequencies and "total digital transfer rates" per channel to optimise the transmission; and

b. Incorporating a linear power amplifier configuration having a capability to support multiple signals simultaneously at an output power of 1 kW or more in the frequency range of 1,5 MHz or more but less than 30 MHz, or 250 W or more in the frequency range of 30 MHz or more but not exceeding 87,5 MHz, over an "instantaneous bandwidth" of one octave or more and with an output harmonic and distortion content of less(better) than -80 dB;

3. Being radio equipment employing "spread spectrum" techniques, including "frequency hopping" techniques, other than those specified in 5A001.b.4. and having any of the following:

a. User programmable spreading codes; or

b. 3. (*continued*)

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 any of the following:*

a. Civil cellular radio-communications systems; or

b. Fixed or mobile "satellite" earth stations for commercial civil telecommunications.

Note: *5A001.b.3 does not control equipment designed to operate at an output power of 1 W or less.*

4. Being radio equipment employing ultra-wideband modulation techniques, having user programmable channelising codes, scrambling codes or network identification codes and having any of the following:

a. A bandwidth exceeding 500 MHz; or

b. A "fractional bandwidth" of 20 % or more;

5. Being digitally controlled radio receivers having all of the following:

a. More than 1 000 channels;

b. A 'channel 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.*

Technical Note:

For the purposes of 5A001.b.5.b., 'channel switching time' means the time (i.e., delay) to change from one receiving frequency to another, to arrive at or within ± 0,05 % of the final specified receiving frequency. Items having a specified frequency range of less than ± 0,05 % around their centre frequency are defined to be incapable of channel frequency switching.

6. Employing functions of digital "signal processing" to provide 'voice coding' output at rates of less than 700 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 fibres of more than 500 m in length and specified by the manufacturer as being capable of withstanding a 'proof test' tensile stress of 2×10^9 N/m^2 or more;

NB: *For* underwater *umbilical cables, see 8A002.a.3.*

c. (*continued*)

Technical Note:

For the purposes of 5A001.c., 'proof test' is the on-line or off-line production screen testing that dynamically applies a prescribed tensile stress over a 0,5 to 3 m length of fibre at a running rate of 2 to 5 m/s while passing between capstans approximately 150 mm in diameter. The ambient temperature is a nominal 293 K (20°C) and relative humidity 40 %. Equivalent national standards may be used for executing the proof test.

d. 'Electronically steerable phased array antennae' as follows:

1. Rated for operation above 31,8 GHz but not exceeding 57 GHz, and having an Effective Radiated Power (ERP) equal to or greater than +20 dBm (22,15 dBm Effective Isotropic Radiated Power (EIRP));

2. Rated for operation above 57 GHz but not exceeding 66 GHz, and having an ERP equal to or greater than +24 dBm (26,15 dBm EIRP);

3. Rated for operation above 66 GHz but not exceeding 90 GHz, and having an ERP equal to or greater than +20 dBm (22,15 dBm EIRP);

4. Rated for operation above 90 GHz;

Note 1: *5A001.d. does not control 'electronically steerable phased array antennae' for landing systems with instruments meeting International Civil Aviation Organization (ICAO) standards covering Microwave Landing Systems (MLS).*

Note 2: *5A001.d. does not control antennae specially designed for any of the following:*

a. Civil cellular or WLAN radio-communications systems;

b. IEEE 802.15 or wireless HDMI; or

c. Fixed or mobile "satellite" earth stations for commercial civil telecommunications.

Technical Note:

For the purposes of 5A001.d., 'electronically steerable phased array antenna' is an antenna which forms a beam by means of phase coupling, (i.e., the beam direction is controlled by the complex excitation coefficients of the radiating elements) and the direction of that beam can be varied (both in transmission and reception) in azimuth or in elevation, or both, by application of an electrical signal.

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

1. "Instantaneous bandwidth" of 10 MHz or more; and

2. Capable of finding a Line Of Bearing (LOB) to non-cooperating radio transmitters with a signal duration of less than 1 ms;

f. Mobile telecommunications interception or jamming equipment, and monitoring equipment therefor, as follows, and specially designed components therefor:

1. Interception equipment designed for the extraction of voice or data, transmitted over the air interface;

2. Interception equipment not specified in 5A001.f.1., designed for the extraction of client device or subscriber identifiers (e.g., International Mobile Subscriber Identity (IMSI), Temporary International Mobile Subscriber Identity (TIMSI) or International Mobile Equipment Identity (IMEI)), signalling, or other metadata transmitted over the air interface;

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

a. Simulate the functions of Radio Access Network (RAN) equipment;

f. 3. (*continued*)

b. Detect and exploit specific characteristics of the mobile telecommunications protocol employed (e.g., GSM); or

c. Exploit specific characteristics of the mobile telecommunications protocol employed (e.g. GSM);

4. Radio Frequency (RF) monitoring equipment designed or modified to identify the operation of items specified in 5A001.f.1., 5A001.f.2. or 5A001.f.3.;

Note: *5A001.f.1. and 5A001.f.2. do not control any of the following:*

a. Equipment specially designed for the interception of analogue Private Mobile Radio (PMR), IEEE 802.11 WLAN;

b. Equipment designed for mobile telecommunications network operators; or

c. Equipment designed for the "development" or "production" of mobile telecommunications equipment or systems.

N.B.1. *SEE ALSO MILITARY GOODS CONTROLS.*

N.B.2. *For radio receivers, see 5A001.b.5.*

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

Technical Note:

For the purposes of 5A001.g., non-radar transmitters may include commercial radio, television or cellular telecommunications base stations.

Note: *5A001.g. does not control any of the following:*

a. Radio-astronomical equipment; or

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

h. Counter Improvised Explosive Device (IED) equipment and related equipment, as follows:

1. Radio Frequency (RF) transmitting equipment, not specified in 5A001.f., designed or modified for prematurely activating or preventing the initiation of Improvised Explosive Devices (IEDs);

2. Equipment using techniques designed to enable radio communications in the same frequency channels on which co-located equipment specified in 5A001.h.1. is transmitting;

NB: *SEE ALSO MILITARY GOODS CONTROLS.*

i. Not used;

j. Internet Protocol (IP) network communications surveillance systems or equipment, and specially designed components therefor, having all of the following:

1. Performing all of the following on a carrier class internet Protocol (IP) network (e.g., national grade IP backbone):

a. Analysis at the application layer (e.g., Layer 7 of Open Systems Interconnection (OSI) model (ISO/IEC 7498-1));

b. Extraction of selected metadata and application content (e.g., voice, video, messages, attachments); and

c. Indexing of extracted data; and

j. (*continued*)

2. Being specially designed to carry out all of the following:

a. Execution of searches on the basis of "hard selectors"; and

b. Mapping of the relational network of an individual or of a group of people.

Note: *5A001.j. does not control systems or equipment, specially designed for any of the following:*

a. Marketing purpose;

b. Network Quality of Service (QoS); or

c. Quality of Experience (QoE).

5A101 Telemetry 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) navigation satellite systems services;

5B1 Test, Inspection and Production Equipment

5B001 Telecommunications test, inspection and production equipment, components and accessories, as follows:

a. Equipment and specially designed components or accessories therefor, specially designed for the "development" or "production" of equipment, functions or features, specified in 5A001;

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. Not used;

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

a. A transmission wavelength exceeding 1 750 nm; or

b. Not used;

c. Not used;

d. Employing analogue techniques and having a bandwidth exceeding 2,5 GHz; or

Note: *5B001.b.2.d. does not control equipment specially designed for the "development" of commercial TV systems.*

3. Not used;

4. Radio equipment employing Quadrature-Amplitude-Modulation (QAM) techniques above level 1 024;

5. Not used.

5C1 Materials

None

5D1 Software

5D001 "Software" as follows:

a. "Software" specially designed or modified for the "development", "production" or "use" of equipment, functions or features, specified in 5A001;

b. Not used;

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. Not used;

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

a. A transmission wavelength exceeding 1 750 nm; or

b. Employing analogue techniques and having a bandwidth exceeding 2,5 GHz; or

Note: 5D001.d.2.b. does not control "software" specially designed or modified for the "development" of commercial TV systems.

3. Not used;

4. Radio equipment employing Quadrature-Amplitude-Modulation (QAM) techniques above level 1 024;

e. "Software", other than that specified in 5D001.a. or 5D001.c., specially designed or modified for monitoring or analysis for law enforcement purposes, providing all of the following:

1. Execution of searches on the basis of "hard selectors" of either the content of communication or metadata acquired from a communications service provider using a 'handover interface'; and

2. Mapping of the relational network or tracking the movement or location of targeted individuals based on the results of searches on content of communication or metadata or searches as described in 5D001.e.1.

Technical Notes:

1. For the purposes of 5D001.e., a 'handover interface' is a physical and logical interface, designed for use by an authorised law enforcement authority, across which targeted interception measures are requested from a communications service provider and the results of interception are delivered from a communications service provider to the requesting authority. The 'handover interface' is implemented within systems or equipment (e.g., mediation devices) that receive and validate the interception request, and deliver to the requesting authority only the results of interception that fulfil the validated request.

2. 'Handover interfaces' may be specified in international standards (including but not limited to ETSI TS 101 331, ETSI TS 101 671, 3GPP TS 33.108) or national equivalents.

Note: 5D001.e. does not control "software" specially designed or modified for any of the following:

a. Billing purposes;

b. Network Quality of Service (QoS);

c. Quality of Experience (QoE);

e. (*continued*)

d. Mediation devices; or

e. Mobile payment or banking use.

5D101 "Software" specially designed or modified for the "use" of equipment specified in 5A101.

5E1 Technology

5E001 "Technology" as follows:

a. "Technology" according to the General Technology Note for the "development", "production" or "use" (excluding operation) of equipment, functions or features specified in 5A001 or "software" specified in 5D001.a. or 5D001.e.;

b. Specific "technology" as follows:

1. "Technology" "required" for the "development" or "production" of telecommunications equipment specially designed to be used on board "spacecraft";

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

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

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

Note: 5E001.b.4. does not control "technology" for the "development" of any of the following:

a. Civil cellular radio-communications systems; or

b. Fixed or mobile satellite earth stations for commercial civil telecommunications.

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

1. Not used;

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

a. A transmission wavelength exceeding 1 750 nm; or

b. Not used;

c. Not used;

d. Employing wavelength division multiplexing techniques of optical carriers at less than 100 GHz spacing; or

e. Employing analogue techniques and having a bandwidth exceeding 2,5 GHz;

Note: 5E001.c.2.e. does not control "technology" for commercial TV systems.

NB: For "technology" for the "development" or "production" of non-telecommunications equipment employing a laser, see 6E.

c. (*continued*)

3. Equipment employing 'optical switching' and having a switching time less than 1 ms;

Technical Note:

For the purposes of 5E001.c.3., 'optical switching' is the routing of or switching of signals in optical form without conversion to electrical signals.

4. Radio equipment having any of the following:

a. Quadrature-Amplitude-Modulation (QAM) techniques above level 1 024;

b. Operating at input or output frequencies exceeding 31,8 GHz; or

Note: *5E001.c.4.b. does not control "technology" for equipment designed or modified for operation in any frequency band which is "allocated by the International Telecommunication Union (ITU)" for radio-communications services, but not for radio-determination.*

c. Operating in the 1,5 MHz to 87,5 MHz band and incorporating adaptive techniques providing more than 15 dB suppression of an interfering signal; or

5. Not used;

6. Mobile equipment having all of the following:

a. Operating at an optical wavelength greater than or equal to 200 nm and less than or equal to 400 nm; and

b. Operating as a "local area network";

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

Technical Note:

For the purposes of 5E001.d., the parameter peak saturated power output may also be referred to on product data sheets as output power, saturated power output, maximum power output, peak power output, or peak envelope power output.

1. Rated for operation at frequencies exceeding 2,7 GHz up to and including 6,8 GHz with a "fractional bandwidth" greater than 15 %, and having any of the following:

a. A peak saturated power output greater than 75 W (48,75 dBm) at any frequency exceeding 2,7 GHz up to and including 2,9 GHz;

b. A peak saturated power output greater than 55 W (47,4 dBm) at any frequency exceeding 2,9 GHz up to and including 3,2 GHz;

c. A peak saturated power output greater than 40 W (46 dBm) at any frequency exceeding 3,2 GHz up to and including 3,7 GHz; or

d. A peak saturated power output greater than 20 W (43 dBm) at any frequency exceeding 3,7 GHz up to and including 6,8 GHz;

2. Rated for operation at frequencies exceeding 6,8 GHz up to and including 16 GHz with a "fractional bandwidth" greater than 10 %, and having any of the following:

a. A peak saturated power output greater than 10W (40 dBm) at any frequency exceeding 6,8 GHz up to and including 8,5 GHz; or

b. A peak saturated power output greater than 5W (37 dBm) at any frequency exceeding 8,5 GHz up to and including 16 GHz;

d. (*continued*)

3. Rated for operation with a peak saturated power output greater than 3 W (34,77 dBm) at any frequency exceeding 16 GHz up to and including 31,8 GHz, and with a "fractional bandwidth" of greater than 10 %;

4. Rated for operation with a peak saturated power output greater than 0,1 nW (-70 dBm) at any frequency exceeding 31,8 GHz up to and including 37 GHz;

5. Rated for operation with a peak saturated power output greater than 1 W (30 dBm) at any frequency exceeding 37 GHz up to and including 43,5 GHz, and with a "fractional bandwidth" of greater than 10 %;

6. Rated for operation with a peak saturated power output greater than 31,62 mW (15 dBm) at any frequency exceeding 43,5 GHz up to and including 75 GHz, and with a "fractional bandwidth" of greater than 10 %;

7. Rated for operation with a peak saturated power output greater than 10 mW (10 dBm) at any frequency exceeding 75 GHz up to and including 90 GHz, and with a "fractional bandwidth" of greater than 5 %; or

8. Rated for operation with a peak saturated power output greater than 0,1 nW (-70 dBm) at any frequency exceeding 90 GHz;

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

1. Current switching for digital circuits using "superconductive" gates with a product of delay time per gate (in seconds) and power dissipation per gate (in watts) of less than 10^{-14} J; or

2. Frequency selection at all frequencies using resonant circuits with Q-values exceeding 10 000.

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

5E501 "Technology" as follows:

f. "Libraries" specially designed or modified to enable equipment to perform the functions of equipment specified in 5A001.h.

NB: For "libraries" specially designed or modified for military use, see the Military Goods Controls.

Part 2 – "**INFORMATION SECURITY"**

Note 1: Not used.

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, 5D002.a.1., 5D002.b. and 5D002.c.1. do not control items as follows:

a. Items that meet all of the following:

1. Generally available to the public by being sold, without restriction, from stock at retail selling points by means of any of the following:

a. Over-the-counter transactions;

b. Mail order transactions;

c. Electronic transactions; or

d. Telephone call transactions;

2. The cryptographic functionality cannot easily be changed by the user;

Note 3: *a.* (*continued*)

3. Designed for installation by the user without further substantial support by the supplier; and

4. When necessary, details of the goods are accessible and will be provided, upon request, to the competent authorities of the EU Member State in which the exporter is established in order to ascertain compliance with conditions described in points 1., 2. and 3.;

b. Hardware components or 'executable software', of existing items described in point a. of this Note, that have been designed for these existing items, meeting all of the following:

1. "Information security" is not the primary function or set of functions of the component or 'executable software';

2. The component or 'executable software' does not change any cryptographic functionality of the existing items, or add new cryptographic functionality to the existing items;

3. The feature set of the component or 'executable software' is fixed and is not designed or modified to customer specification; and

4. When necessary as determined by the competent authorities of the Member State in which the exporter is established, details of the component or 'executable software' and details of relevant end-items are accessible and will be provided to the competent authority upon request, in order to ascertain compliance with conditions described in points 1., 2., and 3.

Technical Note:

For the purposes of the Cryptography Note, 'executable software' means "software" in executable form, from an existing hardware component excluded from 5A002 by the Cryptography Note.

Note: 'Executable software' does not include complete binary images of the "software" running on an end-item.

Note to the Cryptography Note:

1. To meet point a. of Note 3, all of the following must apply:

a. The item is of potential interest to a wide range of individuals and businesses; and

b. The price and information about the main functionality of the item are available before purchase without the need to consult the vendor or supplier. A simple price enquiry is not considered to be a consultation.

2. In determining eligibility of point a. of Note 3, competent authorities may take into account relevant factors such as quantity, price, required technical skill, existing sales channels, typical customers, typical use or any exclusionary practices of the supplier.

5A2 Systems, Equipment and Components

5A002 "Information security" systems, equipment and components, as follows:

NB: For the control of "satellite navigation system" receiving equipment containing or employing decryption, see 7A005.

a. Designed or modified to use 'cryptography for data confidentiality' having a 'described security algorithm', as follows:

1. Items having "information security" as a primary function;

2. Digital communication or networking systems, equipment or components, not specified in 5A002.a.1.;

a. (*continued*)

3. Computers, other items having information storage or processing as a primary function, and components therefor, not specified in 5A002.a.1. or 5A002.a.2.;

NB: *For operating systems, see also 5D002.a.1. and 5D002.c.1.*

4. Items, not specified in 5A002.a.1. to 5A002.a.3., where the 'cryptography for data confidentiality' having a 'described security algorithm' meets all of the following:

a. It supports a non-primary function of the item; and

b. It is performed by incorporated equipment or "software" that would, as a standalone item, be specified in Category 5, Part 2.

Technical Notes:

1. *For the purposes of 5A002.a., 'cryptography for data confidentiality' means "cryptography" that employs digital techniques for a cryptographic function or capability that is usable or can be made usable, other than any of the following:*

a. "Authentication";

b. Digital signature;

c. Data integrity;

d. Non-repudiation;

e. Digital rights management, including the execution of copy-protected "software";

f. Encryption or decryption in support of entertainment, mass commercial broadcasts or medical records management;

g. Wireless "personal area network" functionality implementing only published or commercial cryptographic standards;

h. Cryptographic operations specially designed for and limited to banking use or money transactions, including the collection and settlement of fares or credit functions;

i. Key management in support of and limited to functions and capabilities described in points a. to h.; or

j. Cryptographic functions or capabilities that have not been activated or enabled, and can only be activated or enabled by means of secure "cryptographic activation".

NB: *For 'cryptographic activation token' items, see 5A002.b., 5D002.b. and 5E002.b.*

2. *For the purposes of 5A002.a., 'described security algorithm' means any of the following:*

a. A 'symmetric algorithm' employing a key length in excess of 56 bits, not including parity bits;

Technical Notes:

For the purposes of 5A002.a. Technical Note 2.a.:

1. *'Symmetric algorithm' is a cryptographic algorithm using an identical key for both encryption and decryption.*

2. *A common use of 'symmetric algorithms' is confidentiality of data.*

a. 2. (*continued*)

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 point b.2. in excess of 112 bits (e.g., Diffie-Hellman over an elliptic curve); or

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

1. Shortest vector or closest vector problems associated with lattices (e.g., NewHope, Frodo, NTRUEncrypt, Kyber, Titanium);

2. Finding isogenies between Supersingular elliptic curves (e.g., Supersingular Isogeny Key Encapsulation); or

3. Decoding random codes (e.g., McEliece, Niederreiter).

Technical Note:

An algorithm described by Technical Note 2.c. may be referred to as being post-quantum, quantum-safe or quantum-resistant.

Note 1: When necessary as determined by the appropriate authority in the exporter's country, details of items must be accessible and provided to the authority upon request, in order to establish any of the following:

a. Whether the item meets the criteria of 5A002.a.1. to 5A002.a.4.; or

b. Whether the 'cryptography for data confidentiality' having a 'described security algorithm' is usable without secure "cryptographic activation".

Note 2: 5A002.a. does not control any of the following items, or specially designed "information security" components therefor:

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

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

a. The 'cryptography for data confidentiality' having a 'described security algorithm' meets all of the following:

1. It is restricted for use in equipment or systems to which 5A002.a. does not control for reasons other than the Cryptography Note (Note 3 in Category 5 – Part 2); and

2. It cannot be reprogrammed for any other use; or:

b. Having all of the following:

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

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

3. Where the 'cryptography for data confidentiality' having a 'described security algorithm' is not user-accessible;

Technical Note:

For the purposes of 5A002.a. Note 2.a.1.b.1., 'personal data' includes any data specific to a particular person or entity, such as the amount of money stored and data necessary for "authentication".

a. Note 2: a. (*continued*)

2. *'Readers/writers'.*

Technical Note:

For the purposes of 5A002.a. Note 2.a.2., 'readers/writers' include equipment that communicates with smart cards or electronically readable documents through a network.

b. *Not used;*

c. *Portable or mobile radiotelephones designed for civil use, other than satellite telephones, that are not capable of any of the following:*

1. *Transmitting encrypted data directly to another radiotelephone or equipment (other than Radio Access Network (RAN) equipment); or*

2. *Passing encrypted data through RAN equipment (e.g., Radio Network Controller (RNC) or Base Station Controller (BSC));*

d. *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;*

e. *Portable or mobile radiotelephones and similar client wireless devices, designed for civil use, that have been customised for a specific civil industry application meeting all of the following:*

1. *The non-customised devices satisfy the provisions of the Cryptography Note (Note 3 in Category 5 – Part 2); and*

2. *The 'cryptography for data confidentiality' having a 'described security algorithm' of the non-customised devices is not affected by the customisation, and implements only published or commercial cryptographic standards;*

f. *Not used;*

g. *Mobile telecommunications Radio Access Network (RAN) equipment designed for civil use, which also meet the provisions of points a.2., a.3. and a.4. of the Cryptography Note (Note 3 in Category 5, Part 2), having a Radio Frequency (RF) output power limited to 0,1 W (20 dBm) or less, and supporting 32 or fewer concurrent users;*

h. *Routers, switches, gateways or relays, where the 'cryptography for data confidentiality' having a 'described security algorithm' is limited to the tasks of "Operations, Administration or Maintenance" ("OAM") implementing only published or commercial cryptographic standards;*

i. *General purpose computing equipment or servers, where the 'cryptography for data confidentiality' having a 'described security algorithm' meets all of the following:*

1. *Implements only published or commercial cryptographic standards; and*

2. *Is any of the following:*

a. *Integral to a Central Processing Unit (CPU) that meets the provisions of Note 3 to Category 5, Part 2;*

b. *Integral to an operating system to whitch 5D002 does not control; or*

c. *Limited to "OAM" of the equipment; or*

a. *Note 2:* (*continued*)

j. Items specially designed for a 'connected civil industry application', meeting all of the following:

1. Being any of the following:

a. A network-capable endpoint device meeting any of the following:

1. The 'cryptography for data confidentiality' having a 'described security algorithm' is limited to securing 'non-arbitrary data' or the tasks of "Operations, Administration or Maintenance" ("OAM"); or

2. The device is limited to a specific 'connected civil industry application'; or

b. Networking equipment meeting all of the following:

1. Being specially designed to communicate with the devices specified in point j.1.a.; and

2. The 'cryptography for data confidentiality' having a 'described security algorithm' is limited to supporting the 'connected civil industry application' of devices specified in point j.1.a., or the tasks of "OAM" of this networking equipment or of other items specified in point j. of this Note; and

2. Where the 'cryptography for data confidentiality' having a 'described security algorithm' implements only published or commercial cryptographic standards, and the cryptographic functionality cannot easily be changed by the user.

Technical Notes:

1. For the purposes of 5A002.a. Note 2.j., 'connected civil industry application' means a network connected consumer or civil industry application other than "information security", digital communication, general purpose networking or computing.

2. For the purposes of 5A002.a. Note 2.j.1.a.1., 'non-arbitrary data' means sensor or metering data directly related to the stability, performance or physical measurement of a system (e.g., temperature, pressure, flow rate, mass, volume, voltage, physical location etc.), that cannot be changed by the user of the device.

b. Being a 'cryptographic activation token';

Technical Note:

For the purposes of 5A002.b., a 'cryptographic activation token' is an item designed or modified for any of the following:

1. Converting, by means of "cryptographic activation", an item not specified in Category 5, Part 2 into an item specified in 5A002.a. or 5D002.c.1., and not released by the Cryptography Note (Note 3 in Category 5, Part 2); or

2. Enabling, by means of "cryptographic activation", additional functionality specified in 5A002.a. of an item already specified in Category 5, Part 2.

c. Designed or modified to use or perform "quantum cryptography";

Technical Note:

For the purposes of 5A002.c., "quantum cryptography" is also known as Quantum Key Distribution (QKD).

d. Designed or modified to use cryptographic techniques to generate channelising codes, scrambling codes or network identification codes, for systems using ultra-wideband modulation techniques and having any of the following:

1. A bandwidth exceeding 500 MHz; or

2. A "fractional bandwidth" of 20 % or more;

e. Designed or modified to use cryptographic techniques to generate the spreading code for "spread spectrum" systems, other than those specified in 5A002.d., including the hopping code for "frequency hopping" systems.

5A003 Systems, equipment and components, for non-cryptographic "information security", as follows:

a. Communications cable systems designed or modified to use mechanical, electrical or electronic means to detect surreptitious intrusion;

Note: 5A003.a. only controls physical layer security. For the purpose of 5A003.a., the physical layer includes Layer 1 of the Reference Model of Open Systems Interconnection (OSI) (ISO/IEC 7498-1).

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

5A004 Systems, equipment and components for defeating, weakening or bypassing "information security", as follows:

a. Designed or modified to perform 'cryptanalytic functions'.

Note: 5A004.a. includes systems or equipment, designed or modified to perform 'cryptanalytic functions' by means of reverse engineering.

Technical Note:

For the purposes of 5A004.a., 'cryptanalytic functions' are functions designed to defeat cryptographic mechanisms in order to derive confidential variables or sensitive data, including clear text, passwords or cryptographic keys.

b. Items, not specified in 4A005 or 5A004.a., designed to perform all of the following:

1. 'Extract raw data' from a computing or communications device; and

2. Circumvent "authentication" or authorisation controls of the device, in order to perform the function described in 5A004.b.1.

Technical Note:

For the purposes of 5A004.b.1., 'extract raw data' from a computing or communications device means to retrieve binary data from a storage medium (e.g., RAM, flash or hard disk) of the device without interpretation by the device's operating system or filesystem.

Note 1: 5A004.b. does not control systems or equipment specially designed for the "development" or "production" of a computing or communications device.

Note 2: 5A004.b. does not include:

a. Debuggers, hypervisors;

b. Items limited to logical data extraction;

c. Data extraction items using chip-off or Joint Test Action Group (JTAG); or

d. Items specially designed and limited to jail-breaking or rooting.

5B2 Test, Inspection and Production Equipment

5B002 "Information security" test, inspection and "production" equipment, as follows:

a. Equipment specially designed for the "development" or "production" of equipment specified in 5A002, 5A003, 5A004 or 5B002.b.;

b. Measuring equipment specially designed to evaluate and validate the "information security" functions of the equipment specified in 5A002, 5A003 or 5A004, or of "software" specified in 5D002.a. or 5D002.c.

5C2 **Materials**

None.

5D2 **Software**

5D002 "Software" as follows:

a. "Software" specially designed or modified for the "development", "production" or "use" of any of the following:

1. Equipment specified in 5A002 or "software" specified in 5D002.c.1.;

2. Equipment specified in 5A003 or "software" specified in 5D002.c.2.; or

3. Equipment or "software", as follows:

a. Equipment specified in 5A004.a. or "software" specified in 5D002.c.3.a.;

b. Equipment specified in 5A004.b. or "software" specified in 5D002.c.3.b.

b. "Software" having the characteristics of a 'cryptographic activation token' specified in 5A002.b.;

c. "Software" having the characteristics of, or performing or simulating the functions of, any of the following:

1. Equipment specified in 5A002.a., 5A002.c., 5A002.d. or 5A002.e.;

NB: For decryption "software" relating to "satellite navigation system" receiving equipment, see 7D005.

Note: 5D002.c.1. does not control "software" limited to the tasks of "OAM" implementing only published or commercial cryptographic standards.

2. Equipment specified in 5A003; or

3. Equipment, as follows:

a. Equipment specified in 5A004.a.;

b. Equipment specified in 5A004.b.

Note: 5D002.c.3.b. does not control "intrusion software".

d. Not used.

5E2 Technology

5E002 "Technology" as follows:

a. "Technology" according to the General Technology Note for the "development", "production" or "use" of equipment specified in 5A002, 5A003, 5A004 or 5B002, or of "software" specified in 5D002.a. or 5D002.c.

NB: For decryption "technology" relating to "satellite navigation system" receiving equipment, see 7E001.

Note: 5E002.a. does not control "technology" for items specified in 5A004.b., 5D002.a.3.b. or 5D002.c.3.b.

b. "Technology" having the characteristics of a 'cryptographic activation token' specified in 5A002.b.

Note: 5E002 includes "information security" technical data resulting from procedures carried out to evaluate or determine the implementation of functions, features or techniques specified in Category 5, Part 2.

PART VIII

Category 6

CATEGORY 6 – SENSORS AND LASERS

6A Systems, Equipment and Components

6A001 Acoustic systems, equipment and components, as follows:

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 equipment as follows:*

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

b. Acoustic beacons, as follows:

1. Acoustic emergency beacons;

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

a. Acoustic seabed survey equipment as follows:

Technical Note:

For the purposes of 6A001.a.1.a., 'enhancement' includes the ability to compensate by external means.

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

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

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

c. 'Sounding resolution' less than 2; and

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

1. Motion of the acoustic sensor;

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

3. Sound speed at the sensor;

Technical Note:

For the purposes of 6A001.a.1.a.1.c., 'sounding resolution' is the swath width (degrees) divided by the maximum number of soundings per swath.

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

Technical Note:

For the purposes of 6A001.a.1.a.2., the acoustic sensor pressure rating determines the depth rating.

a. Having all of the following:

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

6A001 a. 1. a. 2. a. (*continued*)

2. 'Sounding rate' greater than 3 800 m/s; or

Technical Note:

For the purposes of 6A001.a.1.a.2.a.2., 'sounding rate' is the product of the maximum speed (m/s) at which the sensor can operate and the maximum number of soundings per swath assuming 100 % coverage. For systems that produce soundings in two directions (3D sonars), the maximum of the 'sounding rate' in either direction should be used.

b. Survey equipment, not specified in 6A001.a.1.a.2.a., having all of the following:

1. Designed or modified to operate at depths exceeding 100 m;

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

3. Having any of the following:

a. Operating frequency below 350 kHz; or

b. Designed to measure seabed topography at a range exceeding 200 m from the acoustic sensor; and

4. 'Enhancement' of the depth "accuracy" through compensation of all of the following:

a. Motion of the acoustic sensor;

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

c. Sound speed at the sensor;

3. Side Scan Sonar (SSS) or Synthetic Aperture Sonar (SAS), designed for seabed imaging and having all of the following, and specially designed transmitting and receiving acoustic arrays therefor:

a. Designed or modified to operate at depths exceeding 500 m;

b. An 'area coverage rate' of greater than 570 m^2/s while operating at the maximum range that it can operate with an 'along track resolution' of less than 15 cm; and

c. An 'across track resolution' of less than 15 cm;

Technical Notes:

For the purposes of 6A001.a.1.a.3.:

1. 'Area coverage rate' (m^2/s) is twice the product of the sonar range (m) and the maximum speed (m/s) at which the sensor can operate at that range.

2. 'Along track resolution' (cm), for SSS only, is the product of azimuth (horizontal) beamwidth (degrees) and sonar range (m) and 0,873.

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

b. Systems or transmitting and receiving arrays, designed for object detection or location, having any of the following:

NB: For acoustic seabed survey equipment, see 6A001.a.1.a.

1. A transmitting frequency below 10 kHz;

2. Sound pressure level exceeding 224 dB (reference 1 µPa at 1 m) for equipment with an operating frequency in the band from 10 kHz to 24 kHz inclusive;

6A001 a. 1. b. (*continued*)

3. Sound pressure level exceeding 235 dB (reference 1 μPa at 1 m) for equipment with an operating frequency in the band between 24 kHz and 30 kHz;

4. Forming beams of less than 1° on any axis and having an operating frequency of less than 100 kHz;

5. Designed to operate with an unambiguous display range exceeding 5 120 m; or

6. Designed to withstand pressure during normal operation at depths exceeding 1 000 m and having transducers with any of the following:

a. Dynamic compensation for pressure; or

b. Incorporating other than lead zirconate titanate as the transduction element;

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

Note 1: *The control status of acoustic projectors, including transducers, specially designed for other equipment not specified in 6A001 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.*

Note 3: *Piezoelectric elements specified in 6A001.a.1.c. include those made from lead-magnesium-niobate/lead-titanate ($Pb(Mg_{1/3}Nb_{2/3})O_3$-$PbTiO_3$, or PMN-PT) single crystals grown from solid solution or lead-indium-niobate/lead-magnesium niobate/lead-titanate ($Pb(In_{1/2}Nb_{1/2})O_3$-$Pb(Mg_{1/3}Nb_{2/3})O_3$-$PbTiO_3$, or PIN-PMN-PT) single crystals grown from solid solution.*

1. Operating at frequencies below 10 kHz and having any of the following:

a. Not designed for continuous operation at 100 % duty cycle and having a radiated 'free-field Source Level (SL_{RMS})' exceeding (10log(f) + 169,77) dB (reference 1 μPa at 1 m) where f is the frequency in Hertz of maximum Transmitting Voltage Response (TVR) below 10kHz; or

b. Designed for continuous operation at 100 % duty cycle and having a continuously radiated 'free-field Source Level (SL_{RMS})' at 100 % duty cycle exceeding (10log(f) + 159,77) dB (reference 1 μPa at 1 m) where f is the frequency in Hertz of maximum Transmitting Voltage Response (TVR) below 10kHz; or

Technical Note:

For the purposes of 6A001.a.1.c.1., the 'free-field Source Level (SL_{RMS})' is defined along the maximum response axis and in the far field of the acoustic projector. It can be obtained from the Transmitting Voltage Response using the following equation: SL_{RMS} = (TVR + 20log V_{RMS}) dB (ref 1μPa at 1 m), where SL_{RMS} is the source level, TVR is the Transmitting Voltage Response and V_{RMS} is the Driving Voltage of the Projector.

2. Not used;

3. Side-lobe suppression exceeding 22 dB;

6A001 a. 1. (*continued*)

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

1. Detection range exceeding 1 000 m; and

2. Determined position error 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 submersible *vehicle;*

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

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

1. Detection range exceeding 530 m;

2. Determined position error of less than 15 m rms (root mean square) when measured at a range of 530 m; and

3. Transmitted pulse signal bandwidth exceeding 3 kHz;

NB: *For diver detection systems specially designed or modified for military use, see the Military Goods Controls.*

Note: *For 6A001.a.1.e., where multiple detection ranges are specified for various environments, the greatest detection range is used.*

2. Passive systems, equipment and specially designed components therefor, as follows:

Note: *6A001.a.2. also controls receiving equipment, whether or not related in normal application to separate active equipment, and specially designed components therefor.*

a. Hydrophones having any of the following:

Note: *The control status of hydrophones specially designed for other equipment is determined by the control status of the other equipment.*

Technical Notes:

For the purposes of 6A001.a.2.a.:

1. Hydrophones consist of one or more sensing elements producing a single acoustic output channel. Those that contain multiple elements can be referred to as a hydrophone group.

2. Underwater acoustic transducers designed to operate as passive receivers are hydrophones.

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;

6A001 a. 2. a. (*continued*)

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)};

c. 'Flexible piezoelectric composites';

d. Lead-magnesium-niobate/lead-titanate (i.e., $Pb(Mg_{1/3}Nb_{2/3})O_3$-$PbTiO_3$, or PMN-PT) piezoelectric single crystals grown from solid solution; or

e. Lead-indium-niobate/lead-magnesium niobate/lead-titanate (i.e., $Pb(In_{1/2}Nb_{1/2})O_3$-$Pb(Mg_{1/3}Nb_{2/3})O_3$-$PbTiO_3$, or PIN-PMN-PT) piezoelectric single crystals grown from solid solution;

4. A 'hydrophone sensitivity' greater (better) than -180 dB at any depth with no acceleration compensation;

5. Designed to operate at depths exceeding 35 m with acceleration compensation; or

6. Designed for operation at depths exceeding 1 000 m and having a 'hydrophone sensitivity' greater (better) than -230 dB below 4 kHz;

Technical Notes:

1. For the purposes of 6A001.a.2.a.3.b., 'piezoelectric polymer film' sensing elements consist of polarised polymer film that is stretched over and attached to a supporting frame or spool (mandrel).

2. For the purposes of 6A001.a.2.a.3.c., '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. For the purposes of 6A001.a.2.a., 'hydrophone sensitivity' is defined as twenty times the logarithm to the base 10 of the ratio of rms output voltage to a 1 V rms reference, when the hydrophone sensor, without a pre-amplifier, is placed in a plane wave acoustic field with an rms pressure of 1 μPa. For example, a hydrophone of -160 dB (reference 1 V per μPa) would yield an output voltage of 10^{-8} V in such a field, while one of -180 dB sensitivity would yield only 10^{-9} V output. Thus, -160 dB is better than -180 dB.

b. Towed acoustic hydrophone arrays having any of the following:

Technical Note:

For the purposes of 6A001.a.2.b., hydrophone arrays consist of a number of hydrophones providing multiple acoustic output channels.

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;

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. Not used;

6A001 a. 2. b. (*continued*)

7. Hydrophone characteristics specified in 6A001.a.2.a.; or

8. Accelerometer-based hydro-acoustic sensors specified in 6A001.a.2.g.;

Technical Note:

For the purposes of 6A001.a.2.b., 'able to be modified' means having provisions to allow a change of the wiring or interconnections to alter hydrophone group spacing or operating depth limits. These provisions are: spare wiring exceeding 10 % of the number of wires, hydrophone group spacing adjustment blocks or internal depth limiting devices that are adjustable or that control more than one hydrophone group.

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

d. Heading sensors having all of the following:

1. An "accuracy" of less (better) than 0,5°; and

2. Designed to operate at depths exceeding 35 m or having an adjustable or removable depth sensing device in order to operate at depths exceeding 35 m;

NB: For inertial heading systems, see 7A003.c.

e. Bottom or bay-cable hydrophone arrays, having any of the following:

1. Incorporating hydrophones specified in 6A001.a.2.a.;

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; or

3. Incorporating accelerometer-based hydro-acoustic sensors specified in 6A001.a.2.g.;

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

g. Accelerometer-based hydro-acoustic sensors having all of the following:

1. Composed of three accelerometers arranged along three distinct axes;

2. Having an overall 'acceleration sensitivity' greater (better) than 48 dB (reference 1 000 mV rms per 1g);

3. Designed to operate at depths greater than 35 meters; and

4. Operating frequency below 20 kHz.

Note: 6A001.a.2.g. does not control particle velocity sensors or geophones.

6A001 a. 2. g. (*continued*)

Technical Notes:

1. For the purposes of 6A001.a.2.g., accelerometer-based hydro-acoustic sensors are also known as vector sensors.

2. For the purposes of 6A001.a.2.g.2., 'acceleration 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 hydro-acoustic sensor, without a preamplifier, is placed in a plane wave acoustic field with an rms acceleration of 1 g (i.e., 9,81 m/s^2).

b. Correlation-velocity and Doppler-velocity sonar log equipment, designed to measure the horizontal speed of the equipment carrier relative to the seabed, as follows:

1. Correlation-velocity sonar log equipment having any of the following characteristics:

a. Designed to operate at distances between the carrier and the seabed exceeding 500 m; or

b. Having speed "accuracy" less (better) than 1 % of speed;

2. Doppler-velocity sonar log equipment having speed "accuracy" less (better) than 1 % of speed.

Note 1: 6A001.b. does not control depth sounders limited to any of the following:

a. Measuring the depth of water;

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

c. Fish finding.

Note 2: 6A001.b. does not control equipment specially designed for installation on surface vessels.

c. Not used.

6A002 Optical sensors or equipment and components therefor, as follows:

NB: SEE ALSO 6A102.

a. Optical detectors as follows:

1. "Space-qualified" solid-state detectors as follows:

Note: For the purpose of 6A002.a.1., solid-state detectors include "focal plane arrays".

a. "Space-qualified" solid-state detectors having all of the following:

1. A peak response in the wavelength range exceeding 10 nm but not exceeding 300 nm; and

2. A response of less than 0,1 % relative to the peak response at a wavelength exceeding 400 nm;

b. "Space-qualified" solid-state detectors having all of the following:

1. A peak response in the wavelength range exceeding 900 nm but not exceeding 1 200 nm; and

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

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

6A002 a. 1. (*continued*)

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

2. Image intensifier tubes and specially designed components therefor, as follows:

Note: *6A002.a.2. does not control non-imaging photomultiplier tubes having an electron sensing device in the vacuum space limited solely to any of the following:*

a. A single metal anode; or

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

a. Image intensifier tubes having all of the following:

1. A peak response in the wavelength range exceeding 400 nm but not exceeding 1 050 nm;

2. Electron image amplification using any of the following:

a. A microchannel plate with a hole pitch (centre-to-centre spacing) of 12 µm or less; or

b. An electron sensing device with a non-binned pixel pitch of 500 µm or less, specially designed or modified to achieve "charge multiplication" other than by a microchannel plate; and

3. Any of the following photocathodes:

a. Multialkali photocathodes (e.g., S-20 and S-25) having a luminous sensitivity exceeding 350 µA/lm;

b. GaAs or GaInAs photocathodes; or

c. Other "III/V compound" semiconductor photocathodes having a maximum "radiant sensitivity" exceeding 10 mA/W;

b. Image intensifier tubes having all of the following:

1. A peak response in the wavelength range exceeding 1 050 nm but not exceeding 1 800 nm;

2. Electron image amplification using any of the following:

a. A microchannel plate with a hole pitch (centre-to-centre spacing) of 12 µm or less; or

b. An electron sensing device with a non-binned pixel pitch of 500 µm or less, specially designed or modified to achieve "charge multiplication" other than by a microchannel plate; and

3. "III/V compound" semiconductor (e.g., GaAs or GaInAs) photocathodes and transferred electron photocathodes, having a maximum "radiant sensitivity" exceeding 15 mA/W;

c. Specially designed components as follows:

1. Microchannel plates having a hole pitch (centre-to-centre spacing) of 12 µm or less;

2. An electron sensing device with a non-binned pixel pitch of 500 µm or less, specially designed or modified to achieve "charge multiplication" other than by a microchannel plate;

6A002 a. 2. c. (*continued*)

3. "III/V compound" semiconductor (e.g., GaAs or GaInAs) photocathodes and transferred electron photocathodes;

Note: *6A002.a.2.c.3. does not control compound semiconductor photocathodes designed to achieve a maximum "radiant sensitivity" of any of the following:*

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

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

3. Non-"space-qualified" "focal plane arrays" as follows:

NB: *'Microbolometer' non-"space-qualified" "focal plane arrays" are only specified in 6A002.a.3.f.*

Technical Note:

For the purposes of 6A002.a.3., linear or two-dimensional multi-element detector arrays are referred to as "focal plane arrays".

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

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

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

b. Pyroelectric detectors using any of the following:

1. Triglycine sulphate and variants;

2. Lead-lanthanum-zirconium titanate and variants;

3. Lithium tantalate;

4. Polyvinylidene fluoride and variants; or

5. Strontium barium niobate and variants;

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

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

2. Any of the following:

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

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

Technical Note:

For the purposes of 6A002.a.3. Note 2.c.2.a., a response limiting mechanism integral to the detector element is designed not to be removed or modified without rendering the detector inoperable.

d. Thermopile arrays having less than 5 130 elements.

6A002 a. 3. (*continued*)

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

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

2. Any of the following:

a. A response "time constant" of less than 0,5 ns; or

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

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

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

2. Any of the following:

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

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

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

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

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

1. Individual elements with a peak response in the wavelength range exceeding 1 200 nm but not exceeding 3 000 nm; and

2. Any of the following:

a. A ratio of 'scan direction' dimension of the detector element to the 'cross-scan direction' dimension of the detector element of less than 3,8; or

b. Signal processing in the detector elements;

Note: 6A002.a.3.d. does not control "focal plane arrays" with 32 elements or fewer, where all the detector elements are made from germanium.

Technical Notes:

For the purposes of 6A002.a.3.d.2.a:

1. 'Scan direction' is defined as the axis perpendicular to the linear array of detector elements.

2. 'Cross-scan direction' is defined as the axis parallel to the linear array of detector elements.

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

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

6A002 a. 3. f. (*continued*)

Technical Note:

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

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

1. Individual detector elements with a peak response in the wavelength range exceeding 400 nm but not exceeding 900 nm;

2. Specially designed or modified to achieve "charge multiplication" and having a maximum "radiant sensitivity" exceeding 10 mA/W for wavelengths exceeding 760 nm; and

3. Greater than 32 elements;

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

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

2. Specified for operation in the wavelength range exceeding 400 nm but not exceeding 30 000 nm and having all the following:

a. Providing output imaging data in digital format; and

b. Having any of the following characteristics:

1. "Space-qualified"; or

2. Designed for airborne operation, using other than silicon detectors, and having an IFOV of less than 2,5 mrad (milliradians);

Note: *6A002.b.1. does not control "monospectral imaging sensors" with a peak response in the wavelength range exceeding 300 nm but not exceeding 900 nm and only incorporating any of the following non–"space-qualified" detectors or non–"space-qualified" "focal plane arrays":*

1. Charge Coupled Devices (CCD) not designed or modified to achieve "charge multiplication"; or

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

c. 'Direct view' imaging equipment incorporating any of the following:

1. Image intensifier tubes specified in 6A002.a.2.a. or 6A002.a.2.b.;

2. "Focal plane arrays" specified in 6A002.a.3.; or

3. Solid-state detectors specified in 6A002.a.1.;

Technical Note:

For the purposes of 6A002.c., 'direct view' refers to imaging equipment that presents a visual image to a human observer without converting the image into an electronic signal for television display, and that cannot record or store the image photographically, electronically or by any other means.

Note: *6A002.c. does not control equipment as follows, when incorporating other than GaAs or GaInAs photocathodes:*

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

b. Medical equipment;

6A002 c. *Note:* (*continued*)

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;

Note 1: 6A002.d.3. does not control encapsulated optical sensing fibres specially designed for bore hole sensing applications.

Note 2: 6A002.d.3. does not control optical fibre Bragg gratings specially designed for thermal sensing, having a maximum sensing temperature less than 423 K (150 °C) and a minimum sensing temperature greater than 173 K (– 100 °C).

e. Not used.

f. 'Read-Out Integrated Circuits' ('ROIC') specially designed for "focal plane arrays" specified in 6A002.a.3.

Note: 6A002.f. does not control 'Read-Out Integrated Circuit' ('ROIC') specially designed for civil automotive applications.

Technical Note:

For the purposes of 6A002.f., a 'Read-Out Integrated Circuit' ('ROIC') is an integrated circuit designed to underlie or be bonded to a "focal plane array" and used to read-out (i.e., extract and register) signals produced by the detector elements. At a minimum the 'ROIC' reads the charge from the detector elements by extracting the charge and applying a multiplexing function in a manner that retains the relative spatial position and orientation information of the detector elements for processing inside or outside the 'ROIC'.

6A003 Cameras, systems or equipment, and components therefor, as follows:

NB: SEE ALSO 6A203.

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. Not used;

2. Not used;

3. Electronic streak cameras having temporal resolution less (better) than 50 ns;

4. Electronic framing cameras having a speed exceeding 1 000 000 frames/s;

5. Electronic cameras having all of the following:

a. An electronic shutter speed (gating capability) of less than 1 µs per full frame; and

b. A read out time allowing a framing rate of more than 125 full frames per second;

6A003 a. (*continued*)

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;

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 x 10^6 "active pixels" per solid-state array for monochrome (black and white) cameras;

2. More than 4 x 10^6 "active pixels" per solid-state array for colour cameras incorporating three solid-state arrays; or

3. More than 12 x 10^6 "active pixels" for solid-state array colour cameras incorporating one solid-state array; and

b. Having any of the following:

1. Optical mirrors specified in 6A004.a.;

2. Optical control equipment specified in 6A004.d.; or

3. The capability for annotating internally generated 'camera tracking data';

Technical Notes:

1. For the purposes of 6A003.b.1., digital video cameras should be evaluated by the maximum number of "active pixels" used for capturing moving images.

2. For the purposes of 6A003.b.1.b.3., '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;

Note: *6A003.b.2. does not control scanning cameras and scanning camera systems, specially designed for any of the following:*

a. Industrial or civilian photocopiers;

b. Image scanners specially designed for civil, stationary, close proximity scanning applications (e.g., reproduction of images or print contained in documents, artwork or photographs); or

c. Medical equipment.

6A003 b. (*continued*)

3. Imaging cameras incorporating image intensifier tubes specified in 6A002.a.2.a. or 6A002.a.2.b.;

4. Imaging cameras, not specified in 6A002.b., incorporating "focal plane arrays" having any of the following:

   a. Incorporating "focal plane arrays" specified in 6A002.a.3.a. to 6A002.a.3.e.;

   b. Incorporating "focal plane arrays" specified in 6A002.a.3.f.; or

   c. Incorporating "focal plane arrays" specified in 6A002.a.3.g.;

Note 1: *Imaging cameras specified 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 12 elements or fewer, not employing time-delay-and-integration within the element and designed for any of the following:*

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

b. Industrial equipment used for inspection or monitoring of heat flows in buildings, equipment or industrial processes;

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

d. Equipment specially designed for laboratory use; or

e. Medical equipment.

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

a. A maximum frame rate equal to or less than 9 Hz;

b. Having all of the following:

1. Having a minimum horizontal or vertical 'Instantaneous Field of View (IFOV)' of at least 2 mrad (milliradians);

Technical Note:

For the purposes of 6A003.b.4. Note 3.b.1., 'Instantaneous Field of View (IFOV)' 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. 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

6A003 b. 4. Note 3: (*continued*)

c. The camera is specially designed for installation into a civilian passenger land vehicle and having all of the following:

1. The placement and configuration of the camera within the vehicle are solely to assist the driver in the safe operation of the vehicle;

2. Is only operable when installed in any of the following:

a. The civilian passenger land vehicle for which it was intended and the vehicle weighs less than 4 500 kg (gross vehicle weight); or

b. A specially designed, authorised maintenance test facility; and

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

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

a. Having all of the following:

1. Where the camera is specially designed for installation as an integrated component into indoor and wall-plug-operated systems or equipment, limited by design for a single kind of application, as follows;

a. Industrial process monitoring, quality control, or analysis of the properties of materials;

b. Laboratory equipment specially designed for scientific research;

c. Medical equipment;

d. Financial fraud detection equipment;

2. Is only operable when installed in any of the following:

a. The system(s) or equipment for which it was intended; or

b. A specially designed, authorised maintenance facility; and

3. Incorporates an active mechanism that forces the camera not to function when it is removed from the system(s) or equipment for which it was intended;

b. Where the camera is specially designed for installation into a civilian passenger land vehicle or passenger and vehicle ferries, and having all of the following:

1. The placement and configuration of the camera within the vehicle or ferry is solely to assist the driver or operator in the safe operation of the vehicle or ferry;

2. Is only operable when installed in any of the following:

a. The civilian passenger land vehicle for which it was intended and the vehicle weighs less than 4 500 kg (gross vehicle weight);

b. The passenger and vehicle ferry for which it was intended and having a Length Overall (LOA) 65 m or greater; or

c. A specially designed, authorised maintenance test facility; and

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

6A003 b. 4. *Note 4:* (*continued*)

c. Limited by design to have a maximum "radiant sensitivity" of 10 mA/W or less for wavelengths exceeding 760 nm, having all of the following:

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

2. Incorporates an active mechanism that forces the camera not to function when the response limiting mechanism is removed; and

3. Not specially designed or modified for underwater use: or

d. Having all of the following:

1. Not incorporating a 'direct view' or electronic image display;

2. Has no facility to output a viewable image of the detected field of view;

3. The "focal plane array" is only operable when installed in the camera for which it was intended; and

4. The "focal plane array" incorporates an active mechanism that forces it to be permanently inoperable when removed from the camera for which it was intended.

Technical Note:

For the purposes of 6A003.b.4., '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.

5. Imaging cameras incorporating solid-state detectors specified in 6A002.a.1.

6A004 Optical equipment and components, as follows:

a. Optical mirrors (reflectors) as follows:

Technical Note:

For the purposes of 6A004.a., Laser Induced Damage Threshold (LIDT) is measured according to ISO 21254-1:2011.

NB: For optical mirrors specially designed for lithography equipment, see 3B001.

1. 'Deformable mirrors' having an active optical aperture greater than 10 mm and having any of the following, and specially designed components therefor,

a. Having all the following:

1. A mechanical resonant frequency of 750 Hz or more; and

2. More than 200 actuators; or

b. A Laser Induced Damage Threshold (LIDT) being any of the following:

1. Greater than 1 kW/ cm^2 using a "Continuous Wave (CW) laser"; or

2. Greater than 2 J/ cm^2 using 20 ns "laser" pulses at 20 Hz repetition rate;

Technical Notes:

For the purposes of 6A004.a.1.:

'Deformable mirrors' are mirrors having any of the following:

1. 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

6A004 a. 1. *1.* (*continued*)

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.

2. 'Deformable mirrors' are also known as adaptive optic mirrors.

2. Lightweight monolithic mirrors having an average "equivalent density" of less than 30 kg/m^2 and a total mass exceeding 10 kg;

Note: 6A004.a.2. does not control mirrors specially designed to direct solar radiation for terrestrial heliostat installations.

3. Lightweight "composite" or foam mirror structures having an average "equivalent density" of less than 30 kg/m^2 and a total mass exceeding 2 kg;

Note: 6A004.a.3. does not control mirrors specially designed to direct solar radiation for terrestrial heliostat installations.

4. Mirrors specially designed for beam steering mirror stages specified in 6A004.d.2.a. with a flatness of λ/10 or better (λ is equal to 633 nm)and having any of the following:

a. Diameter or major axis length greater than or equal to 100 mm; or

b. Having all of the following:

1. Diameter or major axis length greater than 50 mm but less than 100 mm; and

2. A Laser Induced Damage Threshold (LIDT) being any of the following:

a. Greater than 10 kW/cm^2 using a "CW laser"; or

b. Greater than 20 J/cm^2 using 20 ns "laser" pulses at 20 Hz repetition rate;

b. Optical components made from zinc selenide (ZnSe) or zinc sulphide (ZnS) with transmission in the wavelength range exceeding 3 000 nm but not exceeding 25 000 nm and having any of the following:

1. Exceeding 100 cm^3 in volume; or

2. Exceeding 80 mm in diameter or length of major axis and 20 mm in thickness (depth);

c. "Space-qualified" components for optical systems, as follows:

1. Components lightweighted to less than 20 % "equivalent density" compared with a solid blank of the same aperture and thickness;

2. Raw substrates, processed substrates having surface coatings (single-layer or multi-layer, metallic or dielectric, conducting, semiconducting or insulating) or having protective films;

3. Segments or assemblies of mirrors designed to be assembled in space into an optical system with a collecting aperture equivalent to or larger than a single optic 1 m in diameter;

4. Components manufactured from "composite" materials having a coefficient of linear thermal expansion, in any coordinate direction, equal to or less than 5 x 10^{-6}/K;

d. Optical control equipment as follows:

1. Equipment specially designed to maintain the surface figure or orientation of the "space-qualified" components specified in 6A004.c.1. or 6A004.c.3.;

6A004 d. (*continued*)

2. Steering, tracking, stabilisation and resonator alignment equipment as follows:

a. Beam steering mirror stages designed to carry mirrors having diameter or major axis length greater than 50 mm and having all of the following, and specially designed electronic control equipment therefor:

1. A maximum angular travel of ± 26 mrad or more;

2. A mechanical resonant frequency of 500 Hz or more; and

3. An angular "accuracy" of 10 µrad (microradians) or less (better);

b. Resonator alignment equipment having bandwidths equal to or more than 100 Hz and an "accuracy" of 10 µrad or less (better);

3. Gimbals having all of the following:

a. A maximum slew exceeding 5°;

b. A bandwidth of 100 Hz or more;

c. Angular pointing errors of 200 µrad (microradians) or less; and

d. Having any of the following:

1. Exceeding 0,15 m but not exceeding 1 m in diameter or major axis length and capable of angular accelerations exceeding 2 rad (radians)/s^2; or

2. Exceeding 1 m in diameter or major axis length and capable of angular accelerations exceeding 0,5 rad (radians)/s^2;

4. Not used;

e. 'Aspheric optical elements' having all of the following:

1. Largest dimension of the optical-aperture greater than 400 mm;

2. Surface roughness less than 1 nm (rms) for sampling lengths equal to or greater than 1 mm; and

3. Coefficient of linear thermal expansion's absolute magnitude less than 3 x 10^{-6}/K at 25 °C.

Technical Notes:

1. For the purposes of 6A004.e., an 'aspheric optical element' is any element used in an optical system whose imaging surface or surfaces are designed to depart from the shape of an ideal sphere.

2. For the purposes of 6A004.e.2., manufacturers are not required to measure the surface roughness 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. Largest optical-aperture dimension less than 1 m and focal length to aperture ratio equal to or greater than 4,5:1;

b. Largest optical-aperture dimension equal to or greater than 1 m and focal length to aperture ratio equal to or greater than 7:1;

c. Designed as Fresnel, flyeye, stripe, prism or diffractive optical elements;

d. Fabricated from borosilicate glass having a coefficient of linear thermal expansion greater than 2,5 x 10^{-6}/K at 25 °C; or

e. An X-ray optical element having inner mirror capabilities (e.g., tube-type mirrors).

NB: For 'aspheric optical elements' specially designed for lithography equipment, see 3B001.

6A004 (*continued*)

f. Dynamic wavefront measuring equipment having all of the following:

1. 'Frame rates' equal to or more than 1 kHz; and

2. A wavefront accuracy equal to or less (better) than λ/20 at the designed wavelength.

Technical Note:

For the purposes of 6A004.f., 'frame rate' is a frequency at which all "active pixels" in the "focal plane array" are integrated for recording images projected by the wavefront sensor optics.

6A005 "Lasers", other than those specified in 0B001.g.5. or 0B001.h.6., components and optical equipment, as follows:

NB: *SEE ALSO 6A205.*

Note 1: *Pulsed "lasers" include those that run in a Continuous Wave (CW) mode with pulses superimposed.*

Note 2: *Excimer, semiconductor, chemical, CO, CO_2, and "non-repetitive pulsed" Nd:glass "lasers" are only specified in 6A005.d.*

Note 3: *6A005 includes fibre "lasers".*

Note 4: *The control status of "lasers" incorporating frequency conversion (i.e., wavelength change) by means other than one "laser" pumping another "laser" is determined by applying the control parameters for both the output of the source "laser" and the frequency-converted optical output.*

Note 5: *6A005 does not control "lasers" as follows:*

a. *Ruby with output energy below 20 J;*

b. *Nitrogen;*

c. *Krypton.*

Technical Note:

For the purposes of 6A005.a. and 6A005.b., 'single transverse mode' refers to "lasers" with a beam profile having an M^2-factor of less than 1,3, while 'multiple transverse mode' refers to "lasers" with a beam profile having an M^2-factor equal to or greater than 1,3.

a. Non-"tunable" "Continuous Wave (CW) lasers" having any of the following:

1. Output wavelength less than 150 nm and output power exceeding 1 W;

2. Output wavelength of 150 nm or more but not exceeding 510 nm and output power exceeding 30 W;

Note: *6A005.a.2. does not control Argon "lasers" having an output power equal to or less than 50 W.*

3. Output wavelength exceeding 510 nm but not exceeding 540 nm and any of the following:

a. 'Single transverse mode' output and output power exceeding 50 W; or

b. 'Multiple transverse mode' output and output power exceeding 150 W;

4. Output wavelength exceeding 540 nm but not exceeding 800 nm and output power exceeding 30 W;

6A005 a. (*continued*)

5. Output wavelength exceeding 800 nm but not exceeding 975 nm and any of the following:

   a. 'Single transverse mode' output and output power exceeding 50 W; or

   b. 'Multiple transverse mode' output and output power exceeding 80 W;

6. Output wavelength exceeding 975 nm but not exceeding 1 150 nm and any of the following:

   a. 'Single transverse mode' output and any of the following:

      1. Output power exceeding 2 kW; or

      2. Having all of the following:

         a. Output power exceeding 500 W; and

         b. Spectral bandwidth less than 40 GHz; or

      3. Having all of the following:

         a. Output power exceeding 1,5 kW; and

         b. Spectral bandwidth greater than or equal to 40 GHz and less than 100 GHz; or

   b. 'Multiple transverse mode' output and any of the following:

      1. Not used

      2. Output power exceeding3 kW;

      Note 1: *6A005.a.6.b. does not control 'multiple transverse mode', industrial "lasers" with output power exceeding 3 kW and not exceeding 6 kW with a total mass greater than 1 200 kg. For the purposes of this Note, total mass includes all components required to operate the "laser", e.g., "laser", power supply, heat exchanger, but excludes external optics for beam conditioning or delivery.*

      Note 2: *6A005.a.6.b. does not control 'multiple transverse mode', industrial "lasers" having any of the following:*

         a. Not used;

         b. Not used;

         c. Not used;

         d. Not used;

         e. Output power exceeding 3 kW but not exceeding 12 kW and having a Beam Parameter Product (BPP) exceeding 3,2 mm•mrad;

         f. Not used;

         g. Not used;

         h. Output power exceeding 12 kW but not exceeding 20 kW and having a BPP exceeding 3,9 mm•mrad; or

         i. Output power exceeding 20 kW but not exceeding 40 kW and having a BPP exceeding 5 mm•mrad.

7. Output wavelength exceeding 1 150 nm but not exceeding 1 555 nm and any of the following:

   a. 'Single transverse mode' and output power exceeding 50 W; or

   b. 'Multiple transverse mode' and output power exceeding 80 W;

8. Output wavelength exceeding 1 555 nm but not exceeding 1 850 nm and output power exceeding 1 W;

6A005 a. (*continued*)

9. Output wavelength exceeding 1 850 nm but not exceeding 2 100 nm, and any of the following:

a. 'Single transverse mode' and output power exceeding 1 W; or

b. 'Multiple transverse mode' output and output power exceeding 120 W; or

10. Output wavelength exceeding 2 100 nm and output power exceeding 1 W;

b. Non-"tunable" 'pulsed lasers' having any of the following:

Technical Note:

For the purposes of 6A005.b., a 'pulsed laser' is a "laser" having a "pulse duration" that is less than or equal to 0,25 seconds.

1. Output wavelength less than 150 nm and any of the following:

a. Output energy exceeding 50 mJ per pulse and "peak power" exceeding 1 W; or

b. "Average output power" exceeding 1 W;

2. Output wavelength of 150 nm or more but not exceeding 510 nm and any of the following:

a. Output energy exceeding 1,5 J per pulse and "peak power" exceeding 30 W; or

b. "Average output power" exceeding 30 W;

Note: 6A005.b.2.b. does not control Argon "lasers" having an "average output power" equal to or less than 50 W.

3. Output wavelength exceeding 510 nm but not exceeding 540 nm and any of the following:

a. 'Single transverse mode' output and any of the following:

1. Output energy exceeding 1,5 J per pulse and "peak power" exceeding 50 W; or

2. "Average output power" exceeding 80 W; or

b. 'Multiple transverse mode' output and any of the following:

1. Output energy exceeding 1,5 J per pulse and "peak power" exceeding 150 W; or

2. "Average output power" exceeding 150 W;

4. Output wavelength exceeding 540 nm but not exceeding 800 nm and any of the following:

a. "Pulse duration" less than 1 ps and any of the following:

1. Output energy exceeding 0,005 J per pulse and "peak power" exceeding 5 GW; or

2. "Average output power" exceeding 20 W; or

b. "Pulse duration" equal to or exceeding 1 ps and any of the following:

1. Output energy exceeding 1,5 J per pulse and "peak power" exceeding 30 W; or

2. "Average output power" exceeding 30 W;

5. Output wavelength exceeding 800 nm but not exceeding 975 nm and any of the following:

a. "Pulse duration" less than 1 ps and any of the following:

1. Output energy exceeding 0,005 J per pulse and "peak power" exceeding 5 GW; or

2. 'Single transverse mode' output and "average output power" exceeding 20 W;

6A005 b. 5. (*continued*)

b. "Pulse duration" equal to or exceeding 1 ps and not exceeding 1 μs and any of the following:

1. Output energy exceeding 0,5 J per pulse and "peak power" exceeding 50 W;

2. 'Single transverse mode' output and "average output power" exceeding 20 W; or

3. 'Multiple transverse mode' output and "average output power" exceeding 50 W; or

c. "Pulse duration" exceeding 1 μs and any of the following:

1. Output energy exceeding 2 J per pulse and "peak power" exceeding 50 W;

2. 'Single transverse mode' output and "average output power" exceeding 50 W; or

3. 'Multiple transverse mode' output and "average output power" exceeding 80 W;

6. Output wavelength exceeding 975 nm but not exceeding 1 150 nm and any of the following:

a. "Pulse duration" of less than 1 ps, and any of the following:

1. Output "peak power" exceeding 2 GW per pulse;

2. "Average output power" exceeding 30 W; or

3. Output energy exceeding 0,002 J per pulse;

b. "Pulse duration" equal to or exceeding 1 ps and less than 1 ns and any of the following:

1. Output "peak power" exceeding 5 GW per pulse;

2. "Average output power" exceeding 50 W; or

3. Output energy exceeding 0,1 J per pulse;

c. "Pulse duration" equal to or exceeding 1 ns but not exceeding 1 μs, and any of the following:

1. 'Single transverse mode' output and any of the following:

a. "Peak power" exceeding 100 MW;

b. "Average output power" exceeding 20 W limited by design to a maximum pulse repetition frequency less than or equal to 1 kHz;

c. "Wall-plug efficiency" exceeding 12 %, "average output power" exceeding 100 W and capable of operating at a pulse repetition frequency greater than 1 kHz;

d. "Average output power" exceeding 150 W and capable of operating at a pulse repetition frequency greater than 1 kHz; or

e. Output energy exceeding 2 J per pulse; or

2. 'Multiple transverse mode' output and any of the following:

a. "Peak power" exceeding 400 MW;

b. "Wall-plug efficiency" exceeding 18 % and "average output power" exceeding 500 W;

c. "Average output power" exceeding 2 kW; or

d. Output energy exceeding 4 J per pulse; or

6A005 b. 6. (*continued*)

d. "Pulse duration" exceeding 1 μs and any of the following:

1. 'Single transverse mode' output and any of the following:

a. "Peak power" exceeding 500 kW;

b. "Wall-plug efficiency" exceeding 12 % and "average output power" exceeding 100 W; or

c. "Average output power" exceeding 150 W; or

2. 'Multiple transverse mode' output and any of the following:

a. "Peak power" exceeding 1 MW;

b. "Wall-plug efficiency" exceeding 18 % and "average output power" exceeding 500 W; or

c. "Average output power" exceeding 2 kW;

7. Output wavelength exceeding 1 150 nm but not exceeding 1 555 nm, and any of the following:

a. "Pulse duration" not exceeding 1 μs and any of the following:

1. Output energy exceeding 0,5 J per pulse and "peak power" exceeding 50 W;

2. 'Single transverse mode' output and "average output power" exceeding 20 W; or

3. 'Multiple transverse mode' output and "average output power" exceeding 50 W; or

b. "Pulse duration" exceeding 1 μs and any of the following:

1. Output energy exceeding 2 J per pulse and "peak power" exceeding 50 W;

2. 'Single transverse mode' output and "average output power" exceeding 50 W; or

3. 'Multiple transverse mode' output and "average output power" exceeding 80 W;

8. Output wavelength exceeding 1 555 nm but not exceeding 1 850 nm, and any of the following:

a. Output energy exceeding 100 mJ per pulse and "peak power" exceeding 1 W; or

b. "Average output power" exceeding 1 W;

9. Output wavelength exceeding 1 850 nm but not exceeding 2 100 nm, and any of the following

a. 'Single transverse mode' and any of the following:

1. Output energy exceeding 100 mJ per pulse and "peak power" exceeding 1 W; or

2. "Average output power" exceeding 1 W; or

b. 'Multiple transverse mode' and any of the following:

1. Output energy exceeding 100 mJ per pulse and "peak power" exceeding 10 kW; or

2. "Average output power" exceeding 120 W; or

10. Output wavelength exceeding 2 100 nm and any of the following:

a. Output energy exceeding 100 mJ per pulse and "peak power" exceeding 1 W; or

b. "Average output power" exceeding 1 W;

6A005 (*continued*)

c. "Tunable" "lasers" having any of the following:

1. Output wavelength less than 600 nm and any of the following:

a. Output energy exceeding 50 mJ per pulse and "peak power" exceeding 1 W; or

b. Average or CW output power exceeding 1 W;

Note: 6A005.c.1. does not control dye "lasers" or other liquid "lasers", having a multimode output and a wavelength of 150 nm or more but not exceeding 600 nm and all of the following:

1. Output energy less than 1,5 J per pulse or a "peak power" less than 20 W; and

2. Average or CW output power less than 20 W.

2. Output wavelength of 600 nm or more but not exceeding 1 400 nm, and any of the following:

a. Output energy exceeding 1 J per pulse and "peak power" exceeding 20 W; or

b. Average or CW output power exceeding 20 W; or

3. Output wavelength exceeding 1 400 nm and any of the following:

a. Output energy exceeding 50 mJ per pulse and "peak power" exceeding 1 W; or

b. Average or CW output power exceeding 1 W;

Note: 6A005.c.3. does not control "tunable" "lasers" having an average or CW output power exceeding 1 W and not exceeding 10 W, power consumption equal to or exceeding 250 W, and a total mass greater than 50 kg. For the purposes of this Note, total mass includes all components required to operate the "laser", e.g., "laser", power supply, heat exchanger, but excludes external optics for beam conditioning or delivery.

d. Other "lasers", not specified in 6A005.a., 6A005.b. or 6A005.c. as follows:

1. Semiconductor "lasers" as follows:

Note 1: 6A005.d.1. 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.

Technical Notes:

For the purposes of 6A005.d.1.:

1. Semiconductor "lasers" are commonly called "laser" diodes.

2. A 'bar' (also called a semiconductor "laser" 'bar', a "laser" diode 'bar' or diode 'bar') consists of multiple semiconductor "lasers" in a one-dimensional array.

3. A 'stacked array' consists of multiple 'bars' forming a two-dimensional array of semiconductor "lasers".

a. Individual single-transverse mode semiconductor "lasers" having any of the following:

1. Wavelength equal to or less than 1 570 nm and average or CW output power exceeding 2,0 W; or

2. Wavelength greater than 1 570 nm and average or CW output power exceeding 500 mW;

6A005 d. 1. (*continued*)

b. Individual multiple-transverse mode semiconductor "lasers" having any of the following:

1. Wavelength of less than 780 nm and average or CW output power exceeding 25 W;

2. Wavelength equal to or greater than 780 nm and less than 1 100 nm and average or CW output power exceeding 30 W;

3. Wavelength equal to or greater than 1 100 nm and less than 1 400 nm and average or CW output power exceeding 25 W;

4. Wavelength equal to or greater than 1 400 nm and less than 1 900 nm and average or CW output power exceeding 2,5 W; or

5. Wavelength equal to or greater than 1 900 nm and average or CW output power exceeding 1 W;

c. Individual semiconductor "laser" 'bars', having any of the following:

1. Wavelength of less than 1 400 nm and average or CW output power exceeding 100 W;

2. Wavelength equal to or greater than 1 400 nm and less than 1 900 nm and average or CW output power exceeding 25 W; or

3. Wavelength equal to or greater than 1 900 nm and average or CW output power exceeding 10 W;

d. Semiconductor "laser" 'stacked arrays' (two-dimensional arrays) having any of the following:

1. Wavelength less than 1 400 nm and having any of the following:

a. Average or CW total output power less than 3 kW and having average or CW output 'power density' greater than 500 W/cm^2;

b. Average or CW total output power equal to or exceeding 3 kW but less than or equal to 5 kW, and having average or CW output 'power density' greater than 350 W/cm^2;

c. Average or CW total output power exceeding 5 kW;

d. Peak pulsed 'power density' exceeding 2 500 W/cm^2; or

Note: *6A005.d.1.d.1.d. does not control epitaxially-fabricated monolithic devices.*

e. Spatially coherent average or CW total output power, greater than 150 W;

2. Wavelength greater than or equal to 1 400 nm but less than 1 900 nm, and having any of the following:

a. Average or CW total output power less than 250 W and average or CW output 'power density' greater than 150 W/cm^2;

b. Average or CW total output power equal to or exceeding 250 W but less than or equal to 500 W, and having average or CW output 'power density' greater than 50 W/cm^2;

c. Average or CW total output power exceeding 500 W;

d. Peak pulsed 'power density' exceeding 500 W/cm^2; or

Note: *6A005.d.1.d.2.d. does not control epitaxially-fabricated monolithic devices.*

e. Spatially coherent average or CW total output power, exceeding 15 W;

6A005 d. 1. d. (*continued*)

3. Wavelength greater than or equal to 1 900 nm and having any of the following:

a. Average or CW output 'power density' greater than 50 W/cm^2;

b. Average or CW output power greater than 10 W; or

c. Spatially coherent average or CW total output power, exceeding 1,5 W; or

4. At least one "laser" 'bar' specified in 6A005.d.1.c.;

Technical Note:

For the purposes of 6A005.d.1.d., 'power density' means the total "laser" output power divided by the emitter surface area of the 'stacked array'.

e. Semiconductor "laser" 'stacked arrays', other than those specified in 6A005.d.1.d., having all of the following:

1. Specially designed or modified to be combined with other 'stacked arrays' to form a larger 'stacked array'; and

2. Integrated connections, common for both electronics and cooling;

Note 1: *'Stacked arrays', formed by combining semiconductor "laser" 'stacked arrays' specified in 6A005.d.1.e., that are not designed to be further combined or modified are specified in 6A005.d.1.d.*

Note 2: *'Stacked arrays', formed by combining semiconductor "laser" 'stacked arrays' specified in 6A005.d.1.e., that are designed to be further combined or modified are specified in 6A005.d.1.e.*

Note 3: *6A005.d.1.e. does not control modular assemblies of single 'bars' designed to be fabricated into end-to-end stacked linear arrays.*

2. Carbon monoxide (CO) "lasers" having any of the following:

a. Output energy exceeding 2 J per pulse and "peak power" exceeding 5 kW; or

b. Average or CW output power exceeding 5 kW;

3. Carbon dioxide (CO_2) "lasers" having any of the following:

a. CW output power exceeding 15 kW;

b. Pulsed output with a "pulse duration" exceeding 10 μs and any of the following:

1. "Average output power" exceeding 10 kW; or

2. "Peak power" exceeding 100 kW; or

c. Pulsed output with a "pulse duration" equal to or less than 10 μs and any of the following:

1. Pulse energy exceeding 5 J per pulse; or

2. "Average output power" exceeding 2,5 kW;

4. Excimer "lasers" having any of the following:

a. Output wavelength not exceeding 150 nm and any of the following:

1. Output energy exceeding 50 mJ per pulse; or

2. "Average output power" exceeding 1 W;

6A005 d. 4. (*continued*)

b. Output wavelength exceeding 150 nm but not exceeding 190 nm and any of the following:

1. Output energy exceeding 1,5 J per pulse; or

2. "Average output power" exceeding 120 W;

c. Output wavelength exceeding 190 nm but not exceeding 360 nm and any of the following:

1. Output energy exceeding 10 J per pulse; or

2. "Average output power" exceeding 500 W; or

d. Output wavelength exceeding 360 nm and any of the following:

1. Output energy exceeding 1,5 J per pulse; or

2. "Average output power" exceeding 30 W;

NB: *For excimer "lasers" specially designed for lithography equipment, see 3B001.*

5. 'Chemical lasers' as follows:

Technical Note:

For the purposes of 6A005.d.5., 'chemical laser' is a "laser" in which the excited species is produced by the output energy from a chemical reaction.

a. Hydrogen Fluoride (HF) "lasers";

b. Deuterium Fluoride (DF) "lasers";

c. 'Transfer lasers' as follows:

1. Oxygen Iodine (O_2-I) "lasers";

2. Deuterium Fluoride-Carbon dioxide (DF-CO_2) "lasers";

Technical Note:

For the purposes of 6A005.d.5.c., 'transfer lasers' are "lasers" in which the lasing species are excited through the transfer of energy by collision of a non- lasing atom or molecule with a lasing atom or molecule species.

6. "Non-repetitive pulsed" Nd:glass "lasers" having any of the following:

a. "Pulse duration" not exceeding 1 μs and output energy exceeding 50 J per pulse; or

b. "Pulse duration" exceeding 1 μs and output energy exceeding 100 J per pulse;

e. Components as follows:

1. Mirrors cooled either by 'active cooling' or by heat pipe cooling;

Technical Note:

For the purposes of 6A005.e.1., '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, other than fused tapered fibre combiners and Multi-Layer Dielectric gratings (MLDs), specially designed for use with specified "lasers";

Note: *Fibre combiners and MLDs are specified in 6A005.e.3.*

6A005 e. (*continued*)

3. Fibre "laser" components as follows:

a. Multimode to multimode fused tapered fibre combiners having all of the following:

1. An insertion loss better (less) than or equal to 0,3 dB maintained at a rated total average or CW output power (excluding output power transmitted through the single mode core if present) exceeding 1 000 W; and

2. Number of input fibres equal to or greater than 3;

b. Single mode to multimode fused tapered fibre combiners having all of the following:

1. An insertion loss better (less) than 0,5 dB maintained at a rated total average or CW output power exceeding 4 600 W;

2. Number of input fibres equal to or greater than 3; and

3. Having any of the following:

a. A Beam Parameter Product (BPP) measured at the output not exceeding 1,5 mm mrad for a number of input fibres less than or equal to 5; or

b. A BPP measured at the output not exceeding 2,5 mm mrad for a number of input fibres greater than 5;

c. MLDs having all of the following:

1. Designed for spectral or coherent beam combination of 5 or more fibre "lasers"; and

2. CW "Laser" Induced Damage Threshold (LIDT) greater than or equal to 10 kW/cm^2;

f. Optical equipment as follows:

NB: *For shared aperture optical elements, capable of operating in "Super High Power Laser" ("SHPL") applications, see the Military Goods Controls.*

1. Not used;

2. "Laser" diagnostic equipment specially designed for dynamic measurement of "SHPL" system angular beam steering errors and having an angular "accuracy" of 10 μrad (microradians) or less (better);

3. Optical equipment and components, specially designed for coherent beam combination in a phased-array "SHPL" system and having any of the following:

a. An "accuracy" of 0,1 μm or less (better), for wavelengths greater than 1 μm; or

b. An "accuracy" of λ/10 or less (better) at the designed wavelength, for wavelengths equal to or less than 1 μm;

4. Projection telescopes specially designed for use with "SHPL" systems;

g. 'Laser acoustic detection equipment' having all of the following:

1. CW "laser" output power equal to or exceeding 20 mW;

2. "Laser" frequency stability equal to or less (better) than 10 MHz;

3. "Laser" wavelengths equal to or exceeding 1 000 nm but not exceeding 2 000 nm;

4. Optical system resolution less (better) than 1 nm; and

6A005 g. (*continued*)

5. Optical Signal to Noise ratio equal to or exceeding 10^3.

Technical Note:

For the purposes of 6A005.g., 'laser acoustic detection equipment' is sometimes referred to as a "Laser" Microphone or Particle Flow Detection Microphone.

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

NB: *SEE ALSO 7A103.d.*

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

a. "Magnetometers" and subsystems as follows:

1. "Magnetometers" using "superconductive" (SQUID) "technology" and having any of the following:

a. SQUID systems designed for stationary operation, without specially designed subsystems designed to reduce in-motion noise, and having a 'sensitivity' equal to or less (better) than 50 fT (rms) per square root Hz at a frequency of 1 Hz; or

b. SQUID systems having an in-motion-magnetometer 'sensitivity' less (better) than 20 pT (rms) per square root Hz at a frequency of 1 Hz and specially designed to reduce in-motion noise;

2. "Magnetometers" using optically pumped or nuclear precession (proton/Overhauser) "technology" having a 'sensitivity' less (better) than 20 pT (rms) per square root Hz at a frequency of 1 Hz;

3. "Magnetometers" using fluxgate "technology" having a 'sensitivity' equal to or less (better) than 10 pT (rms) per square root Hz at a frequency of 1 Hz;

4. Induction coil "magnetometers" having a 'sensitivity' less (better) than any of the following:

a. 0,05 nT (rms) per square root Hz at frequencies of less than 1 Hz;

b. 1×10^{-3} nT (rms) per square root Hz at frequencies of 1 Hz or more but not exceeding 10 Hz; or

c. 1×10^{-4} nT (rms) per square root Hz at frequencies exceeding 10 Hz;

5. Fibre optic "magnetometers" having a 'sensitivity' less (better) than 1 nT (rms) per square root Hz;

b. Underwater electric field sensors having a 'sensitivity' less (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 'sensitivity' less (better) than 0,3 nT/m rms per square root Hz;

3. "Intrinsic magnetic gradiometers", using "technology" other than fibre-optic "technology", having a magnetic gradient field 'sensitivity' less (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 parameters specified in 6A006.a., 6A006.b. or 6A006.c.;

e. Underwater electromagnetic receivers incorporating magnetic field sensors specified in 6A006.a. or underwater electric field sensors specified in 6A006.b.

6A006 (*continued*)

Technical Note:

For the purposes of 6A006, 'sensitivity' (noise level) is the root mean square of the device-limited noise floor which is the lowest signal that can be measured.

6A007 Gravity meters (gravimeters) and gravity gradiometers, as follows:

NB: *SEE ALSO 6A107.*

a. Gravity meters designed or modified for ground use and 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 and having all of the following:

1. A static "accuracy" of less (better) than 0,7 mGal; and

2. An in-service (operational) "accuracy" of less (better) than 0,7 mGal having a "time-to-steady-state registration" of less than 2 minutes under any combination of attendant corrective compensations and motional influences;

c. Gravity gradiometers.

6A008 Radar systems, equipment and assemblies, having any of the following, and specially designed components therefor:

NB: *SEE ALSO 6A108.*

Note: *6A008 does not control:*

— *Secondary surveillance radar (SSR);*

— *Civil Automotive Radar;*

— *Displays or monitors used for air traffic control (ATC);*

— *Meteorological (weather) radar;*

— *Precision approach radar (PAR) equipment conforming to International Civil Aviation Organization (ICAO) standards and employing electronically steerable linear (1-dimensional) arrays or mechanically positioned passive antennae.*

a. Operating at frequencies from 40 GHz to 230 GHz and having any of the following:

1. An average output power exceeding 100 mW; or

2. Locating "accuracy" of 1 m or less (better) in range and 0,2 degree or less (better) in azimuth;

b. A "tunable" bandwidth exceeding ± 6,25 % of the 'centre operating frequency';

Technical Note:

For the purposes of 6A008.b., 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 Radar (SAR) mode, Inverse Synthetic Aperture Radar (ISAR) mode, or Sidelooking Airborne Radar (SLAR) mode;

6A008 (*continued*)

e. Incorporating electronically scanned array antennae;

Technical Note:

For the purposes of 6A008.e., electronically scanned array antennae are also known as electronically steerable array antennae.

f. Capable of heightfinding non-cooperative targets;

g. Specially designed for airborne (balloon or airframe mounted) operation and having Doppler "signal processing" for the detection of moving targets;

h. Employing processing of radar signals and using any of the following:

1. "Radar spread spectrum" techniques; or

2. 'Radar frequency agility' techniques;

Technical Note:

For the purposes of 6A008.h., 'radar frequency agility' applies to 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.

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 and having all the following:

1. A maximum 'instrumented range' of 500 km or less;

2. Configured so that radar target data can be transmitted only one way from the radar site to one or more civil ATC centres;

3. Contains no provisions for remote control of the radar scan rate from the enroute ATC centre; and

4. Permanently installed;

c. Weather balloon tracking radars.

Technical Note:

For the purposes of 6A008.i. 'instrumented range' is the specified unambiguous display range of a radar.

j. Being "laser" radar or Light Detection and Ranging (LIDAR) equipment and having any of the following:

1. "Space-qualified";

2. Employing coherent heterodyne or homodyne detection techniques and having an angular resolution of less (better) than 20 μrad (microradians); or

3. Designed for carrying out airborne bathymetric littoral surveys to International Hydrographic Organization (IHO) Order 1a Standard (5th Edition February 2008) for Hydrographic Surveys or better, and using one or more "lasers" with a wavelength exceeding 400 nm but not exceeding 600 nm;

Note 1: *LIDAR equipment specially designed for surveying is only specified in 6A008.j.3.*

Note 2: *6A008.j. does not control LIDAR equipment specially designed for meteorological observation.*

6A008 j. (*continued*)

Note 3: *Parameters in the IHO Order 1a Standard (5th Edition February 2008) are summarised as follows:*

— *Horizontal Accuracy (95 % Confidence Level) = 5 m + 5 % of depth.*

— *Depth Accuracy for Reduced Depths (95 % confidence level) = $\pm\sqrt{(a^2+(b \times d)^2)}$, where:*

a = 0,5 m = constant depth error,

i.e., the sum of all constant depth errors

b = 0,013 = factor of depth dependent error

b × d = depth dependent error,

i.e., the sum of all depth dependent errors

d = depth

— *Feature Detection = Cubic features > 2 m in depths up to 40 m; 10 % of depth beyond 40 m.*

k. Having "signal processing" sub-systems using "pulse compression" and having any of the following:

1. A "pulse compression" ratio exceeding 150; or

2. A compressed pulse width of less than 200 ns; or

Note: *6A008.k.2. does not control two dimensional 'marine radar' or 'vessel traffic service' radar, having all of the following;*

a. "Pulse compression" ratio not exceeding 150;

b. Compressed pulse width of greater than 30 ns;

c. Single and rotating mechanically scanned antenna;

d. Peak output power not exceeding 250 W; and

e. Not capable of "frequency hopping".

l. Having data processing sub-systems and having any of the following:

1. 'Automatic target tracking' providing, at any antenna rotation, the predicted target position beyond the time of the next antenna beam passage; or

Note: *6A008.l.1. does not control conflict alert capability in ATC systems, or 'marine radar'.*

Technical Note:

For the purposes of 6A008.l.1., 'automatic target tracking' is a processing technique that automatically determines and provides as output an extrapolated value of the most probable position of the target in real time.

2. Not used;

3. Not used;

4. Configured to provide superposition and correlation, or fusion, of target data within six seconds from two or more 'geographically dispersed' radar sensors to improve the aggregate performance beyond that of any single sensor specified in 6A008.f. or 6A008.i.

Technical Note:

For the purposes of 6A008.l.4., sensors are considered 'geographically dispersed' when each location is distant from any other more than 1 500 m in any direction. Mobile sensors are always considered 'geographically dispersed'.

NB: *See also Military Goods Controls.*

Note: *6A008.l.4. does not control systems, equipment and assemblies designed for 'vessel traffic service'.*

6A008 (*continued*)

Technical Notes:

For the purposes of 6A008:

1. *'Marine radar' is a radar that is designed to navigate safely at sea, inland waterways or near-shore environments.*

2. *'Vessel traffic service' is a vessel traffic monitoring and control service similar to air traffic control for "aircraft".*

6A102 Radiation hardened 'detectors', other than those specified in 6A002, specially designed or modified for protecting against nuclear effects (e.g. electromagnetic pulse (EMP), X-rays, combined blast and thermal effects) and usable for "missiles", designed or rated to withstand radiation levels which meet or exceed a total irradiation dose of 5×10^5 rads (silicon).

Technical Note:

In 6A102, a 'detector' is defined as a mechanical, electrical, optical or chemical device that automatically identifies and records, or registers a stimulus such as an environmental change in pressure or temperature, an electrical or electromagnetic signal or radiation from a radioactive material. This includes devices that sense by one time operation or failure.

6A107 Gravity meters (gravimeters) and components for gravity meters and gravity gradiometers, as follows:

a. Gravity meters, other than those specified in 6A007.b., designed or modified for airborne or marine use, and having a static or operational accuracy equal to or less (better) than 0,7 milligal (mGal), 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, tracking systems and radomes, other than those specified in entry 6A008, as follows:

a. Radar and laser radar systems designed or modified for use in space launch vehicles specified in 9A004 or sounding rockets specified in 9A104;

Note: *6A108.a. includes the following:*

a. Terrain contour mapping equipment;

b. Scene mapping and correlation (both digital and analogue) equipment;

c. Doppler navigation radar equipment;

d. Passive interferometer equipment;

e. Imaging sensor equipment (both active and passive).

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 1,5 milliradians;

b. Range of 30 km or greater with a range resolution better than 10 m rms; and

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.

6A108 (*continued*)

c. Radomes designed to withstand a combined thermal shock greater than 4,184 x 10^6 J/m^2 accompained by a peak over pressure of greater than 50 kPa, and usable in "missiles" for protecting against nuclear effects (e.g. electromagnetic pulse (EMP), X-rays, combined blast and thermal effects).

6A202 Photomultiplier tubes having both of the following characteristics:

a. Photocathode area of greater than 20 cm^2; and

b. Anode pulse rise time of less than 1 ns.

6A203 Cameras and components, other than those specified in 6A003, as follows:

N.B.1. "Software" specially designed to enhance or release the performance of a camera or imaging device to meet the characteristics of 6A203.a., 6A203.b. or 6A203.c. is specified in 6D203.

N.B.2. "Technology" in the form of codes or keys to enhance or release the performance of a camera or imaging device to meet the characteristics of 6A203.a., 6A203.b. or 6A203.c. is specified in 6E203.

Note: 6A203.a. to 6A203.c. does not control cameras or imaging devices if they have hardware, "software" or "technology" constraints that limit the performance to less than that specified below, provided they meet any of the following:

1. They need to be returned to the original manufacturer to make the enhancements or release the constraints;

2. They require "software" as specified in 6D203 to enhance or release the performance to meet the characteristics of 6A203; or

3. They require "technology" in the form of keys or codes as specified in 6E203 to enhance or release the performance to meet the characteristics of 6A203.

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

1. Streak cameras with writing speeds greater than 0,5 mm/μs;

2. Electronic streak cameras capable of 50 ns or less time resolution;

3. Streak tubes for cameras specified in 6A203.a.2.;

4. Plug-ins specially designed for use with streak cameras which have modular structures and that enable the performance specifications in 6A203.a.1. or 6A203.a.2.;

5. Synchronizing electronics units, rotor assemblies consisting of turbines, mirrors and bearings specially designed for cameras specified in 6A203.a.1.;

b. Framing cameras, and specially designed components therefor, as follows:

1. Framing cameras with recording rates greater than 225 000 frames per second;

2. Framing cameras capable of 50 ns or less frame exposure time;

3. Framing tubes and solid-state imaging devices having a fast image gating (shutter) time of 50 ns or less specially designed for cameras specified in 6A203.b.1. or 6A203.b.2.;

4. Plug-ins specially designed for use with framing cameras which have modular structures and that enable the performance specifications in 6A203.b.1. or 6A203.b.2.;

5. Synchronizing electronics units, rotor assemblies consisting of turbines, mirrors and bearings specially designed for cameras specified in 6A203.b.1. or 6A203.b.2.;

Technical Note:

In 6A203.b., high speed single frame cameras can be used alone to produce a single image of a dynamic event, or several such cameras can be combined in a sequentially-triggered system to produce multiple images of an event.

6A203 (*continued*)

c. Solid-state or electron tube cameras, and specially designed components therefor, as follows:

1. Solid-state cameras or electron tube cameras with a fast image gating (shutter) time of 50 ns or less;

2. Solid-state imaging devices and image intensifiers tubes having a fast image gating (shutter) time of 50 ns or less specially designed for cameras specified in 6A203.c.1.;

3. Electro-optical shuttering devices (Kerr or Pockels cells) with a fast image gating (shutter) time of 50 ns or less;

4. Plug-ins specially designed for use with cameras which have modular structures and that enable the performance specifications in 6A203.c.1.

d. Radiation-hardened TV cameras, or lenses therefor, specially designed or rated as radiation hardened to withstand a total radiation dose greater than 50×10^3 Gy(silicon) (5×10^6 rad (silicon)) without operational degradation.

Technical Note:

The term Gy(silicon) refers to the energy in Joules per kilogram absorbed by an unshielded silicon sample when exposed to ionising radiation.

6A205 "Lasers", "laser" amplifiers and oscillators, other than those specified in 0B001.g.5., 0B001.h.6. and 6A005, as follows:

NB: For copper vapour lasers, see 6A005.b.

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.

d. Pulsed carbon dioxide (CO_2) "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 μm output wavelength and at a repetition rate greater than 250 Hz;

6A205 (*continued*)

f. Neodymium-doped (other than glass) "lasers" with an output wavelength between 1 000 and 1 100 nm having either of the following:

1. Pulse-excited and Q-switched with a pulse duration equal to or more than 1 ns, and having either of the following:

a. A single–transverse mode output with an "average output power" greater than 40W; or

b. A multiple-transverse mode output having an average power greater than 50 W; or

2. Incorporating frequency doubling to give an output wavelength between 500 and 550 nm with an "average output power" of more than 40 W;

g. Pulsed carbon monoxide (CO) "lasers", other than those specified in 6A005.d.2., having all of the following:

1. Operating at wavelengths between 5 000 and 6 000 nm;

2. A repetition rate greater than 250 Hz;

3. An "average output power" greater than 200 W; and

4. Pulse width of less than 200 ns.

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), DLIs (Doppler Laser Interferometers), PDV (Photonic Doppler Velocimeters) also known as Het-V (Heterodyne Velocimeters) and microwave velocity interferometers including optic-microvawe mixing velocimeters.

6A226 Pressure sensors, as follows:

a. Shock pressure gauges capable of measuring pressures greater than 10 GPa, including gauges made with manganin, ytterbium, and polyvinylidene fluoride (PVDF) / polyvinyl difluoride (PVF_2);

b. Quartz pressure transducers for pressures greater than 10 GPa.

6B Test, Inspection and Production Equipment

6B002 Masks and reticles, specially designed for optical sensors specified in 6A002.a.1.b. or 6A002.a.1.d.

6B004 Optical equipment as follows:

a. Equipment for measuring absolute reflectance to an "accuracy" of equal to or less (better) than 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 less (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.

NB: SEE ALSO 6B108.

6B108 Systems, other than those specified in 6B008, specially designed for radar cross section measurement usable for 'missiles' and their subsystems.

Technical Note:

In 6B108 'missile' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.

6C Materials

6C002 Optical sensor materials as follows:

a. Elemental tellurium (Te) having a purity equal to or greater (better) than 99,9995 %;

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:

For the purposes of 6C002.b.1., '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 (CVD) process and having any of the following:

1. A volume greater than 100 cm^3; or

2. A diameter greater than 80 mm and a thickness of 20 mm or more;

b. Electro-optic materials and non-linear optical materials, as follows:

1. Potassium titanyl arsenate (KTA) (CAS 59400-80-5);

2. Silver gallium selenide ($AgGaSe_2$, also known as AGSE) (CAS 12002-67-4);

3. Thallium arsenic selenide (Tl_3AsSe_3, also known as TAS) (CAS 16142-89-5);

4. Zinc germanium phosphide ($ZnGeP_2$, also known as ZGP, zinc germanium biphosphide or zinc germanium diphosphide);

5. Gallium selenide (GaSe) (CAS 12024-11-2);

c. Non-linear optical materials, other than those specified in 6C004.b., having any of the following:

1. Having all of the following:

a. Dynamic (also known as non-stationary) third order non-linear susceptibility ($\chi^{(3)}$, chi 3) of 10^{-6} m^2/V^2 or more; and

b. Response time of less than 1 ms; or

2. Second order non-linear susceptibility ($\chi^{(2)}$, chi 2) of $3{,}3\times10^{-11}$ m/V or more;

d. "Substrate blanks" of silicon carbide or beryllium beryllium (Be/Be) deposited materials, exceeding 300 mm in diameter or major axis length;

e. Glass, including fused silica, phosphate glass, fluorophosphate glass, zirconium fluoride (ZrF_4) (CAS 7783-64-4) and hafnium fluoride (HfF_4) (CAS 13709-52-9) and having all of the following:

1. A hydroxyl ion (OH^-) concentration of less than 5 ppm;

2. Integrated metallic purity levels of less than 1 ppm; and

3. High homogeneity (index of refraction variance) less than 5×10^{-6};

f. Synthetically produced diamond material with an absorption of less than 10^{-5} cm^{-1} for wavelengths exceeding 200 nm but not exceeding 14 000 nm.

6C005 "Laser" materials as follows:

a. Synthetic crystalline "laser" host material in unfinished form as follows:

1. Titanium doped sapphire;

2. Not used.

6C005 (*continued*)

b. Rare-earth-metal doped double-clad fibres having any of the following:

1. Nominal "laser" wavelength of 975 nm to 1 150 nm and having all of the following:

a. Average core diameter equal to or greater than 25 μm; and

b. Core 'Numerical Aperture' ('NA') less than 0,065; or

Note: *6C005.b.1. does not control double-clad fibres having an inner glass cladding diameter exceeding 150 μm and not exceeding 300 μm.*

2. Nominal "laser" wavelength exceeding 1 530 nm and having all of the following:

a. Average core diameter equal to or greater than 20 μm; and

b. Core 'Numerical Aperture' ('NA') less than 0,1.

Note: *6C005.b. includes fibres assembled with end caps.*

Technical Note:

For the purposes of 6C005.b., the core 'Numerical Aperture' ('NA') is measured at the emission wavelengths of the fibre.

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. "Software" as follows:

1. "Software" specially designed for acoustic beam forming for the "real-time processing" of acoustic data for passive reception using towed hydrophone arrays;

2. "Source code" for the "real-time processing" of acoustic data for passive reception using towed hydrophone arrays;

3. "Software" specially designed for acoustic beam forming for "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;

5. "Software" or "source code", specially designed for all of the following:

a. "Real-time processing" of acoustic data from sonar systems specified in 6A001.a.1.e.; and

b. Automatically detecting, classifying and determining the location of divers or swimmers;

NB: *For diver detection "software" or "source code", specially designed or modified for military use, SEE THE MILITARY GOODS CONTROLS.*

b. Not used;

6D003 (*continued*)

c. "Software" designed or modified for cameras incorporating "focal plane arrays" specified in 6A002.a.3.f. and designed or modified to remove a frame rate restriction and allow the camera to exceed the frame rate specified in 6A003.b.4. Note 3.a;

d. "Software" specially designed to maintain the alignment and phasing of segmented mirror systems consisting of mirror segments having a diameter or major axis length equal to or larger than 1 m;

e. Not used;

f. "Software" as follows:

1. "Software" specially designed for magnetic and electric field "compensation systems" for magnetic sensors designed to operate on mobile platforms;

2. "Software" specially designed for magnetic and electric field anomaly detection on mobile platforms;

3. "Software" specially designed for "real-time processing" of electromagnetic data using underwater electromagnetic receivers specified in 6A006.e.;

4. "Source code" for "real time processing" of electromagnetic data using underwater electromagnetic receivers specified in 6A006.e.;

g. "Software" specially designed to correct motional influences of gravity meters or gravity gradiometers;

h. "Software" as follows:

1. Air Traffic Control (ATC) "software" designed to be hosted on general purpose computers located at Air Traffic Control centres and capable of accepting radar target data from more than four primary radars;

2. "Software" for the design or "production" of radomes having all of the following:

a. Specially designed to protect the electronically scanned array antennae specified in 6A008.e.; and

b. Resulting in an antenna pattern having an 'average side lobe level' more than 40 dB below the peak of the main beam level.

Technical Note:

For the purposes of 6D003.h.2.b., 'average side lobe level' 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 'missiles' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.

6D203 "Software" specially designed to enhance or release the performance of cameras or imaging devices to meet the characteristics of 6A203.a. to 6A203.c.

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. "Technology" as follows:

1. "Technology" "required" for the coating and treatment of optical surfaces to achieve an 'optical thickness' uniformity of 99,5 % or better for optical coatings 500 mm or more in diameter or major axis length and with a total loss (absorption and scatter) of less than 5×10^{-3};

NB: *See also 2E003.f.*

Technical Note:

For the purposes of 6E003.a.1., 'optical thickness' is the mathematical product of the index of refraction and the physical thickness of the coating.

2. "Technology" for the fabrication of optics using single point diamond turning techniques to produce surface finish "accuracies" of less (better) than 10 nm rms on non-planar surfaces exceeding 0,5 m^2;

b. "Technology" "required" for the "development", "production" or "use" of specially designed diagnostic instruments or targets in test facilities for "SHPL" testing or testing or evaluation of materials irradiated by "SHPL" beams;

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 controls "technology" for items specified in 6A002, 6A007 and 6A008 if the items were designed for airborne applications and are usable in "missiles".*

6E201 "Technology" according to the General Technology Note for the "use" of equipment specified in 6A003, 6A005.a.2., 6A005.b.2., 6A005.b.3., 6A005.b.4., 6A005.b.6., 6A005.c.2., 6A005.d.3.c., 6A005.d.4.c., 6A202, 6A203, 6A205, 6A225 or 6A226.

Note 1: *6E201 only controls "technology" for cameras specified in 6A003 if the cameras are also specified by any of the control parameters of 6A203.*

Note 2: *6E201 only controls "technology" for lasers in 6A005.b.6. that are neodymium-doped and specified by any of the control parameters of 6A205.f.*

6E203 "Technology", in the form of codes or keys, to enhance or release the performance of cameras or imaging devices to meet the characteristics of 6A203.a. to 6A203.c.

PART IX

Category 7

CATEGORY 7 – NAVIGATION AND AVIONICS

7A Systems, Equipment and Components

NB: *For automatic pilots for submersible vehicles, see Category 8.*

For radar, see Category 6.

7A001 Accelerometers as follows and specially designed components therefor:

NB: SEE ALSO 7A101.

NB: For angular or rotational accelerometers, see 7A001.b.

a. Linear accelerometers having any of the following:

1. Specified to function at linear acceleration levels less than or equal to 15 g and having any of the following:

a. A "bias" "stability" of less (better) than 130 micro g with respect to a fixed calibration value over a period of one year; or

b. A "scale factor" "stability" of less (better) than 130 ppm with respect to a fixed calibration value over a period of one year;

2. Specified to function at linear acceleration levels exceeding 15 g but less than or equal to 100 g and having all of the following:

a. A "bias" "repeatability" of less (better) than 1 250 micro g over a period of one year; and

b. A "scale factor" "repeatability" of less (better) than 1 250 ppm over a period of one year; or

3. Designed for use in inertial navigation or guidance systems and specified to function at linear acceleration levels exceeding 100 g;

Note: 7A001.a.1. and 7A001.a.2. do not control accelerometers limited to measurement of only vibration or shock.

b. Angular or rotational accelerometers, specified to function at linear acceleration levels exceeding 100 g.

7A002 Gyros or angular rate sensors, having any of the following and specially designed components therefor:

NB: SEE ALSO 7A102.

NB: For angular or rotational accelerometers, see 7A001.b.

a. Specified to function at linear acceleration levels less than or equal to 100 g and having any of the following:

1. An angular rate range of less than 500 degrees per second and having any of the following:

a. A "bias" "stability" of less (better) than 0,5 degree per hour, when measured in a 1 g environment over a period of one month, and with respect to a fixed calibration value; or

b. An "angle random walk" of less (better) than or equal to 0,0035 degree per square root hour; or

Note: 7A002.a.1.b. does not control "spinning mass gyros".

2. An angular rate range greater than or equal to 500 degrees per second and having any of the following:

a. A "bias" "stability" of less (better) than 4 degrees per hour, when measured in a 1 g environment over a period of three minutes, and with respect to a fixed calibration value; or

b. An "angle random walk" of less (better) than or equal to 0,1 degree per square root hour; or

Note: 7A002.a.2.b. does not control "spinning mass gyros".

b. Specified to function at linear acceleration levels exceeding 100 g.

7A003 'Inertial measurement equipment or systems', having any of the following:

NB: *SEE ALSO 7A103.*

Note: *7A003. does not apply to 'inertial measurement equipment or systems' which are certified for use on "civil aircraft" by civil aviation authorities of one or more Member States or Wassenaar Arrangement Participating States.*

Technical Notes:

For the purposes of 7A003:

1. *'Inertial measurement equipment or systems' incorporate accelerometers or gyroscopes to measure changes in velocity and orientation in order to determine or maintain heading or position without requiring an external reference once aligned. 'Inertial measurement equipment or systems' include:*

   — *Attitude and Heading Reference Systems (AHRSs);*

   — *Gyrocompasses;*

   — *Inertial Measurement Units (IMUs);*

   — *Inertial Navigation Systems (INSs);*

   — *Inertial Reference Systems (IRSs);*

   — *Inertial Reference Units (IRUs).*

2. *'Positional aiding references' independently provide position, and include:*

   a. *"Satellite navigation system";*

   b. *"Data-Based Referenced Navigation" ("DBRN").*

a. Designed for "aircraft", land vehicles or vessels, providing position without the use of 'positional aiding references', and having any of the following "accuracies" subsequent to normal alignment:

   1. 0,8 nautical miles per hour (nm/hr) "Circular Error Probable" ("CEP") rate or less (better);

   2. 0,5 % distanced travelled "CEP" or less (better); or

   3. Total drift of 1 nautical mile "CEP" or less (better) in a 24 hr period;

   Technical Note:

   For the purposes of 7A003.a.1., 7A003.a.2. and 7A003.a.3., the performance parameters typically apply to 'inertial measurement equipment or systems' designed for "aircraft", vehicles and vessels, respectively. These parameters result from the utilisation of specialised non-'positional aiding references' (e.g., altimeter, odometer, velocity log). As a consequence, the specified performance values cannot be readily converted between these parameters. Equipment designed for multiple platforms are evaluated against each applicable entry 7A003.a.1., 7A003.a.2., or 7A003.a.3.

b. Designed for "aircraft", land vehicles or vessels, with an embedded 'positional aiding reference' and providing position after loss of all 'positional aiding references' for a period of up to 4 minutes, having an "accuracy" of less (better) than 10 meters "CEP";

   Note: *7A003.b. refers to systems in which 'inertial measurement equipment or systems' and other independent 'positional aiding references' are built into a single unit (i.e., embedded) in order to achieve improved performance.*

7A003 (*continued*)

c. Designed for "aircraft", land vehicles or vessels, providing heading or True North determination and having any of the following:

1. A maximum operating angular rate less (lower) than 500 deg/s and a heading "accuracy" without the use of 'positional aiding references' equal to or less (better) than 0,07 deg sec(Lat) (equivalent to 6 arc minutes rms at 45 degrees latitude); or

2. A maximum operating angular rate equal to or greater (higher) than 500 deg/s and a heading "accuracy" without the use of 'positional aiding references' equal to or less (better) than 0,2 deg sec(Lat) (equivalent to 17 arc minutes rms at 45 degrees latitude); or

d. Providing acceleration measurements or angular rate measurements, in more than one dimension, and having any of the following:

1. Performance specified in 7A001 or 7A002 along any axis, without the use of any aiding references; or

2. Being "space-qualified" and providing angular rate measurements having an "angle random walk" along any axis of less (better) than or equal to 0,1 degree per square root hour.

Note: 7A003.d.2. does not control 'inertial measurement equipment or systems' that contain "spinning mass gyros" as the only type of gyro.

7A004 'Star trackers' and components therefor, as follows:

NB: SEE ALSO 7A104.

a. 'Star trackers' with a specified azimuth "accuracy" of equal to or less (better) than 20 seconds of arc throughout the specified lifetime of the equipment;

b. Components specially designed for equipment specified in 7A004.a. as follows:

1. Optical heads or baffles;

2. Data processing units.

Technical Note:

For the purposes of 7A004.a., 'star trackers' are also referred to as stellar attitude sensors or gyro-astro compasses.

7A005 "Satellite navigation system" receiving equipment having any of the following and specially designed components therefor:

NB: SEE ALSO 7A105.

NB: For equipment specially designed for military use, SEE MILITARY GOODS CONTROLS.

a. Employing a decryption algorithm specially designed or modified for government use to access the ranging code for position and time; or

b. Employing 'adaptive antenna systems'.

Note: 7A005.b. does not control "satellite navigation system" receiving equipment that only uses components designed to filter, switch, or combine signals from multiple omni-directional antennae that do not implement adaptive antenna techniques.

Technical Note:

For the purposes of 7A005.b., 'adaptive antenna systems' dynamically generate one or more spatial nulls in an antenna array pattern by signal processing in the time domain or frequency domain.

7A006 Airborne altimeters operating at frequencies other than 4,2 to 4,4 GHz inclusive and having any of the following:

NB: *SEE ALSO 7A106.*

a. 'Power management'; or

b. Using phase shift key modulation.

Technical Note:

For the purposes of 7A006.a., 'power management' is 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.

7A008 Underwater sonar navigation systems using doppler velocity or correlation velocity logs integrated with a heading source and having a positioning "accuracy" of equal to or less (better) than 3 % of distance travelled "Circular Error Probable" ("CEP") and specially designed components therefor.

Note: *7A008 does not control systems specially designed for installation on surface vessels or systems requiring acoustic beacons or buoys to provide positioning data.*

NB: *For acoustic systems, see 6A001.a., and for correlation-velocity and Doppler-velocity sonar log equipment, see 6A001.b.*

For other marine systems, see 8A002.

7A101 Linear accelerometers, other than those specified in 7A001, designed for use in inertial navigation systems or in guidance systems of all types, usable in 'missiles', having all of the following characteristics, and specially designed components therefor:

a. A "bias" "repeatability" of less (better) than 1 250 micro g; and

b. A "scale factor" "repeatability" of less (better) than 1 250 ppm;

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

Technical Notes:

1. *In 7A101 'missile' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km;*

2. *In 7A101 the measurement of "bias" and "scale factor" refers to one sigma standard deviation with respect to a fixed calibration over a period of one year;*

7A102 All types of gyros, other than those specified in 7A002, usable in 'missiles', with a rated "drift rate" 'stability' of less than 0,5° (1 sigma or rms) per hour in a 1 g environment and specially designed components therefor.

Technical Notes:

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

2. *In 7A102 'stability' is defined as a measure of the ability of a specific mechanism or performance coefficient to remain invariant when continuously exposed to a fixed operating condition (IEEE STD 528-2001 point 2.247).*

7A103 Instrumentation, navigation equipment and systems, other than those specified in 7A003, as follows; and specially designed components therefor:

a. 'Inertial measurement equipment or systems', using accelerometers or gyros as follows:

1. Accelerometers specified in 7A001.a.3., 7A001.b. or 7A101 or gyros specified in 7A002 or 7A102; or

Note: 7A103.a.1. does not control equipment containing accelerometers specified in 7A001.a.3. that are designed to measure vibration or shock.

2. Accelerometers specified in 7A001.a.1. or 7A001.a.2., designed for use in inertial navigation systems or in guidance systems of all types, and usable in 'missiles';

Note: 7A103.a.2. does not control equipment containing accelerometers specified in 7A001.a.1. or 7A001.a.2. where such accelerometers are specially designed and developed as MWD (Measurement While Drilling) sensors for use in down-hole well services operations

Technical Note:

'Inertial measurement equipment or systems' specified in 7A103.a. incorporate accelerometers or gyros to measure changes in velocity and orientation in order to determine or maintain heading or position without requiring an external reference once aligned.

Note: 'Inertial measurement equipment or systems' in 7A103.a. include:

— *Attitude and Heading Reference Systems (AHRSs);*

— *Gyrocompasses;*

— *Inertial Measurement Units (IMUs);*

— *Inertial Navigation Systems (INSs);*

— *Inertial Reference Systems (IRSs);*

— *Inertial Reference Units (IRUs).*

b. Integrated flight instrument systems which include gyrostabilisers or automatic pilots, designed or modified for use in 'missiles';

c. 'Integrated navigation systems', designed or modified for 'missiles' and capable of providing a navigational accuracy of 200 m 'CEP' or less;

Technical Notes:

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

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. 'CEP' (Circular Error Probable or Circle of Equal Probability) is a measure of accuracy, defined as the radius of the circle inside of which there is a 50 % probability of being located.

7A103 (*continued*)

d. Three axis magnetic heading sensors, designed or modified to be integrated with flight control and navigation systems, other than those specified in 6A006, having all of the following characteristics, and specially designed components therefor:

1. Internal tilt compensation in pitch (± 90 degrees) and roll (± 180 degrees) axes; and

2. Azimuthal accuracy better (less) than 0,5 degrees rms at latitude of ± 80 degrees, reference to local magnetic field.

Note: Flight control and navigation systems in 7A103.d. include gyrostabilisers, automatic pilots and inertial navigation systems.

Technical Note:

In 7A103 'missile' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.

7A104 Gyro-astro compasses and other devices, other than those specified in 7A004, which derive position or orientation by means of automatically tracking celestial bodies or satellites and specially designed components therefor.

7A105 Receiving equipment for navigation satellite systems, other than those specified in 7A005, having any of the following characteristics, and specially designed components therefor:

a. Designed or modified for use in space launch vehicles specified in 9A004, sounding rockets specified in 9A104 or unmanned aerial vehicles specified in 9A012 or 9A112.a.; 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;

2. Employing decryption, designed or modified for military or governmental services, to gain access to a 'navigation satellite system' 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.

Notes:

1. 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) navigation satellite system services.

2. In 7A105, navigation satellite system include Global Navigation Satellite Systems (GNSS; e.g., GPS, GLONASS, Galileo or BeiDou) and Regional Navigation Satellite Systems (RNSS; e.g., NavIC, QZSS).

7A106 Altimeters, other than those specified in 7A006, of radar or laser radar type, designed or modified for use in space launch vehicles specified in 9A004 or sounding rockets specified in 9A104.

7A115 Passive sensors for determining bearing to specific electromagnetic source (direction finding equipment) or terrain characteristics, designed or modified for use in space launch vehicles specified in 9A004 or sounding rockets specified in 9A104.

Note: Equipment specified in 7A105, 7A106, and 7A115 includes the following:

a. Terrain contour mapping equipment;

b. Scene mapping and correlation (both digital and analogue) equipment;

c. Doppler navigation radar equipment;

d. Passive interferometer equipment;

e. Imaging sensor equipment (both active and passive).

7A116 Flight control systems and servo valves, as follows; designed or modified for use in space launch vehicles specified in 9A004, sounding rockets specified in 9A104 or "missiles".

a. Pneumatic, hydraulic, mechanical, electro-optical, or electro-mechanical flight control systems (including fly-by-wire and fly-by-light systems);

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.

Note: *For conversion of manned aircraft to operate as "missiles", 7A116 includes the systems, equipment and valves designed or modified to enable operation of manned aircraft as unmanned aerial vehicles.*

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).

Technical Note:

In 7A117 'CEP' (Circular Error Probable or Circle of Equal Probability) is a measure of accuracy, defined as the radius of the circle centred at the target, at a specific range, in which 50 % of the payloads impact.

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".*

7B002 Equipment specially designed to characterize mirrors for ring "laser" gyros, as follows:

NB: *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:*

— *Gyro tuning test stations;*

— *Gyro dynamic balance stations;*

— *Gyro run-in/motor test stations;*

— *Gyro evacuation and fill stations;*

— *Centrifuge fixtures for gyro bearings;*

— *Accelerometer axis align stations;*

— *Fibre optic gyro coil winding machines.*

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.

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 operation or maintenance of any inertial navigation equipment, including inertial equipment not specified in 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:

For the purposes of 7D002, '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, 7A004 or 7A008;

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 or 7A008 by continuously combining heading data with any of the following:

1. Doppler radar or sonar velocity data;

2. "Satellite navigation system" reference data; or

3. Data from "Data-Based Referenced Navigation" ("DBRN") systems;

c. Not used;

d. Not used;

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.1., 7E004.b.3. to 7E004.b.5., 7E004.b.7., 7E004.b.8., 7E004.c.1. or 7E004.c.2.

7D004 "Source code" incorporating "development" "technology" specified in 7E004.a.2., 7E004.a.3., 7E004.a.5., 7E004.a.6. or 7E004.b., for any of the following:

a. Digital flight management systems for "total control of flight";

b. Integrated propulsion and flight control systems;

c. "Fly-by-wire systems" or "fly-by-light systems";

d. Fault-tolerant or self-reconfiguring "active flight control systems";

e. Not used;

f. Air data systems based on surface static data; or

g. Three dimensional displays.

Note: *7D004. does not control "source code" associated with common computer elements and utilities (e.g., input signal acquisition, output signal transmission, computer "program" and data loading, built-in test, task scheduling mechanisms) not providing a specific flight control system function.*

7D005 "Software" specially designed to decrypt "satellite navigation system" ranging code designed for government use.

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.

7D104 "Software" specially designed or modified for the operation or maintenance of "guidance sets" specified in 7A117.

Note: 7D104 includes "software", specially designed or modified to enhance the performance of "guidance sets" to achieve or exceed the accuracy specified in 7A117.

7E Technology

7E001 "Technology" according to the General Technology Note for the "development" of equipment or "software", specified in 7A, 7B, 7D001, 7D002, 7D003, 7D005 and 7D101 to 7D103.

Note: 7E001 includes key management "technology" exclusively for equipment specified in 7A005.a.

7E002 "Technology" according to the General Technology Note for the "production" of equipment specified in 7A or 7B.

7E003 "Technology" according to the General Technology Note for the repair, refurbishing or overhaul of equipment specified in 7A001 to 7A004.

Note: 7E003 does not control "technology" for maintenance, 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".

7E004 Other "technology" as follows:

a. "Technology" for the "development" or "production" of any of the following:

1. Not used;

2. Air data systems based on surface static data only, i.e., which dispense with conventional air data probes;

3. Three dimensional displays for "aircraft";

4. Not used;

5. Electric actuators (i.e., electromechanical, electrohydrostatic and integrated actuator package) specially designed for ‘primary flight control’;

7E004 a. 5. (*continued*)

Technical Note:

For the purposes of 7E004.a.5., 'primary flight control' is "aircraft" stability or manoeuvring control using force/moment generators, i.e., aerodynamic control surfaces or propulsive thrust vectoring.

6. 'Flight control optical sensor array' specially designed for implementing "active flight control systems"; or

Technical Note:

For the purposes of 7E004.a.6., a 'flight control optical sensor array' is a network of distributed optical sensors, using "laser" beams, to provide real-time flight control data for on-board processing.

7. "DBRN" systems designed to navigate underwater, using sonar or gravity databases, that provide a positioning "accuracy" equal to or less (better) than 0,4 nautical miles;

b. "Development" "technology", as follows, for "active flight control systems" (including "fly-by-wire systems" or "fly-by-light systems"):

1. Photonic-based "technology" for sensing "aircraft" or flight control component state, transferring flight control data, or commanding actuator movement, "required" for "fly-by-light systems" "active flight control systems";

2. Not used;

3. Real-time algorithms to analyse component sensor information to predict and preemptively mitigate impending degradation and failures of components within an "active flight control system";

Note: *7E004.b.3. does not control algorithms for purpose of off-line maintenance.*

4. Real-time algorithms to identify component failures and reconfigure force and moment controls to mitigate "active flight control system" degradations and failures;

Note: *7E004.b.4. does not control algorithms for the elimination of fault effects through comparison of redundant data sources, or off-line pre-planned responses to anticipated failures.*

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. *"Technology" for integration of digital flight control, navigation and propulsion control data, into a digital flight management system for 'flight path optimisation';*

b. *"Technology" for "aircraft" flight instrument systems integrated solely for Very High Frequency Omni-directional Range (VOR), Distance Measuring Equipment (DME), Instrument Landing System (ILS) or Microwave Landing Systems (MLS) navigation or approaches.*

Technical Note:

'Flight path optimisation' is a procedure that minimises deviations from a four-dimensional (space and time) desired trajectory based on maximising performance or effectiveness for mission tasks.

6. Not used;

7E004 b. (*continued*)

7. "Technology" "required" for deriving the functional requirements for "fly-by-wire systems" having all of the following:

a. 'Inner-loop' airframe stability controls requiring loop closure rates of 40 Hz or greater; and

Technical Note:

For the purposes of 7E004.b.7.a., 'inner-loop' refers to functions of "active flight control systems" that automate airframe stability controls.

b. Having any of the following:

1. Corrects an aerodynamically unstable airframe, measured at any point in the design flight envelope, that would lose recoverable control if not corrected within 0,5 seconds;

2. Couples controls in two or more axes while compensating for 'abnormal changes in aircraft state';

Technical Note:

For the purposes of 7E004.b.7.b.2., 'abnormal changes in aircraft state' include in-flight structural damage, loss of engine thrust, disabled control surface, or destabilising shifts in cargo load.

3. Performs the functions specified in 7E004.b.5.; or

Note: *7E004.b.7.b.3. does not control autopilots.*

4. Enables "aircraft" to have stable controlled flight, other than during take-off or landing, at greater than 18 degrees angle of attack, 15 degrees side slip, 15 degrees/second pitch or yaw rate, or 90 degrees/second roll rate;

8. "Technology" "required" for deriving the functional requirements for "fly-by-wire systems" to achieve all of the following:

a. No loss of control of the "aircraft" in the event of a consecutive sequence of any two individual faults within the "fly-by-wire system"; and

b. Probability of loss of control of the "aircraft" being less (better) than 1×10^{-9} failures per flight hour;

Note: *7E004.b. does not control "technology" associated with common computer elements and utilities (e.g., input signal acquisition, output signal transmission, computer "program" and data loading, built-in test, task scheduling mechanisms) not providing a specific flight control system function.*

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 direction control systems";

3. Rotor blades incorporating 'variable geometry aerofoils', for use in systems using individual blade control.

7E004 c. 3. (*continued*)

Technical Note:

For the purposes of 7E004.c.3., 'variable geometry aerofoils' use trailing edge flaps or tabs, or leading edge slats or pivoted nose droop, the position of which can be controlled in flight.

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 optimisation of rocket system trajectory.

PART X

Category 8

CATEGORY 8 – MARINE

8A Systems, Equipment and Components

8A001 Submersible vehicles and surface vessels, as follows:

NB: For the control status of equipment for submersible vehicles, see:

— *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 of the following:

a. 10 % or more of their weight in air; and

b. 15 kN or more;

2. Designed to operate at depths exceeding 1 000 m; or

3. Having all of the following:

a. Designed to continuously 'operate autonomously' for 10 hours or more; and

b. 'Range' of 25 nautical miles or more;

Technical Notes:

1. For the purposes of 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, seabed or shore, and containing a propulsion system for submerged or surface use.

8A001 b. (*continued*)

2. For the purposes of 8A001.b.3.b., 'range' means half the maximum distance a submersible vehicle can 'operate autonomously'.

c. Unmanned submersible vehicles, as follows:

1. Unmanned submersible vehicles having any of the following:

a. Designed for deciding a course relative to any geographical reference without real-time human assistance; or

b. Acoustic data or command link;

c. Not used;

2. Unmanned submersible vehicles, not specified in 8A001.c.1., having all of the following:

a. Designed to operate with a tether;

b. Designed to operate at depths exceeding 1 000 m;

c. Having any of the following:

1. Designed for self-propelled manoeuvre using propulsion motors or thrusters specified in 8A002.a.2.; or

2. Fibre optic data link;

d. Not used;

e. Ocean salvage systems with a lifting capacity exceeding 5 MN for salvaging objects from depths exceeding 250 m and having any of the following:

1. Dynamic positioning systems capable of position keeping within 20 m of a given point provided by the navigation system; or

2. Seafloor navigation and navigation integration systems, for depths exceeding 1 000 m and with positioning "accuracies" to within 10 m of a predetermined point;

f. Not used;

g. Not used;

h. Not used;

i. Not used.

8A002 Marine systems, equipment and components, as follows:

Note: For underwater communications systems, see Category 5, Part 1 – Telecommunications.

a. Systems, equipment and components, specially designed or modified for submersible vehicles and designed to operate at depths exceeding 1 000 m, as follows:

1. Pressure housings or pressure hulls with a maximum inside chamber diameter exceeding 1,5 m;

2. Direct current electric propulsion thrusters and specially designed motors therefor;

Technical Note:

For the purposes of 8A002.a.2., brushless direct current motors may be referred to as Permanent Magnet Alternating Current (PMAC) motors.

3. Umbilical cables, and connectors therefor, using optical fibre and having synthetic strength members;

4. Components manufactured from material specified in 8C001;

8A002 (*continued*)

b. Systems specially designed or modified for the 'automated control' of the motion of submersible vehicles specified in 8A001, using navigation data, having closed loop servo-controls and having any of the following:

1. Enabling a vehicle to move within 10 m of a predetermined point in the water column;

2. Maintaining the position of the vehicle within 10 m of a predetermined point in the water column; or

3. Maintaining the position of the vehicle within 10 m while following a cable on or under the seabed;

Technical Note:

For the purposes of 8A002.b., 'automated control' systems apply to systems onboard submersible vehicles.

c. Fibre optic pressure hull penetrators;

d. Not used;

e. Not used;

f. Not used;

g. Not used;

h. "Robots" specially designed for underwater use, controlled by using a dedicated computer and having any of the following:

1. Systems that control the "robot" using information from sensors which measure force or torque applied to an external object, distance to an external object, or tactile sense between the "robot" and an external object; or

2. The ability to exert a force of 250 N or more or a torque of 250 Nm or more and using titanium based alloys or "composite" "fibrous or filamentary materials" in their structural members;

i. Remotely controlled articulated manipulators specially designed or modified for use with submersible vehicles and having any of the following:

1. Systems which control the manipulator using information from sensors which measure any of the following:

a. Torque or force applied to an external object; or

b. Tactile sense between the manipulator and an external object; or

2. Controlled by proportional master-slave techniques and having 5 degrees of 'freedom of movement' or more;

Technical Note:

For the purposes of 8A002.i.2., only functions having proportionally related motion control using positional feedback are counted when determining the number of degrees of 'freedom of movement'.

8A002 (*continued*)

j. Air independent power systems specially designed for underwater use, as follows:

1. Brayton or Rankine cycle engine air independent power systems having any of the following:

a. Chemical scrubber or absorber systems, specially designed to remove carbon dioxide, carbon monoxide and particulates from recirculated engine exhaust;

b. Systems specially designed to use a monoatomic gas;

c. Devices or enclosures, specially designed for underwater noise reduction in frequencies below 10 kHz, or special mounting devices for shock mitigation; or

d. Systems having all of the following:

1. Specially designed to pressurise the products of reaction or for fuel reformation;

2. Specially designed to store the products of the reaction; and

3. Specially designed to discharge the products of the reaction against a pressure of 100 kPa or more;

2. Diesel cycle engine air independent systems having all of the following:

a. Chemical scrubber or absorber systems, specially designed to remove carbon dioxide, carbon monoxide and particulates from recirculated engine exhaust;

b. Systems specially designed to use a monoatomic gas;

c. Devices or enclosures, specially designed for underwater noise reduction in frequencies below 10 kHz, or special mounting devices for shock mitigation; and

d. Specially designed exhaust systems that do not exhaust continuously the products of combustion;

3. "Fuel cell" air independent power systems with an output exceeding 2 kW and having any of the following:

a. Devices or enclosures, specially designed for underwater noise reduction in frequencies below 10 kHz, or special mounting devices for shock mitigation; or

b. Systems having all of the following:

1. Specially designed to pressurise the products of reaction or for fuel reformation;

2. Specially designed to store the products of the reaction; and

3. Specially designed to discharge the products of the reaction against a pressure of 100 kPa or more;

4. Stirling cycle engine air independent power systems having all of the following:

a. Devices or enclosures, specially designed for underwater noise reduction in frequencies below 10 kHz, or special mounting devices for shock mitigation; and

b. Specially designed exhaust systems which discharge the products of combustion against a pressure of 100 kPa or more;

k. Not used;

8A002 (*continued*)

l. Not used;

m. Not used;

n. Not used;

o. Propellers, power transmission systems, power generation systems and noise reduction systems and related equipment, as follows:

1. Not used;

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 motors with a power output exceeding 2,5 MW;

c. "Superconductive" propulsion motors, with a power output exceeding 0,1 MW;

d. Power transmission systems incorporating "composite" shafts and designed to transmit power exceeding 10 MW;

e. Ventilated or base-ventilated propeller systems, rated at more than 2,5 MW;

3. Noise reduction systems and related equipment, designed for use on vessels of 1 000 tonnes displacement or more, as follows:

a. Systems that attenuate underwater noise at frequencies below 500 Hz and consist of compound acoustic mounts for the acoustic isolation of diesel engines, diesel generator sets, gas turbines, gas turbine generator sets, propulsion motors or propulsion reduction gears, specially designed for sound or vibration isolation and having an intermediate mass exceeding 30 % of the equipment to be mounted;

b. 'Active noise reduction or cancellation systems' or magnetic bearings, specially designed for power transmission systems;

Technical Note:

For the purposes of 8A002.o.3.b., 'active noise reduction or cancellation systems' incorporate electronic control systems capable of actively reducing equipment vibration by the generation of anti-noise or anti-vibration signals directly to the source.

4. Permanent magnet electric propulsion motors specially designed for submersible vehicles, having a power output exceeding 0,1 MW.

Note: *8A002.o.4. includes rim-driven propulsion systems.*

p. Pumpjet propulsion systems having all of the following:

1. Power output exceeding 2,5 MW; and

2. Using divergent nozzle and flow conditioning vane techniques to improve propulsive efficiency or reduce propulsion-generated underwater-radiated noise;

q. Underwater swimming and diving equipment as follows:

1. Closed circuit rebreathers;

2. Semi-closed circuit rebreathers;

Note: *8A002.q. does not control individual rebreathers for personal use when accompanying their users.*

NB: *For equipment and devices specially designed for military use, SEE THE MILITARY GOODS CONTROLS.*

8A002 (*continued*)

r. Diver deterrent acoustic systems specially designed or modified to disrupt divers and having a sound pressure level equal to or exceeding 190 dB (reference 1 μPa at 1 m) at frequencies of 200 Hz and below.

Note 1: 8A002.r. does not control diver deterrent systems based on underwater explosive devices, air guns or combustible sources.

Note 2: 8A002.r. includes diver deterrent acoustic systems that use spark gap sources, also known as plasma sound sources.

8B Test, Inspection and Production Equipment

8B001 Water tunnels designed to have a background noise of less than 100 dB (reference 1 μPa, 1 Hz) within the frequency range exceeding 0 Hz but not exceeding 500 Hz and designed for measuring acoustic fields generated by a hydro-flow around propulsion system models.

8C Materials

8C001 'Syntactic foam' designed for underwater use and having all of the following:

NB: See also 8A002.a.4.

a. Designed for marine depths exceeding 1 000 m; and

b. A density less than 561 kg/m^3.

Technical Note:

For the purposes of 8C001, '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.;

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

1. Surface-effect vehicles (fully skirted variety) having all of the following:

a. Maximum design speed, fully loaded, exceeding 30 knots in a significant wave height of 1,25 m or more;

b. Cushion pressure exceeding 3 830 Pa; and

c. Light-ship-to-full-load displacement ratio of less than 0,70;

8E002 c. (*continued*)

2. Surface-effect vehicles (rigid sidewalls) with a maximum design speed, fully loaded, exceeding 40 knots in a significant wave height of 3,25 m or more;

3. 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 or more; or

4. 'Small waterplane area vessels' having any of the following:

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 or more; or

b. 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 or more.

Technical Note:

For the purposes of 8E002.c.4., a 'small waterplane area vessel' is defined by the following formula: waterplane area at an operational design draft less than 2 x (displaced volume at the operational design draft)$^{2/3}$.

PART XI

Category 9

CATEGORY 9 – AEROSPACE AND PROPULSION

9A Systems, Equipment and Components

NB: For propulsion systems designed or rated against neutron or transient ionising radiation, SEE THE MILITARY GOODS CONTROLS.

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

NB: SEE ALSO 9A101.

a. Incorporating any of the "technologies" specified in 9E003.a., 9E003.h. or 9E003.i.

Note 1: 9A001 does not control aero gas turbine engines which meet all of the following:

a. Certified by the civil aviation authorities of one or more EU Member States or Wassenaar Arrangement Participating States; and

b. Intended to power non-military manned "aircraft" for which any of the following has been issued by civil aviation authorities of one or more Member States or Wassenaar Arrangement Participating States for the "aircraft" with this specific engine type:

1. A civil type certificate; or

2. An equivalent document recognised by the International Civil Aviation Organization (ICAO).

Note 2: 9A001 does not control aero gas turbine engines designed for Auxiliary Power Units (APUs) approved by the civil aviation authority in a Member States or Wassenaar Arrangement Participating States.

b. Not used.

9A002 'Marine gas turbine engines' designed to use liquid fuel and having all of the following, and specially designed assemblies and components therefor:

a. Maximum continuous power when operating in "steady state mode" at standard reference conditions specified in ISO 3977-2:1997 (or national equivalent) of 24 245 kW or more; and

b. 'Corrected specific fuel consumption' not exceeding 0,219 kg/kWh at 35 % of the maximum continuous power when using liquid fuel.

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.*

Technical Note:

For the purposes of 9A002, 'corrected specific fuel consumption' is the specific fuel consumption of the engine corrected to a marine distillate liquid fuel having a net specific energy (i.e. net heating value) of 42MJ/kg (ISO 3977-2:1997).

9A003 Specially designed assemblies or components, incorporating any of the "technologies" specified in 9E003.a., 9E003.h. 9E003.i., or 9E003.k, for any of the following aero gas turbine engines:

a. Specified in 9A001; or

b. Whose design or production origins are either non-EU Member States or Wassenaar Arrangement Participating States or unknown to the manufacturer.

9A004 Space launch vehicles, "spacecraft", "spacecraft buses", "spacecraft mission equipment", "spacecraft" on-board systems or equipment, terrestrial equipment, air-launch platforms and "sub-orbital craft" as follows:

NB: *SEE ALSO 9A104.*

a. Space launch vehicles;

b. "Spacecraft";

NB: *For "sub-orbital craft", see 9A004.h.*

c. "Spacecraft buses";

d. "Spacecraft mission equipment" incorporating items specified in 3A001.b.1.a.4., 3A002.g., 5A001.a.1., 5A001.b.3., 5A002.c., 5A002.e., 6A002.a.1., 6A002.a.2., 6A002.b., 6A002.d., 6A003.b., 6A004.c., 6A004.e., 6A008.d., 6A008.e., 6A008.k., 6A008.l. or 9A010.c.;

e. On-board systems or equipment, specially designed for "spacecraft" and having any of the following functions:

1. Command and telemetry data handling;

Note: *9A004.e.1. includes bus data management, storage, and processing.*

2. Payload data handling; or

Note: *9A004.e.2. includes management, storage, and processing of "spacecraft mission equipment" data.*

3. Attitude and orbit control;

Note: *9A004.e.3 includes sensing and actuation to determine and control the position and orientation of a "spacecraft".*

NB: *For equipment specially designed for military use, SEE MILITARY GOODS CONTROLS.*

9A004 (*continued*)

f. Terrestrial equipment specially designed for "spacecraft", as follows:

1. Telemetry and telecommand equipment specially designed for any of the following data processing functions:

a. Telemetry data processing of frame synchronisation and error corrections, for monitoring of operational status (also known as health and safe status) of the "spacecraft bus"; or

b. Command data processing for formatting command data being sent to the "spacecraft" to control the "spacecraft bus";

2. Simulators specially designed for 'verification of operational procedures' of "spacecraft";

Technical Note:

For the purposes of 9A004.f.2., 'verification of operational procedures' is any of the following:

1. Command sequence confirmation;

2. Operational training;

3. Operational rehearsals; or

4. Operational analysis.

g. "Aircraft" specially designed or modified to be air-launch platforms for space launch vehicles or "sub-orbital craft";

h. "Sub-orbital craft".

9A005 Liquid rocket propulsion systems containing any of the systems or components, specified in 9A006.

NB: SEE ALSO 9A105 AND 9A119.

9A006 Systems and components, specially designed for liquid rocket propulsion systems, as follows:

NB: SEE ALSO 9A106, 9A108 AND 9A120.

a. Cryogenic refrigerators, flightweight dewars, cryogenic heat pipes or cryogenic systems, designed to restrict cryogenic fluid losses to less than 30 % per year;

b. Cryogenic containers or closed-cycle refrigeration systems, designed to maintain or produce temperatures less than or equal to 100 K (- 173,15 °C);

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 x 10^{-3} cm^2 or smaller for non-circular orifices) and specially designed for liquid rocket engines;

h. One-piece carbon-carbon thrust chambers or one-piece carbon-carbon exit cones, with densities exceeding 1,4 g/cm^3 and tensile strengths exceeding 48 MPa.

9A007 Solid rocket propulsion systems having any of the following:

NB: SEE ALSO 9A107 AND 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. 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.

9A008 Components specially designed for solid rocket propulsion systems, as follows:

NB: 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;

b. Filament-wound "composite" motor cases exceeding 0,61 m in diameter or having 'structural efficiency ratios (PV/W)' exceeding 25 km;

Technical Note:

For the purposes of 9A008.b., 'structural efficiency ratio (PV/W)' is the burst pressure (P) multiplied by the vessel volume (V) divided by the total pressure vessel weight (W).

c. Nozzles with thrust levels exceeding 45 kN or nozzle throat erosion rates of less than 0,075 mm/s;

d. Movable nozzle or secondary fluid injection thrust vector control systems, capable of any of the following:

1. Omni-axial movement exceeding ± 5°;

2. Angular vector rotations of 20°/s or more; or

3. Angular vector accelerations of $40°/s^2$ or more.

9A009 Hybrid rocket propulsion systems having any of the following:

NB: 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:

NB: SEE ALSO 1A002 AND 9A110.

a. Components and structures, each exceeding 10 kg and specially designed for launch vehicles manufactured using any of the following:

1. "Composite" materials consisting of "fibrous or filamentary materials" specified in 1C010.e. and resins specified in 1C008 or 1C009.b.;

2. Metal "matrix" "composites" reinforced by any of the following:

a. Materials specified in 1C007 or 1C507;

b. "Fibrous or filamentary materials" specified in 1C010; or

c. Aluminides specified in 1C002.a.; or

9A010 a. (*continued*)

3. Ceramic "matrix" "composite" materials specified in 1C007 or 1C507;

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 any of the following:

1. "Fibrous or filamentary materials" specified in 1C010.e. and resins specified in 1C008 or 1C009.b.;

2. Metal "matrix" "composites" reinforced by any of the following:

a. Materials specified in 1C007 or 1C507;

b. "Fibrous or filamentary materials" specified in 1C010; or

c. Aluminides specified in 1C002.a.; or

3. Ceramic "matrix" "composite" materials specified in 1C007 or 1C507;

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' of less than 30 ms.

Technical Note:

For the purposes of 9A010.d., 'response time' is the time required to achieve 90 % of total rated thrust from start-up.

9A011 Ramjet, scramjet or 'combined cycle engines', and specially designed components therefor.

NB: *SEE ALSO 9A111 AND 9A118.*

Technical Note:

For the purposes of 9A011, 'combined cycle engines' combine two or more of the following types of engines:

— *Gas turbine engine (turbojet, turboprop and turbofan);*

— *Ramjet or scramjet;*

— *Rocket motor or engine (liquid/gel/solid-propellant and hybrid).*

9A012 "Unmanned aerial vehicles" ("UAVs"), unmanned "airships", related equipment and components, as follows:

N.B.1. *SEE ALSO 9A112.*

N.B.2. *For "UAVs" that are "sub-orbital craft", see 9A004.h.*

a. "UAVs" or unmanned "airships", designed to have controlled flight out of the direct 'natural vision' of the 'operator' and having any of the following:

1. Having all of the following:

a. A maximum 'endurance' greater than or equal to 30 minutes but less than 1 hour; and

b. Designed to take-off and have stable controlled flight in wind gusts equal to or exceeding 46,3 km/h (25 knots); or

2. A maximum 'endurance' of 1 hour or greater;

9A012 a. (*continued*)

Technical Notes:

For the purposes of 9A012.a.:

1. *'Operator' is a person who initiates or commands the "UAV" or unmanned "airship" flight.*

2. *'Endurance' is to be calculated for International Standard Atmosphere (ISA) conditions (ISO 2533:1975) at sea level in zero wind.*

3. *'Natural vision'means unaided human sight, with or without corrective lenses.*

b. Related equipment and components, as follows:

1. Not used;

2. Not used;

3. Equipment or components, specially designed to convert a manned "aircraft" or manned "airship", to a "UAV" or unmanned "airship", specified in 9A012.a.;

4. Air breathing reciprocating or rotary internal combustion type engines, specially designed or modified to propel "UAVs" or unmanned "airships", at altitudes above 15 240 metres (50 000 feet).

9A101 Turbojet and turbofan engines, other than those specified in 9A001, as follows;

a. Engines having all of the following characteristics:

1. 'Maximum thrust value' greater than 400 N excluding civil certified engines with a 'maximum thrust value' greater than 8 890 N;

2. Specific fuel consumption of 0,15 kg N^{-1} h^{-1} or less;

3. 'Dry weight' less than 750 kg; and

4. 'First-stage rotor diameter' less than 1 m;

Technical Notes:

1. *For the purpose of 9A101.a.1., 'maximum thrust value' is the manufacturer's demonstrated maximum thrust for the engine type un-installed at sea level static conditions using the ICAO standard atmosphere. The civil type certified thrust value will be equal to or less than the manufacturer's demonstrated maximum thrust for the engine type un-installed.*

2. *Specific fuel consumption is determined at maximum continuous thrust for engine type un-installed at sea level static conditions using the ICAO standard atmosphere.*

3. *'Dry weight' is the weight of the engine without fluids (fuel, hydraulic fluid, oil, etc.) and does not include the nacelle (housing).*

4. *'First-stage rotor diameter' is the diameter of the first rotating stage of the engine, whether a fan or compressor, measured at the leading edge of the blade tips.*

b. Engines designed or modified for use in "missiles" or unmanned aerial vehicles specified in 9A012 or 9A112.a.

9A102 'Turboprop engine systems' specially designed for unmanned aerial vehicles specified in 9A012 or 9A112.a., and specially designed components therefor, having a 'maximum power' greater than 10 kW.

Note: 9A102 does not control civil certified engines.

9A102 (*continued*)

Technical Notes:

1. *For the purposes of 9A102, a 'turboprop engine system' incorporates all of the following:*

   a. *Turboshaft engine; and*

   b. *Power transmission system to transfer the power to a propeller.*

2. *For the purposes of 9A102, the 'maximum power' is achieved un-installed at sea level static conditions using ICAO standard atmosphere.*

9A104 Sounding rockets, capable of a range of at least 300 km.

NB: SEE ALSO 9A004.

9A105 Liquid propellant rocket engines or gel propellant rocket motors, as follows:

NB: SEE ALSO 9A119.

a. Liquid propellant rocket engines or gel propellant rocket motors, usable in "missiles", other than those specified in 9A005, integrated, or designed or modified to be integrated, into a liquid propellant or gel propellant propulsion system which has a total impulse capacity equal to or greater than 1,1 MNs;

b. Liquid propellant rocket engines or gel propellant rocket motors, usable in complete rocket systems or unmanned aerial vehicles, capable of a range of 300 km, other than those specified in 9A005 or 9A105.a., integrated, or designed or modified to be integrated, into a liquid propellant or gel propellant propulsion system which has a total impulse capacity equal to or greater than 0,841 MNs.

9A106 Systems or components, other than those specified in 9A006 as follows, specially designed for liquid rocket propulsion or gel propellant rocket systems:

a. Not used;

b. Not used;

c. Thrust vector control sub-systems, usable in "missiles";

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.*

d. Liquid, slurry and gel propellant (including oxidisers) control systems, and specially designed components therefor, usable in "missiles", designed or modified to operate in vibration environments greater than 10 g rms between 20 Hz and 2 kHz;

Note: The only servo valves, pumps and gas turbines 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;

9A106 d. *Note:* (*continued*)

b. Pumps, for liquid propellants, with shaft speeds equal to or greater than 8 000 r.p.m. at a maximum operating mode or with discharge pressures equal to or greater than 7 MPa;

c. Gas turbines, for liquid propellant turbopumps, with shaft speeds equal to or greater than 8 000 r.p.m. at the maximum operating mode.

e. Combustion chambers and nozzles for liquid propellant rocket engines or gel propellant rocket motors specified in 9A005 or 9A105.

9A107 Solid propellant rocket motors, usable in complete rocket systems or unmanned aerial vehicles, capable of a range of 300 km, other than those specified in 9A007, having total impulse capacity equal to or greater than 0,841 MNs.

NB: SEE ALSO 9A119.

9A108 Components, other than those specified in 9A008, as follows, specially designed for solid and hybrid rocket propulsion systems:

a. Rocket motor cases and insulation components therefor, usable in subsystems specified in 9A007, 9A009, 9A107 or 9A109.a.;

NB: For insulation material in bulk or sheet form, SEE ALSO 9C108.

Note:

In 9A108, insulation intended to be applied to the components of a rocket motor, i.e. the case, nozzle inlets, case closures, includes cured or semi-cured compounded rubber components comprising sheet stock containing an insulating or refractory material. It may also be incorporated as stress relief boots or flaps.

b. Rocket nozzles, usable in subsystems specified in 9A007, 9A009, 9A107 or 9A109.a.;

c. Thrust vector control sub-systems, usable in "missiles".

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 and specially designed components as follows:

a. Hybrid rocket motors usable in complete rocket systems or unmanned aerial vehicles, capable of 300 km, other than those specified in 9A009, having a total impulse capacity equal to or greater than 0,841 MNs, and specially designed components therefor;

b. Specially designed components for hybrid rocket motors specified in 9A009 that are usable in "missiles".

NB: SEE ALSO 9A009 AND 9A119.

9A110 Composite structures, laminates and manufactures thereof, other than those specified in 9A010, specially designed for use in 'missiles' or the subsystems specified in 9A005, 9A007, 9A105, 9A106.c., 9A107, 9A108.c., 9A116 or 9A119.

NB: *SEE ALSO 1A002.*

Technical Note:

In 9A110 'missile' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.

9A111 Pulse jet or detonation engines, usable in "missiles" or unmanned aerial vehicles specified in 9A012 or 9A112.a., and specially designed components therefor.

NB: *SEE ALSO 9A011 AND 9A118.*

Technical Note:

In 9A111 detonation engines utilise detonation to produce a rise in effective pressure across the combustion chamber. Examples of detonation engines include pulse detonation engines, rotating detonation engines or continuous wave detonation engines.

9A112 "Unmanned aerial vehicles" ("UAVs"), other than those specified in 9A012, as follows:

a. "Unmanned aerial vehicles" ("UAVs") capable of a range of 300 km;

b. "Unmanned aerial vehicles" ("UAVs") having all of the following:

1. Having any of the following:

a. An autonomous flight control and navigation capability; or

b. Capability of controlled flight out of the direct vision range involving a human operator; and

2. Having any of the following:

a. Incorporating an aerosol dispensing system/mechanism with a capacity greater than 20 litres; or

b. Designed or modified to incorporate an aerosol dispensing system/mechanism with a capacity greater than 20 litres.

Technical Notes:

1. An aerosol consists of particulate or liquids other than fuel components, by products or additives, as part of the payload to be dispersed in the atmosphere. Examples of aerosols include pesticides for crop dusting and dry chemicals for cloud seeding.

2. An aerosol dispensing system/mechanism contains all those devices (mechanical, electrical, hydraulic, etc.), which are necessary for storage and dispersion of an aerosol into the atmosphere. This includes the possibility of aerosol injection into the combustion exhaust vapour and into the propeller slip stream.

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, sounding rockets specified in 9A104 or 'missiles';

Technical Notes:

1. In 9A115.a 'missile' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.

9A115 a. (*continued*)

2. Apparatus and devices specified in 9A115.a include those installed on a manned aircraft or an unmanned aerial vehicle.

b. Vehicles for transport, handling, control, activation or launching, designed or modified for space launch vehicles specified in 9A004, sounding rockets specified in 9A104 or "missiles".

9A116 Reentry vehicles, usable in "missiles", and equipment designed or modified therefor, as follows:

a. Reentry vehicles;

b. Heat shields and components therefor, fabricated of ceramic or ablative materials;

c. Heat sinks and components therefor, fabricated of light-weight, high heat capacity materials;

d. Electronic equipment specially designed for reentry vehicles.

9A117 Staging mechanisms, separation mechanisms, and interstages, usable in "missiles".

NB: SEE ALSO 9A121.

9A118 Devices to regulate combustion usable in engines, which are usable in "missiles" or unmanned aerial vehicles specified in 9A012 or 9A112.a., 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, other than those specified in 9A005, 9A007, 9A009, 9A105, 9A107 and 9A109.

9A120 Liquid or gel propellant tanks, other than those specified in 9A006, specially designed for propellants specified in 1C111 or 'other liquid or gel 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 or gel propellants' includes, but is not limited to, propellants specified in THE MILITARY GOODS CONTROLS.

9A121 Umbilical and interstage electrical connectors specially designed for "missiles", space launch vehicles specified in 9A004 or sounding rockets specified in 9A104.

Note:

In 9A121, interstage electrical connectors also include electrical connectors installed between the "missile", space launch vehicle or sounding rocket and their payload.

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 atomisers and similar devices.

9A350 (*continued*)

Note: *9A350 does not control spraying or 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

Note *9B includes test, inspection and production equipment applicable to aero, aero-derivative, industrial or marine gas turbine engines.*

9B001 Manufacturing equipment, tooling or fixtures, as follows:

NB: *SEE ALSO 2B226*

a. Directional-solidification or single-crystal casting equipment designed for "superalloys";

b. Casting tooling, specially designed for manufacturing gas turbine engine blades, vanes or "tip shrouds", manufactured from refractory metals or ceramics, as follows:

   1. Cores;

   2. Shells (moulds);

   3. Combined core and shell (mould) units;

c. Directional-solidification or single-crystal additive-manufacturing equipment, designed for "superalloys".

9B002 On-line (real time) control systems, instrumentation (including sensors) or automated data acquisition and processing equipment, having all of the following:

a. Specially designed for the "development" of gas turbine engines, assemblies or components; and

b. Incorporating any of the "technologies" specified in 9E003.h. or 9E003.i.

9B003 Equipment specially designed for the "production" or test of gas turbine engine 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 aerofoil-to-disk combinations described in 9E003.a.3. or 9E003.a.6. for gas turbine engines.

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:

NB: SEE ALSO 9B105.

a. Wind tunnels designed for speeds of Mach 1,2 or more;

Note: 9B005.a. does not apply to wind tunnels specially designed for educational purposes and having a 'test section size' (measured laterally) of less than 250 mm.

Technical Note:

For the purposes of 9B005.a. Note, 'test section size' means the diameter of the circle, or the side of the square, or the longest side of the rectangle, at the largest test section location.

b. Devices for simulating flow-environments at speeds exceeding Mach 5, including hot-shot tunnels, plasma arc tunnels, shock tubes, shock tunnels, gas tunnels and light gas guns; or

c. Wind tunnels or devices, other than two-dimensional sections, capable of simulating Reynolds number flows exceeding 25×10^6.

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.

NB: SEE ALSO 9B106.

9B007 Equipment specially designed for inspecting the integrity of rocket motors and using Non-Destructive Test (NDT) techniques other than planar x-ray or basic physical or chemical analysis.

9B008 Direct measurement wall skin friction transducers specially designed to operate at a test flow total (stagnation) temperature exceeding 833 K (560 °C).

9B009 Tooling specially designed for producing gas turbine engine powder metallurgy rotor components having all of the following:

a. Designed to operate at stress levels of 60 % of ultimate tensile strength or more measured at a temperature of 873 K (600 °C); and

b. Designed to operate at 873 K (600 °C) or more.

Note: 9B009 does not control tooling for the "production" of powder.

9B010 Equipment specially designed for the "production" of items specified in 9A012.

9B105 Aerodynamic test facilities for speeds of Mach 0,9 or more, usable for 'missiles' and their subsystems.

NB: SEE ALSO 9B005.

Notes:

1. 9B105 includes wind tunnels and shock tunnels for the study of airflow over objects.

2. 9B105 does not control wind-tunnels for speeds of Mach 3 or less with dimension of the 'test cross section size' equal to or less than 250 mm.

9B105 (*continued*)

Technical Notes:

1. *In Note to 9B105, 'test cross section size' means the diameter of the circle, or the side of the square, or the longest side of the rectangle, or the major axis of the ellipse at the largest 'test cross section' location. 'Test cross section' is the section perpendicular to the flow direction.*

2. *In 9B105 'missile' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.*

9B106 Environmental chambers and anechoic chambers, as follows:

a. Environmental chambers having all of the following:

1. Capable of simulating any of the following flight conditions:

a. Altitude equal to or greater than 15 km; or

b. Temperature range from below 223 K (-50°C) to above 398 K (125°C); and

2. Incorporating, or 'designed or modified' to incorporate, a shaker unit or other vibration test equipment to produce vibration environments equal to or greater than 10 g rms, measured 'bare table', between 20 Hz and 2 kHz while imparting forces equal to or greater than 5 kN;

Technical Notes:

1. *9B106.a.2. 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.2., 'designed or modified' means the environmental chamber provides appropriate interfaces (e.g., sealing devices) to incorporate a shaker unit or other vibration test equipment as specified in 2B116.*

3. *In 9B106.a.2., '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 from below 223 K (-50°C) to above 398 K (125°C).

9B107 Aerothermodynamic test facilities, usable for 'missiles', 'missile' rocket propulsion systems, and reentry vehicles and equipment specified in 9A116, having any of the following characteristics:

a. An electrical power supply equal to or greater than 5 MW; or

b. A gas supply total pressure equal to or greater than 3 MPa.

Notes:

1. *9B107 includes plasma arc jet facilities and plasma wind tunnels for the study of thermal and mechanical effects of airflow on objects.*

2. *In 9B107 'missile' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.*

9B115 Specially designed "production equipment" for the systems, sub-systems and components specified in 9A005 to 9A009, 9A011, 9A101, 9A102, 9A105 to 9A109, 9A111, 9A116 to 9A120.

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, 9A102, 9A104 to 9A109, 9A111, 9A116 to 9A120 or 'missiles'.

Technical Note:

In 9B116 'missile' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.

9B117 Test benches or test stands for solid or liquid propellant rockets or rocket motors, having either of the following characteristics:

a. The capacity to handle more than 68 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", other than those specified in 9A008, for rocket motor cases usable in "missiles" or specially designed for solid propellant rocket engines specified in 9A007 or 9A107.

Note:

In 9C108, insulation intended to be applied to the components of a rocket motor, i.e. the case, nozzle inlets, case closures, 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 specified in 9A108.

9C110 Resin impregnated fibre prepregs and metal coated fibre preforms therefor, for composite structures, laminates and manufactures specified in 9A110, made either with organic matrix or metal matrix utilising fibrous or filamentary reinforcements having a "specific tensile strength" greater than $7{,}62 \times 10^4$ m and a "specific modulus" greater than $3{,}18 \times 10^6$ m.

NB: SEE ALSO 1C010 AND 1C210.

Note: The only resin impregnated fibre prepregs specified in entry 9C110 are those using resins with a glass transition temperature (T_g), after cure, exceeding 418 K (145°C) as determined by ASTM D4065 or equivalent.

9D Software

9D001 "Software", not specified in 9D003 or 9D004, specially designed or modified for the "development" of equipment or "technology", specified in 9A001 to 9A119, 9B or 9E003.

9D002 "Software", not specified in 9D003 or 9D004, specially designed or modified for the "production" of equipment specified in 9A001 to 9A119 or 9B.

9D003 "Software" incorporating "technology" specified in 9E003.h. and used in "Full Authority Digital Engine Control (FADEC) Systems" for systems specified in 9A or equipment specified in 9B.

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;

9D004 (*continued*)

b. "Software" for testing aero gas turbine engines, assemblies or components, having all of the following:

1. Specially designed for testing any of the following:

a. Aero gas turbine engines, assemblies or components, incorporating "technology" specified in 9E003.a., 9E003.h. or 9E003.i.; or

b. Multi-stage compressors providing either bypass or core flow, specially designed for aero gas turbine engines incorporating "technology" specified in 9E003.a. or 9E003.h.; and

2. Specially designed for all of the following:

a. Acquisition and processing of data, in real time; and

b. Feedback control of the test article or test conditions (e.g. temperature, pressure, flow rate) while the test is in progress;

Note: *9D004.b. does not control software for operation of the test facility or operator safety (e.g. overspeed shutdown, fire detection and suppression), or "production", repair or maintenance acceptance-testing limited to determining if the item has been properly assembled or repaired.*

c. "Software" specially designed to control directional solidification or single crystal material growth in equipment specified in 9B001.a. or 9B001.c.;

d. Not used;

e. "Software" specially designed or modified for the operation of items specified in 9A012;

f. "Software" specially designed to design the internal cooling passages of aero gas turbine blades, vans and "tip shrouds";

g. "Software" having all of the following:

1. Specially designed to predict aero thermal, aeromechanical and combustion conditions in aero gas turbine engines; and

2. Theoretical modelling predictions of the aero thermal, aeromechanical and combustion conditions, which have been validated with actual aero gas turbine engine (experimental or production) performance data.

9D005 "Software" specially designed or modified for the operation of items specified in 9A004.e. or 9A004.f.

NB: *For "software" for items specified in 9A004.d. that are incorporated into "spacecraft mission equipment", see the appropriate Categories.*

9D101 "Software" specially designed or modified for the "use" of goods specified in 9B105, 9B106, 9B107, 9B116 or 9B117.

9D103 "Software" specially designed for modelling, simulation or design integration of the space launch vehicles specified in 9A004, sounding rockets specified in 9A104 or "missiles", or the subsystems specified in 9A005, 9A007, 9A105, 9A106.c., 9A107, 9A108.c., 9A116 or 9A119.

Note: *"Software" specified in 9D103 remains controlled when combined with specially designed hardware specified in 4A102.*

9D104 "Software" as follows:

a. "Software" specially designed or modified for the "use" of goods specified in 9A001, 9A005, 9A006.d., 9A006.g., 9A007.a., 9A009.a., 9A010.d., 9A011, 9A101, 9A102, 9A105, 9A106.d., 9A107, 9A109, 9A111, 9A115.a., 9A117 or 9A118.

9D104 (*continued*)

b. "Software" specially designed or modified for the operation or maintenance of subsystems or equipment specified in 9A008.d., 9A106.c., 9A108.c. or 9A116.d.

9D105 "Software" specially designed or modified to coordinate the function of more than one subsystem, other than that specified in 9D004.e., in space launch vehicles specified in 9A004 or sounding rockets specified in 9A104 or 'missiles'

Note: *9D105 includes "software" specially designed for a manned "aircraft" converted to operate as "unmanned aerial vehicle", as follows:*

a. "Software" specially designed or modified to integrate the conversion equipment with the "aircraft" system functions; and

b. "Software" specially designed or modified to operate the "aircraft" as an "unmanned aerial vehicle".

Technical Note:

In 9D105 'missile' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.

9E Technology

Note: *"Development" or "production" "technology" specified in 9E001 to 9E003 for gas turbine engines remains controlled when used for repair or 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 9A004 to 9A012, 9A350, 9B or 9D.

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

NB: *For "technology" for the repair of controlled structures, laminates or materials, see 1E002.f.*

9E003 Other "technology" as follows:

Note: *9E003 includes technology applicable to aero, aero-derivative, marine or industrial gas turbine engines.*

a. "Technology" "required" for the "development" or "production" of any of the following gas turbine engine components or systems:

1. Turbine blades, vanes or "tip shrouds", made from directionally-solidified or single-crystal alloys and having (in the 001 Miller Index Direction) a stress-rupture life exceeding 400 hours at 1 273 K (1 000 °C) at a stress of 200 MPa, based on the average property values;

Technical Note:

For the purposes of 9E003.a.1., stress-rupture life testing is typically conducted on a test specimen.

2. Combustors having any of the following:

a. 'Thermally decoupled liners' designed to operate at 'combustor exit temperature' exceeding 1 883K (1 610 °C);

b. Non-metallic liners;

c. Non-metallic shells;

9E003 a. 2. (*continued*)

d. Liners designed to operate at 'combustor exit temperature' exceeding 1 883 K (1 610 °C) and having holes that meet the parameters specified in 9E003.c.; or

e. 'Pressure gain combustion';

Note: *The "required" "technology" for holes in 9E003.a.2. is limited to the derivation of the geometry and location of the holes.*

Technical Notes:

1. *For the purposes of 9E003.a.2.a., 'thermally decoupled liners' are liners that feature at least a support structure designed to carry mechanical loads and a combustion facing structure designed to protect the support structure from the heat of combustion. The combustion facing structure and support structure have independent thermal displacement (mechanical displacement due to thermal load) with respect to one another, i.e., they are thermally decoupled.*

2. *For the purposes of 9E003.a.2.a. and 9E003.a.2.d., 'combustor exit temperature' is the bulk average gas path total (stagnation) temperature between the combustor exit plane and the leading edge of the turbine inlet guide vane (i.e., measured at engine station T40 as defined in SAE ARP 755A) when the engine is running in a "steady state mode" of operation at the certificated maximum continuous operating temperature.*

3. *For the purposes of 9.E.3.a.2.e., 'pressure gain combustion' refers to a combustor where the bulk average stagnation pressure at the combustor outlet is greater than the bulk average stagnation pressure at the combustor inlet due primarily to the combustion process, when the engine is running in a "steady state mode" of operation.*

NB: *For "technology" "required" for manufacturing cooling holes, see 9E003.c.*

3. Components that are any of the following:

a. Manufactured from organic "composite" materials designed to operate above 588 K (315 °C);

b. Manufactured from any of the following:

1. Metal "matrix" "composites" reinforced by any of the following:

a. Materials specified in 1C007 or 1C507;

b. "Fibrous or filamentary materials" specified in 1C010; or

c. Aluminides specified in 1C002.a.; or

2. Ceramic "matrix" "composites" specified in 1C007 or 1C507; or

c. Stators, vanes, blades, tip seals (shrouds), rotating blings, rotating blisks, or 'splitter ducts', that are all of the following:

1. Not specified in 9E003.a.3.a.;

2. Designed for compressors or fans; and

3. Manufactured from material specified in 1C010.e. with resins specified in 1C008;

Technical Note:

For the purposes of 9E003.a.3.c., a 'splitter duct' performs the initial separation of the air-mass flow between the bypass and core sections of the engine.

9E003 a. (*continued*)

4. Uncooled turbine blades, vanes or "tip shrouds", designed to operate at a 'gas path temperature' of 1 373 K (1 100 °C) or more;

5. Cooled turbine blades, vanes, "tip shrouds" other than those described in 9E003.a.1., designed to operate at a 'gas path temperature' of 1 693 K (1 420 °C) or more;

Technical Note:

For the purposes of 9E003.a.4. and 9E003.a.5., 'gas path temperature' is the bulk average gas path total (stagnation) temperature at the leading edge plane of the turbine component when the engine is running in a "steady state mode" of operation at the certificated or specified maximum continuous operating temperature.

6. Aerofoil-to-disk blade combinations using solid-state joining;

7. Not used;

8. 'Damage tolerant' rotor components using powder metallurgy materials specified in 1C002.b.; or

Technical Note:

For the purposes of 9E003.a.8., 'damage tolerant' components are designed using methodology and substantiation to predict and limit crack growth.

9. Not used;

10. Not used;

11. 'Fan blades' having all of the following:

a. 20 % or more of the total volume being one or more closed cavities containing vacuum or gas only; and

b. One or more closed cavities having a volume of 5 cm^3 or larger;

Technical Note:

For the purposes of 9E003.a.11., a 'fan blade' is the aerofoil portion of the rotating stage or stages, which provide both compressor and bypass flow in a gas turbine engine.

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 manufacturing cooling holes in gas turbine engine components incorporating any of the "technologies" specified in 9E003.a.1., 9E003.a.2. or 9E003.a.5., and having any of the following:

1. Having all of the following:

a. Minimum 'cross-sectional area' less than 0,45 mm^2;

b. 'Hole shape ratio' greater than 4,52; and

c. 'Incidence angle' equal to or less than 25°; or

9E003 c. (*continued*)

2. Having all of the following:

a. Minimum 'cross-sectional area' less than 0,12 mm^2;

b. 'Hole shape ratio' greater than 5,65; and

c. 'Incidence angle' more than 25°;

Note: *9E003.c. does not control "technology" for manufacturing constant radius cylindrical holes that are straight through and enter and exit on the external surfaces of the component.*

Technical Notes:

For the purposes of 9E003.c.:

1. The 'cross-sectional area' is the area of the hole in the plane perpendicular to the hole axis.

2. 'Hole shape ratio' is the nominal length of the axis of the hole divided by the square root of its minimum 'cross-sectional area'.

3. 'Incidence angle' is the acute angle measured between the plane tangential to the aerofoil surface and the hole axis at the point where the hole axis enters the aerofoil surface.

4. Methods for manufacturing holes include "laser" beam machining, water jet machining, Electro-Chemical Machining (ECM) or Electrical Discharge Machining (EDM).

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. 'Box volume' of 1,2 m^3 or less;

2. An overall power output of more than 750 kW based on 80/1269/EEC, ISO 2534 or national equivalents; and

3. Power density of more than 700 kW/m^3 of 'box volume';

Technical Note:

For the purposes of 9E003.e., '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 largest of any of the following:

a. The outside dimension from valve cover to valve cover;

b. The dimensions of the outside edges of the cylinder heads; or

c. The diameter of the flywheel housing;

Height: The largest of any of the following:

a. The dimension of the crankshaft centre-line to the top plane of the valve cover (or cylinder head) plus twice the stroke; or

b. The diameter of the flywheel housing.

f. "Technology" "required" for the "production" of specially designed components for "high output diesel engines", as follows:

1. "Technology" "required" for the "production" of engine systems having all of the following components employing ceramics materials specified in 1C007 or 1C507:

a. Cylinder liners;

9E003 f. 1. (*continued*)

b. Pistons;

c. Cylinder heads; and

d. One or more other components (including exhaust ports, turbochargers, valve guides, valve assemblies or insulated fuel injectors);

2. "Technology" "required" for the "production" of turbocharger systems with single-stage compressors and having all of the following:

a. Operating at pressure ratios of 4:1 or higher;

b. Mass flow in the range from 30 to 130 kg per minute; and

c. Variable flow area capability within the compressor or turbine sections;

3. "Technology" "required" for the "production" of fuel injection systems with a specially designed multifuel (e.g., diesel or jet fuel) capability covering a viscosity range from diesel fuel (2,5 cSt at 310,8 K (37,8 °C)) down to gasoline fuel (0,5 cSt at 310,8 K (37,8 °C)) and having all of the following:

a. Injection amount in excess of 230 mm^3 per injection per cylinder; and

b. Electronic control features specially designed for switching governor characteristics automatically depending on fuel property to provide the same torque characteristics by using the appropriate sensors;

g. "Technology" "required" for the "development" or "production" of "high output diesel engines" for solid, gas phase or liquid film (or combinations thereof) cylinder wall lubrication and permitting operation to temperatures exceeding 723 K (450 °C), measured on the cylinder wall at the top limit of travel of the top ring of the piston;

h. "Technology" for gas turbine engine "Full Authority Digital Engine Control (FADEC) systems" as follows:

1. "Development" "technology" for deriving the functional requirements for the components necessary for the "FADEC system" to regulate engine thrust or shaft power (e.g., feedback sensor time constants and accuracies, fuel valve slew rate);

2. "Development" or "production" "technology" for control and diagnostic components unique to the "FADEC system" and used to regulate engine thrust or shaft power;

3. "Development" "technology" for the control law algorithms, including "source code", unique to the "FADEC system" and used to regulate engine thrust or shaft power;

Note: *9E003.h. does not control technical data related to engine-"aircraft" integration required by the civil aviation authorities of one or more Member States or Wassenaar Arrangement Participating States to be published for general airline use (e.g., installation manuals, operating instructions, instructions for continued airworthiness) or interface functions (e.g., input/output processing, airframe thrust or shaft power demand).*

i. "Technology" for gas turbine engine adjustable flow path systems designed to maintain engine stability for gas generator turbines, fan or power turbines, or propelling nozzles, as follows:

1. "Development" "technology" for deriving the functional requirements for the components that maintain engine stability;

2. "Development" or "production" "technology" for components unique to the adjustable flow path system and that maintain engine stability;

9E003 i. (*continued*)

3. "Development" "technology" for the control law algorithms, including "source code", unique to the adjustable flow path system and that maintain engine stability;

Note: *9E003.i. does not control "technology" for any of the following:*

a. Inlet guide vanes;

b. Variable pitch fans or prop-fans;

c. Variable compressor vanes;

d. Compressor bleed valves; or

e. Adjustable flow path geometry for reverse thrust.

j. "Technology" "required" for the "development" of wing-folding systems designed for fixed-wing "aircraft" powered by gas turbine engines;

NB: *For "technology" "required" for the "development" of wing-folding systems designed for fixed-wing "aircraft" SEE ALSO MILITARY GOODS CONTROLS.*

k. "Technology", not specified in 9E003.a., 9E003.h., or 9E003.i., "required" for the "development" of any of the following components or systems, specially designed for aero gas turbine engines to enable "aircraft" to cruise at Mach 1 or greater for more than 30 minutes:

1. Propulsion inlet systems;

2. Propulsion exhaust systems;

3. 'Reheat systems';

4. 'Active thermal management systems' to condition fluids used to lubricate or cool 'engine rotor supports';

5. Oil-free 'engine rotor supports'; or

6. Systems to remove heat from 'compression system' core gas path flow.

Technical Notes:

For the purposes of 9E003.k.:

1. Propulsion inlet systems include core flow pre-coolers.

2. 'Reheat systems' provide additional thrust by combusting fuel in exhaust and/or bypass flow downstream of the last turbomachinery stage. 'Reheat systems' are also referred to as afterburners.

3. 'Active thermal management systems' employ methods other than passive oil-to-air cooling or oil-to-fuel cooling, such as vapour cycle systems.

4. 'Compression system' is any stage or combination of stages between the engine inlet face and the combustor that increases gas path pressure through mechanical work.

5. An 'engine rotor support' is the bearing supporting the main engine shaft that drives the compression system or turbine rotors.

N.B.1 *For engine control technology, see 9E003.h.*

N.B.2 *For adjustable flow path systems technology, see 9E003i.*

9E101 "Technology" as follows:

a. "Technology" according to the General Technology Note for the "development" of goods specified in 9A101, 9A102, 9A104 to 9A111, 9A112.a. or 9A115 to 9A121.

b. "Technology" according to the General Technology Note for the "production" of 'UAV's specified in 9A012 or goods specified in 9A101, 9A102, 9A104 to 9A111, 9A112.a. or 9A115 to 9A121.

Technical Note:

In 9E101.b. 'UAV' means unmanned aerial vehicle systems capable of a range exceeding 300 km.

9E102 "Technology" according to the General Technology Note for the "use" of space launch vehicles specified in 9A004, goods specified in 9A005 to 9A011, 'UAV's specified in 9A012 or goods specified in 9A101, 9A102, 9A104 to 9A111, 9A112.a., 9A115 to 9A121, 9B105, 9B106, 9B107, 9B115, 9B116, 9B117, 9D101 or 9D103.

Technical Note:

In 9E102 'UAV' means unmanned aerial vehicle systems capable of a range exceeding 300 km.'.

9E503 Other "technology" as follows:

Note: 9E503 includes technology applicable to aero, aero-derivative, marine or industrial gas turbine engines.

l. "Technology" "required" for the "development" of a gas turbine engine axial compressor having all of the following:

1. Having any of the following:

a. Specially designed for 'multiple stream fan systems'; or

b. Having any of the following:

1. Feedback control of compressor blade tip clearance;

2. Feedback management for the purpose of compressor aerofoil flutter avoidance;

3. Cooled gas path or cooled rotating compressor components;

4. 'Tandem or splittered rotating aerofoils'; or

5. 'Casings having non-axisymmetric geometry' at the blade tip interface; and

2. Having all of the following calculated parameters:

a. Average 'alternate stage loading' greater than or equal to 0,22;

b. A sum of the 'alternate stage loading' multiplied by 41,6 and the 'polytropic efficiency' greater than or equal to 102;

c. 'Stability margin' greater than or equal to 20 %; and

d. Average stage pressure ratio greater than 1,2.

Technical Notes:

1. For the purposes of 9E503.l.1.a., 'multiple stream fan systems' allow the movement of airflow between at least two bypass flows to control fan pressure ratio or bypass ratio (by means other than use of fan corrected speed or the primary nozzle area to change the fan pressure ratio or bypass ratio.)

2. For the purposes of 9E503.l.1.b.3., cooled gas path components do not include compressor components indirectly cooled by leakage flows, flows for bearing load management or anti-icing flows.

9E503 l. (*continued*)

3. *For the purposes of 9E503.l.1.b.4., 'tandem or splittered rotating aerofoils' consist of two or more rotating blade rows in the axial direction without an intervening stator. Aerofoils are considered splittered when the leading-edge plane of each row is offset axially by 25 % or more of the axial chord length of the first row.*

4. *For the purposes of 9E503.l.1.b.5., 'casings having non-axisymmetric geometry' contain features that are non-uniformly spaced or inconsistently shaped or inconsistently oriented in the circumferential direction at the blade tip, e.g., variable spacing of slots parallel to the engine shaft. 'Casings having non-axisymmetric geometry' do not include features designed for assembly or mechanical designs that result in circumferentially uniform geometry during engine operation.*

5. *For the purposes of 9E503.l.2, the calculated parameters are as follows:*

   a. *Start at the engine inlet and are performed at sea level static conditions using ICAO standard atmosphere, zero aircraft bleed (e.g., no stability, start, anti-ice or customer bleeds), and at the "steady state mode" 'Aerodynamic Design Point' ('ADP'). Compressor bleeds and "steady state mode" shaft power offtake for normal engine operation at the specified point, e.g., turbine cooling, are included.*

   b. *Stages that provide fan bypass flow on a continuous basis are not to be included in the calculations.*

   c. *Values are calculated for each rotor stage individually, then averaged over all compression stages operating at the same shaft speed (i.e., average of all low-, intermediate-, or high-pressure compressor stages, or all compression stages for a single spool engine)*

   d. *'Alternate stage loading' is defined as the average isentropic work divided by the square of the mechanical tip speed of the rotor and then multiplied by the ratio of standard day temperature divided by the spool inlet total temperature.*

$$Lp'_{alt} = \frac{T_{STD}}{T_{0spool}} \frac{1}{N} \sum_{i=1}^{N} \frac{c_{p_i} T_{0i} \left(\pi_i^{(\gamma_i - 1)/\gamma_i} - 1 \right)}{U_i^2}$$

Where:

T_{STD} – *Standard day temperature at ICAO standard atmosphere (K)*

T_{0spool} – *Spool entrance inlet temperature (K)*

N – *Number of stages*

T_0 – *Stage inlet total temperature (K)*

c_p – *Specific heat capacity (J kg^{-1} K^{-1} or m^2 s^{-2} K^{-1}) as a function of temperature*

γ – *Ratio of specific heats as a function of temperature*

U – *Mechanical tip speed of the rotor leading edge (m/s)*

π – *Stage total-to-total pressure ratio*

The individual stage loading should be computed stage-by-stage and then the average of all stages should be assessed as the loading parameter.

   e. *'Polytropic efficiency' is defined as the overall compression divided into an infinite number of small steps with the same isentropic efficiency, expressed as a percentage.*

   f. *'Stability margin' is the difference between the design operating line and the calculated compressor surge point at constant inlet corrected mass flow, expressed as a percent of the operating line.*

6. *For the purposes of Technical Note 5.a., 'ADP' refers to the corrected conditions (flow rate, pressure ratio, and speed) for the compressor flow path design (e.g. optimum efficiency or optimum incidence point). The 'ADP' may be consistent with an aero gas turbine engine 'ADP' or a specific condition along an operating line such as top of climb, cruise, or takeoff.'*