NEW ZEALAND
FOREIGN AFFAIRS & TRADE

NEW ZEALAND STRATEGIC GOODS LIST

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Implemented by the
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under the
Customs Export Prohibition Order 2021[1]

[1] Or successive Customs Export Prohibition Orders

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Introduction

New Zealand controls the export of strategic goods, namely:

- firearms, ammunition, military goods and technologies; and
- dual-use goods and technologies which may have a civilian use but that are intended for military end-use or that may have a military application, including those that can be used in the production, development or delivery of nuclear, chemical or biological weapons.

Controlled items are those listed in the **New Zealand Strategic Goods List**.

Controlled items may not be exported from New Zealand, including the electronic export of listed software and technology, unless an export licence or permission has been obtained from the Secretary of Foreign Affairs and Trade.

Controls on the export of strategic goods are implemented through the Customs Export Prohibition (Strategic Goods) Order 2021 (or successive Orders), promulgated under the Customs and Excise Act 2018.

Chemical Weapons (Prohibition) Act 1996

Additionally, the Strategic Goods List **incorporates** those chemicals covered by Chemical Weapons (Prohibition) Act 1996.

Except with the consent of the Secretary of Foreign Affairs and Trade, the importation into New Zealand, and the exportation from New Zealand, of any toxic chemical or precursor listed in Schedules 1, 2, and 3 of the Annex on Chemicals of the Act is prohibited.

Applications to export or import these controlled chemicals should be made through the export controls regime administered by the Ministry of Foreign Affairs and Trade, using the same process as for controlled goods.

New Zealand Strategic Goods List

The New Zealand Strategic Goods List includes items set out in the control lists of the four international export control and non-proliferation regimes of which New Zealand is a member and the Arms Trade Treaty:

- the Wassenaar Arrangement, which controls conventional weapons and dual-use goods and technologies;
- the Missile Technology Control Regime; which controls missile-related goods and technologies;
- the Australia Group, which controls chemical and biological weapons-related materials;
- the Nuclear Suppliers Group, which controls nuclear material, equipment and technology; and

- the Arms Trade Treaty, which controls certain conventional weapons and their associated ammunition/munitions.

The New Zealand Strategic Goods List is amended from time to time to reflect changes in the control lists of these international export control regimes. The amendments incorporated into this 2021 Strategic Goods List can be accessed on the Ministry of Foreign Affairs and Trade website: https://www.mfat.govt.nz/en/trade/trading-weapons-and-controlled-chemicals/

The New Zealand Strategic Goods List includes equipment, assemblies and components, associated test, inspection and production equipment, materials, software and technology.

The list is divided into two parts.

PART 1: **Military goods and technologies and non-military lethal goods**

Part 1 covers defence and related goods and technology and includes:

- *Military Goods and Technologies* – defence and related goods or technology designed or adapted for military purposes including parts and accessories

- *Non Military Lethal Goods* – goods that are inherently lethal, incapacitating or destructive such as non-military firearms, non-military ammunition and commercial explosives and initiators.

PART 2**: Dual-use goods and technologies**

Part 2 covers goods and technologies developed to meet commercial needs but which may be used either as military components or for the development or production of military systems or weapons of mass destruction. This part is further subdivided into the following categories:

- *Category 0* – Nuclear Materials, Facilities and Equipment
- *Category 1* – Materials, Chemicals, Microorganisms and Toxins
- *Category 2* – Materials Processing
- *Category 3* – Electronics
- *Category 4* – Computers
- *Category 5* – Telecommunications and Information Security
- *Category 6* – Sensors and Lasers
- *Category 7* – Navigation and Avionics
- *Category 8* – Marine
- *Category 9* – Aerospace and Propulsion
- Sensitive list of dual-use goods and technologies
- Very Sensitive list of dual-use goods and technologies

Catch-all/End-use Controls

The Customs and Excise Act 2018 also controls the physical and electronic transfer of **non-listed** goods, software and technologies in certain circumstances. These are known as "catch-all" or "end-use" controls.

The Catch-all control provisions have been expanded and are given effect through a Gazette Notice which entered into force on 9 October 2020.

The Gazette Notice and explanatory information on the application of the catch-all controls can be viewed on the export controls webpage at the Ministry of Foreign Affairs and Trade: Which goods are controlled? | New Zealand Ministry of Foreign Affairs and Trade (mfat.govt.nz)

In brief, the upgraded controls:

- Carry over the existing prohibition on the export of items with an end-use related to weapons of mass destruction and their means of delivery.
- Establish a new prohibition on items for use in terrorist acts, as provided for in the Act.
- Carry forward the existing prohibition on items for military end-use[2], but remove the caveat that it only apply to countries under a UN arms embargo.
- Extend military end-use controls to items that "materially enable or support operations or functions of a military or internal security nature".
- Apply controls to all countries and products.
- Provide exemptions for exporters from needing to seek permits for low-risk countries and products; for goods supplied under government assistance programmes; and for parts, components and replacement items (unless incorporated into weapons or used for the production, maintenance or testing of weapons).

Further information

Application forms and information on how to apply for an export permit are set out on the Ministry of Foreign Affairs and Trade website. For further information, please contact:

Export Controls Office
International Security and Disarmament Division
Ministry of Foreign Affairs and Trade
Private Bag 18 901
Wellington 6160
New Zealand

Phone: +64 4 439 8227
E-mail: exportcontrols@mfat.govt.nz
Website: https://mfat.govt.nz/en/trade/trading-weapons-and-controlled-chemicals/

[2] "Military" includes any armed force, paramilitary force, police force, or militia.

General Notes

Definitions

Terms in "quotation marks" are defined terms as per the Definition of Terms (see page 14). Words and terms that are defined and that appear in the New Zealand Strategic Goods List without quotation marks are intended to take their ordinary dictionary meanings.

Notes

The Notes, Technical Notes and Nota Bene (N.B.) appearing in the New Zealand Strategic Goods List form an integral part of the control text.

Index

The New Zealand Strategic Goods List does not contain an index. Text based searches can made of this document.

Incorporated goods

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

Note: 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.

New and used goods

Goods specified in the New Zealand Strategic Goods List include both new and used goods.

Exemptions

The Secretary of Foreign Affairs and Trade has issued certain General Consents (exemptions) for the export of strategic goods without the need for a permit from the Ministry of Foreign Affairs and Trade (MFAT). These are listed under the General Consents section of the Strategic Goods List (see page 11). In some cases there is still a requirement to notify the Ministry of Foreign Affairs and Trade of the details of the export, including for international reporting requirements of arms transfers.

Ammunition

Permits are required for the export of ammunition although there are some exemptions for ammunition collectors exporting for exhibitions. These are listed under the General Consents section of the Strategic Goods List on Page 11.

Civil Aircraft

Unless subject to catch-all controls, export permits are **not** required for "Civil aircraft" (including helicopters) as specified in the New Zealand Strategic Good List Definition of Terms, meaning:

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

CAS numbers

In some instances, chemicals are listed by name and CAS number. The list applies to chemicals of the same structural formula (including hydrates, isotopically-labelled forms or all possible steroisomers) regardless of name or CAS number. CAS numbers are shown to assist in identifying a particular chemical or mixture, irrespective of nomenclature. CAS numbers cannot be used as unique identifiers because:

(a) some forms of the listed chemical have different CAS numbers; and

(b) mixtures containing a listed chemical may also have different CAS numbers.

Source code

"Source code" items are controlled either by "software" or by "software" and "technology" controls, except when such "source code" items are explicitly decontrolled.

Medical equipment

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

Part 2: Dual-use Goods and Technologies: Sensitive and Very Sensitive List

The Sensitive and Very Sensitive Lists contain a sub-set of the items controlled in Categories 1 to 9 of the Part 2 Dual-Use List. The items in these Lists require additional care in their transfer. General Consent Permits are generally not available for the export of these items.

Nuclear technology note (NTN)

Note: 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 "fundamental research".

General technology note (GTN)

Note: This note applies to all technology controls in Categories 1 to 9 of the Dual-Use List.

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

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

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

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

Controls on “technology” transfer do not apply to information “in the public domain”, to “fundamental research” or to the minimum necessary information for patent applications.

General software note (GSN)

Note: This note applies to all software controls in the New Zealand Strategic Goods List.

The New Zealand Strategic Goods List does not control “software” which is any of the following:

(1) generally available to the public by being:
  (a) sold from stock at retail selling points, without restriction, by means of:
    1. over the counter transactions; or
    2. mail order transactions; or
    3. electronic transactions; or
    4. telephone order transactions; and
  (b) designed for installation by the user without further substantial support by the supplier;

Note: Entry (1) does not release “software” specified in Category 5 - Part 2 (“Information Security”).

(2) “in the public domain”;

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

Note: Entry (3) does not release “software” controlled by 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.

Clinical trials note

Clinical trials where the therapeutic goods are subject to, or proposed to be subject to, an exemption or approval under a specified legislative framework.

General Consents to Export without a Permit (Exemptions)

The Secretary of Foreign Affairs and Trade has issued the following General Consents (exemptions) for the export of strategic goods without the need for a permit from the Ministry of Foreign Affairs and Trade (MFAT).

These General Consents replace those issued in September 2019.

(I) Approvals for private persons to export certain firearms and ammunition

Private persons may export up to five sporting firearms (**see Note 1 below**) and related ammunition without a permit from MFAT in the following circumstances, **other than to the countries listed below**, and subject to the **notification requirements** listed below:

(a) Persons taking their own sporting firearms overseas for recreational purposes, and who will be returning those firearms to New Zealand; or

(b) New Zealand competitors in international shooting contests taking competition sporting firearms overseas for their own use, and who will be returning those firearms to New Zealand; or

(c) Persons who have been in New Zealand on a hunting holiday may export their firearms and/or parts which they originally imported with a permit issued by the New Zealand Police; or

(d) Persons who have been in New Zealand competing in a national or international shooting competition, or who are transiting New Zealand to attend or return from a competition in a third country may export their firearms and/or parts which they originally imported with a permit issued by the New Zealand Police; and

(e) Persons exporting firearms covered by (a) to (d) above may export related ammunition and/or used cartridges. The ammunition/used cartridges must accompany the firearms (this approval does not permit the export of ammunition on its own).

Notification Requirements

Exempted exports of firearms and ammunition covered by (a) to (e) above, however, are required to be notified to the Ministry of Foreign Affairs and Trade. The notification form can be accessed from the MFAT website: https://mfat.govt.nz/en/trade/trading-weapons-and-controlled-chemicals/which-goods-are-controlled/#exemptions

Countries not covered by the above general consents to export

The above general consents to export do not apply to firearms being exported to the following countries or territories, with the exception of (I)(d) above, and ammunition/used cartridges related to (I)(d):

American Samoa	Cook Islands
Federated States of Micronesia	Fiji
French Polynesia	Guam
Kiribati	Marshall Islands
Nauru	New Caledonia
Niue	Palau
Papua New Guinea	Samoa
Solomon Islands	Tokelau
Tonga	Tuvalu
Vanuatu	Wallis and Futuna

(II) New Zealand Defence Force, Ministry of Defence, New Zealand Police and Visiting Forces

The New Zealand Defence Force, Ministry of Defence, The New Zealand Police, Visiting Military Forces (as defined by the Visiting Forces Act 2004), foreign Police and other officers/officials authorised by the Commissioner of Police to carry arms visiting in an official capacity may export the following without a permit from MFAT:

(a) Stores, equipment, parts, software, technical publications, ammunition and explosives for overseas activities in the course of which they may either be consumed, written off, disposed of (subject to meeting end user obligations), or subsequently returned to New Zealand.

(b) Stores, equipment, software, technical publications, ammunition and explosives of a Visiting Force.

(c) Equipment, parts, software, technical publications, and munitions for repair, servicing or upgrade, and subsequent return to New Zealand (e.g. ships, vehicles, aircraft, weapons, electronic equipment and their parts).

Note: with respect to (a) and (c) above, NZDF, MoD and NZ Police owned stores, equipment, parts, software, technical publications, and munitions, may be exported without a permit from MFAT by a contractor on behalf of, or in the course of providing services to, those organisations.

(III) New Zealand government officials

New Zealand Government officials may temporarily export secure GSM (Global System for Mobile Communications) cellular telephones, PDAs, encrypted laptops or other secure electronic devices without a permit from MFAT. These items must be personally carried outside New Zealand by the officials and must be for their own use on official travel.

Secure or other controlled electronic devices, and related materials, for official use outside New Zealand, may be exported without a permit from MFAT (e.g. for use in a New Zealand Embassy or at an official meeting).

(IV) Vintage Military Aircraft

Vintage military aircraft first manufactured in or before 1950 and their subsequent derivatives, including restorations, reproductions or replicas thereof, may be exported without a permit from MFAT.

(V) Ammunition belonging to a Collector

Members of the New Zealand Cartridge Collectors Club (NZCCC) may export ammunition from New Zealand without a permit from MFAT for exhibition purposes where the combined weight of that ammunition does not exceed five kilograms, and is being exported as accompanied baggage of that member. It is understood that some ammunition may be sold or traded through individual non-commercial sales while the NZCCC member is abroad.

Members of the Australian Cartridge Collectors Association (ACCA) following their attendance at conferences, exhibitions, swap-meets, etc. in New Zealand may export ammunition from New Zealand without a permit from MFAT for exhibition purposes where the combined weight of that ammunition does not exceed five kilograms, and is being exported as accompanied baggage of that member.

(VI) Firearms on visiting vessels

Firearms on visiting vessels which have been surrendered to the Police for safekeeping for the duration of the visit, or have been approved by the Police for secure storage on-board, may be exported without a permit from MFAT.

Firearms transiting New Zealand on vessels which are intended for sale at a subsequent destination are not exempt from the requirement for an export permit, i.e. those firearms in excess of those retained on-board for legitimate security purposes or being transported as part of a commercial shipment.

Definitions of Terms

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:

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

"Accuracy" (2 3 6 7 8), 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.

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

"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.

Note: See Category 4, Technical Note.

"Aircraft" (1 6 7 9 ML8 ML10 ML14) means a fixed wing, swivel wing, rotary wing (helicopter), tilt rotor or tilt-wing airborne vehicle.

Note: 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 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.

Note: Additional and alternative allocations are not included.

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

"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.

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

Note: 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.

"Automated Command and Control Systems" (ML11) means electronic systems, through which information essential to the effective operation of the grouping, major formation, tactical formation, unit, ship, subunit or weapons under command is entered, processed and transmitted. This is achieved by the use of computer and other specialised hardware designed to support the functions of a military command and control organisation. The main functions of an automated command and control system are: the efficient automated collection, accumulation, storage and processing of information; the display of the situation and the circumstances affecting the preparation and conduct of combat operations; operational and tactical calculations for the allocation of resources among force groupings or elements of the operational order of battle or battle deployment according to the mission or stage of the operation; the preparation of data for appreciation of the situation and decision-making at any point during operation or battle; computer simulation of operations.

"Average output power" (6) means the total "laser" output energy in joules divided by the "laser duration" in seconds.

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

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

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

(a) the common hardware and software architecture; and

(b) the common design and process technology; and

(c) the common basic characteristics.

"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 STD 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 STD 528-2001).

"Biocatalysts" (ML7 ML22) means 'enzymes' for specific chemical or biochemical reactions or other biological compounds which bind to and accelerate the degradation of CW agents.

Technical Note:

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

"Biological agents" (1 ML7) means 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.

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

(a) enzymes for specific chemical or biochemical reactions;

(b) 'anti-idiotypic', 'monoclonal' or 'polyclonal' 'antibodies';

(c) specially designed or specially processed 'receptors'.

Technical Notes:

1. 'Anti-idiotypic antibodies' means antibodies which bind to the specific antigen binding sites of other antibodies;

2. 'Monoclonal antibodies' means proteins which bind to one antigenic site and are produced by a single clone of cells;

3. 'Polyclonal antibodies' means a mixture of proteins which bind to the specific antigen and are produced by more than one clone of cells;

4. 'Receptors' means biological macromolecular structures capable of binding ligands, the binding of which affects physiological functions.

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

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

"Chemical mixture" (1) means a solid, liquid or gaseous product made up of two or more components that do not react together under normal storage conditions.

"Circuit elements" (6) means a single active or passive functional part of an electronic circuit, such as one diode, one transistor, one resistor, one capacitor, etc.

"Circular Error Probable" ("CEP") (7) means, 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.

"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 9 ML4 ML10) means those "aircraft" listed by designation in published airworthiness certification lists by the civil aviation authorities of one or more Wassenaar Arrangement Participating States to fly commercial civil internal and external routes or for legitimate civil, private or business use.

Note: See also "aircraft".

"Common channel signalling" (5) is a signalling method in which a single channel between exchanges conveys, by means of labelled messages, signalling information relating to a multiplicity of circuits or calls and other information such as that used for network management.

"Communications channel controller" (4) means the physical interface which controls the flow of synchronous or asynchronous digital information. It is an assembly that can be integrated into computer or telecommunications equipment to provide communications access.

"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 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) 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).

"Computing element" ("CE") (4) means the smallest computational unit that produces an arithmetic or logic result.

"Contouring control" (2) means two or more "numerically controlled" motions operating in accordance with instructions that specify the next required position and the required feed rates to that position. These feed rates are varied in relation to each other so that a desired contour is generated (Ref. ISO 2806:1994).

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

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

(1) a single instance of the item;

(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.

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

Note 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 ML21) is 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-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.

"Deactivated firearm" (ML1) means a firearm that:

(a) was in a condition in which it could discharge shot, bullets or other projectiles by means of an explosive charge or a compressed gas; and

(b) has been rendered incapable of discharging shot, bullets or other projectiles by means of an explosive charge or a compressed gas; and

(c) cannot be returned to a condition in which it could discharge shot, bullets or other projectiles by means of an explosive charge or a compressed gas; and

(d) still has the appearance of a firearm, and could reasonably be taken to be a firearm.

Note: A firearm can be deactivated to the extent that it is incapable of being returned to its original firing condition, while keeping the appearance of a firearm. For the article to be incapable of being returned to its original firing condition, all major parts of the article must be destroyed, permanently incapacitated or permanently immobilised. This includes (but is not limited to) the bolt, barrel, gas system, receiver, trigger, sear or hammer, feed pawls and actuating arm or arms. This can be done by any of the following:

(a) fusion welding, which is welding material into the barrel, and welding of all the major parts of the firearm, in a way that cannot be reversed;

(b) sectioning, which is the machining or milling of all the major parts of the firearm in a way that cannot be reversed, exposing the internal mechanism;

(c) another method of treating the major parts that ensures that the parts are deactivated to the extent that the firearm is incapable of being returned to its original firing condition.

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

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

"Diffusion bonding" (1 2 9) means a solid state molecular joining of at least two separate metals into a single piece with a joint strength equivalent to that of the weakest material, wherein the principal mechanism is interdiffusion of atoms across the interface.

"Digital computer" (4 5 ML21) means equipment which can, in the form of one or more discrete variables, perform all of the following:

(a) accept data;

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

(c) process data by means of a stored sequence of instructions which is modifiable; and

(d) provide output of data.

Technical Note:

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

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

Note: See also "total digital transfer rate".

"Discrete component" means a separately packaged "circuit element" with its own external connections.

"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.

Note 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.

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

"End-effectors" (2 ML17) means grippers, 'active tooling units' and any other tooling that is attached to the baseplate on the end of a "robot" manipulator arm.

Note: 'Active tooling units' are devices for applying motive power, process energy or sensing to the workpiece.

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

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

"Equivalent standards" (1 ML6 ML13) are comparable national or international standards recognised by one or more Wassenaar Arrangement Participating States and applicable to the relevant entry.

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

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

"Fibrous or filamentary materials" (0 1 2 8 9 ML13) include:

(a) continuous "monofilaments";
(b) continuous "yarns" and "rovings";
(c) "tapes", fabrics, random mats and braids;
(d) chopped fibres, staple fibres and coherent fibre blankets;
(e) whiskers, either monocrystalline or polycrystalline, of any length;
(f) aromatic polyamide pulp.

"Film type integrated circuit" (3) means an array of 'circuit elements' and metallic interconnections formed by deposition of a thick or thin film on an insulating "substrate".

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

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

"Fly-by-light system" (7) is 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) is 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) means a linear or two-dimensional planar layer, or combination of planar layers, of individual detector elements, with or without readout electronics, which work in the focal plane.

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

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

"Frequency hopping" (5 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 ML17) means an electrochemical device that converts chemical energy directly into Direct Current (DC) electricity by consuming fuel from an external source.

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

"Fundamental research" means basic or applied research conducted in circumstances where the results of the research:

(a) are intended for public disclosure, or would ordinarily be published or shared broadly; and

(b) are not subject to any restrictions on disclosure (however imposed) for purposes connected with the security or defence of New Zealand or any foreign country.

"Fusible" (1) means capable of being cross-linked or polymerised 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) 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.

Note: 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 vehicle's position and velocity (i.e. navigation) with that of computing and sending commands to the vehicle's flight control systems to correct the trajectory.

"Hard selectors" (5P1) means data or a set of data, related to an individual (e.g., family name, given name, email address, street address, phone number or group affiliations).

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

(a) accept data;

(b) process data, in both analogue and digital representations;

(c) provide output of data.

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

(a) containing at least one unencapsulated device;

(b) connected together using typical IC production methods;

(c) replaceable as an entity;

(d) not normally capable of being disassembled.

Note 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.

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

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

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

"Information security" (GSN GTN 5P2) 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.

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

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

"Insulation" (9) is applied to the components of a rocket motor, i.e. the case, nozzle, inlets, case closures, and includes cured or semi-cured compounded rubber

sheet stock containing an insulating or refractory material. It may also be incorporated as stress relief boots or flaps.

"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.

"In the public domain" (GTN NTN GSN ML22), as it applies herein, means "technology" or "software" which has been made available without restrictions upon its further dissemination (copyright restrictions do not remove "technology" or "software" from being "in the public domain").

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

Note: See also "magnetic gradiometer".

"Intrusion software" (4 5P2) is "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.

Note 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.

Note 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 5P1 6 7 8 9 ML5 ML9 ML19) is an item that produces spatially and temporally coherent light through amplification by stimulated emission of radiation.

"Laser duration" (6) means the time over which a "laser" emits "laser" radiation, which for "pulsed lasers" corresponds to the time over which a single pulse or series of consecutive pulses is emitted.

"Library" (parametric technical database) (1 ML17) is a collection of technical information, reference to which may enhance the performance of relevant systems, equipment or components.

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

"Local area network" (4) is a data communication system having all of the following characteristics:

(a) allows an arbitrary number of independent 'data devices' to communicate directly with each other;

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

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

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

Note: 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) may be copper, stainless steel, aluminium, aluminium oxide, aluminium alloys, nickel or alloy containing 60 weight percent or more nickel and UF_6 resistant fluorinated hydrocarbon polymers, as appropriate for the type of separation process.

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

"Measurement uncertainty" (2) is the characteristic parameter which specifies in what range around the output value the correct value of the measurable variable lies with a confidence level of 95%. It includes the uncorrected systematic deviations, the uncorrected backlash and the random deviations (Reference: 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.

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

"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.

“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.

Note 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.

Note 2: This includes chip sets which are designed to operate together to provide the function of a “microprocessor microcircuit”.

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

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

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

“Monolithic integrated circuit” (3) means a combination of passive or active ‘circuit elements’ or both which:

(a) are formed by means of diffusion processes, implantation processes or deposition processes in or on a single semiconducting piece of material, a so-called ‘chip’; and

(b) can be considered as indivisibly associated; and

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

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

“Monolithic Microwave Integrated Circuit” (“MMIC”) (3 5) means a “monolithic integrated circuit” that operates at microwave or millimeter 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.

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

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

"Nuclear reactor" (0 ML17) means the items within or attached directly to the reactor vessel, the equipment which controls the level of power in the core, and the components which normally contain, come into direct contact with or control the primary coolant of the reactor core.

"Numerical control" (2) means the automatic control of a process performed by a device that makes use of numeric data usually introduced as the operation is in progress (Ref. ISO 2382:2015).

"Object code" (GSN) means an equipment executable form of a convenient expression of one or more processes ("source code" (source language)) which has been converted 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;
    (3) authentication data in support of the tasks described in paragraphs (a)(1) or (a)(2);
(b) monitoring or managing the operating condition or performance of an item;
(c) managing logs or audit data in support of any of the tasks described in paragraphs (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 paragraphs (a)(1) or (a)(2) above;
    (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).

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

"Overall current density" (3) means the total number of ampere-turns in the coil (i.e., the sum of the number of turns multiplied by the maximum current carried by each turn) divided by the total cross-section of the coil (comprising the superconducting filaments, the metallic matrix in which the superconducting filaments are embedded, the encapsulating material, any cooling channels, etc.).

"Peak power" (6), means the highest level of power attained in the "laser duration".

"Personal area network" (5) is 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 Notes:

1. ‘Data device’ means equipment capable of transmitting or receiving sequences of digital information.

2. The “local area network” extends beyond the geographical area of the “personal area network”.

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

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

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

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

“Production equipment” (1 7 9) means tooling, templates, jigs, mandrels, moulds, dies, fixtures, alignment mechanisms, test equipment, other machinery and components therefor, limited to those specially designed or modified for “development” or for one or more phases of “production”.

“Production facilities” (7 9) means equipment and specially designed software therefor integrated into installations for “development” or for one or more phases of “production”.

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

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

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

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

“Pulsed laser” (6) means a “laser” having a “pulse duration” that is less than or equal to 0.25 seconds.

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

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

"Radar frequency agility" (6) means any technique which changes, in a pseudo-random sequence, the carrier frequency of a pulsed radar transmitter between pulses or between groups of pulses by an amount equal to or larger than the pulse bandwidth.

"Radar spread spectrum" (6) means any modulation technique for spreading energy originating from a signal with a relatively narrow frequency band, over a much wider band of frequencies, by using random or pseudo-random coding.

"Radiant sensitivity" (6) Radiant sensitivity (mA/W) = 0.807 x (wavelength in nm) x Quantum Efficiency (QE).

Technical Note:

QE is usually expressed as a percentage; however, for the purposes of this formula QE is expressed as a decimal number less than one, e.g., 78% is 0.78.

"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.

"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 STD 528-2001 (one sigma standard deviation)).

"Required" (GTN 1 5 6 7 9 ML22), 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" (ML7) mean substances which, under the expected conditions of use for riot control purposes, rapidly produce in humans sensory irritation or disabling physical effects which disappear within a short time following termination of exposure.

Technical Note:

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

"Robot" (2 8 ML17) means a manipulation mechanism, which may be of the continuous path or of the point-to-point variety, may use sensors, and has all the following characteristics:

(a) is multifunctional;
(b) is capable of positioning or orienting material, parts, tools or special devices through variable movements in three dimensional space;
(c) incorporates three or more closed or open loop servo-devices which may include stepping motors;
(d) has "user-accessible programmability" by means of teach/playback method or by means of an electronic computer which may be a programmable logic controller, i.e., without mechanical intervention.

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

1. Manipulation mechanisms which are only manually/teleoperator controllable;
2. Fixed sequence manipulation mechanisms which are automated moving devices, operating according to mechanically fixed programmed motions. The program is mechanically limited by fixed stops, such as pins or cams. The sequence of motions and the selection of paths or angles are not variable or changeable by mechanical, electronic or electrical means;
3. Mechanically controlled variable sequence manipulation mechanisms which are automated moving devices, operating according to mechanically fixed programmed

motions. The program is mechanically limited by fixed, but adjustable stops, such as pins or cams. The sequence of motions and the selection of paths or angles are variable within the fixed program pattern. Variations or modifications of the program pattern (e.g., changes of pins or exchanges of cams) in one or more motion axes are accomplished only through mechanical operations;

4. Non-servo-controlled variable sequence manipulation mechanisms which are automated moving devices, operating according to mechanically fixed programmed motions. The program is variable but the sequence proceeds only by the binary signal from mechanically fixed electrical binary devices or adjustable stops;
5. Stacker cranes defined as Cartesian coordinate manipulator systems manufactured as an integral part of a vertical array of storage bins and designed to access the contents of those bins for storage or retrieval.

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

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

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

"Sample rate" (3) means for an Analogue-to-Digital Converter (ADC) 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 navigation system" (5P2 7 ML11) 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 and Regional Navigation Satellite Systems.

"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) mean apparatus capable of measuring and displaying basic properties of the single-frequency components of multi-frequency signals.

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

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

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

"Spacecraft" (7 9 ML11) means active and passive satellites and space probes.

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

"Spacecraft payload" (9) is equipment, attached to the "spacecraft bus", designed to perform a mission in space (e.g., communications, observation, science).

"Space-qualified" (3 6 7 9 ML19) refers to products designed, manufactured, or qualified through successful testing, for operation at altitudes greater than 100 km above the surface of the Earth.

Note: 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/m2 divided by specific weight in N/m3, measured at a temperature of (296 ± 2) K ((23 ± 2)ºC) and a relative humidity of (50 ± 5)%.

"Specific tensile strength" (0 1 9) is ultimate tensile strength in pascals, equivalent to N/m2 divided by specific weight in N/m3, measured at a temperature of (296 ± 2) K ((23 ± 2)ºC) and a relative humidity of (50 ± 5)%.

"Spinning mass gyros" (7) "Spinning mass gyros" are 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.

Technical Note:

For gyroscopes and accelerometers, "stability" can be estimated by determining the Allan variance noise-analysis value at the integration period (i.e., sample time) consistent with the stated measurement period, which may include extrapolating the Allan variance noise analysis beyond the instability point into the rate/acceleration random walk or rate/acceleration ramp regions to an integration period consistent with the stated measurement period (Reference: IEEE Std 952-1997 [R2008] or IEEE Std 1293-1998 [R2008]).

"States 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 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.

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

(a) operate above the stratosphere;
(b) perform a non-orbital trajectory; 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.

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

Note 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".

"Superalloy" (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 6 8 ML18 ML20) means materials, i.e., metals, alloys or compounds, which can lose all electrical resistance, i.e., which can attain infinite electrical conductivity and carry very large electrical currents without Joule heating.

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

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

"Superplastic forming" (1 2) means a deformation process using heat for metals that are normally characterised by low values of elongation (less than 20%) at the breaking point as determined at room temperature by conventional tensile strength testing, in order to achieve elongations during processing which are at least 2 times those values.

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

Note: A common use of "symmetric algorithms" is confidentiality of data.

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

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

"Technology" (GTN NTN All) means specific information necessary for the "development", "production" or "use" of a product. This information takes the form of 'technical data' or 'technical assistance'. Specified "technology" for the Dual-Use List is defined in the General Technology Note and in the Dual-Use List. Specified "technology" for the Munitions List is defined in ML22.

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

Note 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.

"Three dimensional integrated circuit" (3) means 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.

"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 gravity meter's response time) is the time over which the disturbing effects of platform-induced acceleration (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.

Note: 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 ML10) 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 Dual-Use List) 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) are 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.

"Viruses" (1 2) are an infectious agent generally composed of genetic material packaged with a protein coat. "Viruses" must infect host cells in order to replicate, burst out of the host cell, and spread the infection.

"Vulnerability disclosure" (4 ML21) is 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 purpose of resolving the vulnerability.

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

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

Acronyms and Abbreviations

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

Acronym or abbreviation	Meaning
ABEC	Annular Bearing Engineers Committee
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
ALU	Arithmetic Logic Unit
AMPS	Aircraft Missile Protection System
ANSI	American National Standards Institute
APP	Adjusted Peak Performance
APU	Auxiliary Power Unit
ASTM	the American Society for Testing and Materials
ATC	Air Traffic Control
AVLIS	Atomic Vapour Laser Isotope Separation
BJT	Bipolar Junction Transistors
BPP	Beam Parameter Product
BSC	Base Station Controller
C3I	Command, Communications, Control & Intelligence
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
CRISLA	Chemical Reaction by Isotope Selective Laser Activation.
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
DEW	Directed Energy Weapon Systems
DMA	Dynamic Mechanical Analysis
DME	Distance Measuring Equipment
DMOSFET	Diffused Metal Oxide Semiconductor Field Effect Transistor

Acronym or abbreviation	Meaning
DS	Directionally Solidified
EB	Exploding Bridge
EB-PVD	Electron Beam Physical Vapour Deposition
EBW	Exploding Bridge Wire
ECAD	Electronic Computer-Aided Design
ECM	Electro-Chemical Machining
ECR	Electron Cyclotron Resonance
EDM	Electrical Discharge Machines
EFI	Exploding Foil Initiators
EIRP	Effective Isotropic Radiated Power
EMC	Electromagnetic Compatibility
EMCDB	Elastomer Modified Cast Double Based Propellants
EMP	Electromagnetic Pulse
ENOB	Effective Number of Bits
ERF	Electrorheological Finishing
ERP	Effective Radiated Power
ESD	Electrostatic Discharge
ETO	Emitter Turn-Off Thyristor
ETT	Electrical Triggering Thyristor
EUV	Extreme Ultraviolet
FADEC	Full Authority Digital Engine Control
FFT	Fast Fourier Transform
FPGA	Field Programmable Gate Array
FPIC	Field Programmable Interconnect
FPLA	Field Programmable Logic Array
FPO	Floating Point Operation
FWHM	Full-Width Half-Maximum
GAAFET	Gate-All-Around Field-Effect Transistor
GLONASS	Global Navigation Satellite System
GPS	Global Positioning System
GSM	Global System for Mobile Communications
GTO	Gate Turn-off Thyristor
GVWR	Gross Vehicle Weight Rating
HBT	Hetero-Bipolar Transistors
HDMI	High-Definition Multimedia Interface
HEMT	High Electron Mobility Transistor
ICAO	International Civil Aviation Organisation
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

Acronym or abbreviation	Meaning
IMU	Inertial Measurement Unit
INS	Inertial Navigation System
IP	Internet Protocol
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
JT	Joule-Thomson
LIDAR	Light Detection and Ranging
LIDT	Laser Induced Damage Threshold
LOA	Length Overall
LRU	Line Replaceable Unit
LTT	Light Triggering Thyristor
Mach	Ratio of speed of an object to speed of sound (after Ernst Mach)
MLIS	Molecular Laser Isotopic Separation
MLS	Microwave Landing Systems
MMIC	Monolithic Microwave Integrated Circuit
MOCVD	Metal Organic Chemical Vapour Deposition
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
NBC	Nuclear, Biological and Chemical
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
PMR	Private Mobile Radio
Ppm	Parts per million
PVD	Physical Vapour Deposition
QAM	Quadrature-Amplitude-Modulation
QE	Quantum Efficiency
RAP	Reactive Atom Plasmas

Acronym or abbreviation	Meaning
RF	Radio Frequency
RNC	Radio Network Controller
ROIC	Read-out Integrated Circuit
RPV	Remotely Piloted Air Vehicle
S-FIL	Step and Flash Imprint Lithography
SAR	Synthetic Aperture Radar
SAS	Synthetic Aperture Sonar
SC	Single Crystal
SCR	Silicon Controlled Rectifier
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
TCSEC	Trusted Computer System Evaluation Criteria
TE-PVD	Thermal Evaporation-Physical Vapour Deposition
TIR	Total Indicated Reading
TVR	Transmitting Voltage Response
UAV	Unmanned Aerial Vehicle
UPR	Unidirectional Positioning Repeatability
UTS	Ultimate Tensile Strength
VJFET	Vertical Junction Field Effect Transistor
VOR	Very High Frequency Omni-directional Range
WLAN	Wireless Local Area Network
YAG	Yttrium/Aluminium Garnet

Note 1: Terms in "quotations" are defined terms. Refer to 'Definitions of Terms used in these Lists' annexed to this List.

Note 2: In some instances chemicals are listed by name and CAS number. The list applies to chemicals of the same structural formula (including hydrates) regardless of name or CAS number. CAS numbers cannot be used as unique identifiers because some forms of the listed chemical have different CAS numbers, and mixtures containing a listed chemical may also have different CAS numbers. However CAS numbers are shown to assist in identifying a particular chemical or mixture, irrespective of nomenclature.

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

Note: ML1. does not apply to:

a. Firearms specially designed for dummy ammunition and which are incapable of discharging a projectile;

b. Firearms specially designed to launch tethered projectiles having no high explosive charge or communications link, to a range of less than or equal to 500 m.;

c. Weapons using non-centre fire cased ammunition and which are not of the fully automatic firing type;

d. "Deactivated firearms".

Technical Note:

A 'deactivated firearm' is a firearm that has been made incapable of firing any projectile by processes defined by the Wassenaar Arrangement Participating State's national authority. These processes irreversibly modify the essential elements of the firearm. According to national laws and regulations, deactivation of the firearm may be attested by a certificate delivered by a competent authority and may be marked on the firearm by a stamp on an essential part

a. Rifles and combination guns, handguns, machine, sub-machine and volley guns;

Note: ML1.a. does not apply to the following:

a. Rifles and combination guns, manufactured earlier than 1938;

b. Reproductions of rifles and combination guns, the originals of which were manufactured earlier than 1890;

c. Handguns, volley guns and machine guns, manufactured earlier than 1890, and their reproductions;

d. Rifles or handguns, specially designed to discharge an inert projectile by compressed air or CO_2;

e. Handguns specially designed for any of the following:

1. Slaughtering of domestic animals; or

2. Tranquillising of animals.

b. Smooth-bore weapons as follows:

1. Smooth-bore weapons specially designed for military use;
2. Other smooth-bore weapons as follows:
   a. Fully automatic type weapons;

b. Semi-automatic or pump-action type weapons;

Note: ML1.b.2. does not apply to weapons specially designed to discharge an inert projectile by compressed air or CO_2.

Note: ML1.b. does not apply to the following:

a. Smooth-bore weapons manufactured earlier than 1938;

b. Reproductions of smooth-bore weapons, the originals of which were manufactured earlier than 1890;

c. Smooth-bore weapons used for hunting or sporting purposes. These weapons must not be specially designed for military use or of the fully automatic firing type;

d. Smooth-bore weapons specially designed for any of the following:

1. Slaughtering of domestic animals;

2. Tranquillising of animals;

3. Seismic testing;

4. Firing of industrial projectiles; or

5. Disrupting Improvised Explosive Devices (IEDs).

N.B.: For disruptors, see ML4. and 1A006. on the Dual-Use List.

c. Weapons using caseless ammunition;

d. Accessories designed for arms specified by ML1.a., ML1.b. or ML1.c., as follows:

1. Detachable cartridge magazines;

2. Sound suppressors or moderators;

3. 'gun-mountings';

Technical Note:

For the purposes of ML1.d.3., a 'gun-mounting' is a fixture designed to mount a gun onto a ground vehicle, "aircraft", vessel or structure.

4. Flash suppressors;

5. Optical weapon-sights with electronic image processing;

6. Optical weapon-sights specially designed for military use.

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

a. Guns, howitzers, cannon, mortars, anti-tank weapons, projectile launchers, military flame throwers, rifles, recoilless rifles and smooth-bore weapons;

Note 1: ML2.a. includes injectors, metering devices, storage tanks and other specially designed components for use with liquid propelling charges for any of the equipment specified by ML2.a.

Note 2: ML2.a. does not apply to weapons as follows:

a. Rifles, smooth-bore weapons and combination guns, manufactured earlier than 1938;

b. Reproductions of rifles, smooth-bore weapons and combination guns, the originals of which were manufactured earlier than 1890;

c. Guns, howitzers, cannons, mortars, manufactured earlier than 1890;

d. Smooth-bore weapons used for hunting or sporting purposes. These weapons must not be specially designed for military use or of the fully automatic firing type;

e. Smooth-bore weapons specially designed for any of the following:

1. Slaughtering of domestic animals;

2. Tranquillising of animals;

3. Seismic testing;

4. Firing of industrial projectiles; or

5. Disrupting Improvised Explosive Devices (IEDs);

N.B. For disruptors, see ML4. and 1A006. on the Dual-Use List.

f. Hand-held projectile launchers specially designed to launch tethered projectiles having no high explosive charge or communications link, to a range of less than or equal to 500 m.

b. Projectors, specially designed or modified for military use, as follows:

1. Smoke canister projectors;
2. Gas canister projectors;
3. Pyrotechnics projectors;

Note: ML2.b. does not apply to signal pistols.

c. Accessories specially designed for the weapons specified in ML2.a., as follows:

1. Weapon sights and weapon sight mounts, specially designed for military use;
2. Signature reduction devices;
3. Mountings;
4. Detachable cartridge magazines;

d. Not used since 2019.

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

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

b. Fuse setting devices specially designed for ammunition specified by ML3.a.

Note 1: Specially designed components specified by ML3. include:

a. Metal or plastic fabrications such as primer anvils, bullet cups, cartridge links, rotating bands and munitions metal parts;

b. Safing and arming devices, fuzes, sensors and initiation devices;

c. Power supplies with high one-time operational output;

d. Combustible cases for charges;

e. Submunitions including bomblets, minelets and terminally guided projectiles.

Note 2: ML3.a. does not apply to any of the following:

a. Ammunition crimped without a projectile (blank star);

b. Dummy ammunition with a pierced powder chamber;

c. Other blank and dummy ammunition, not incorporating components designed for live ammunition; or

d. Components specially designed for blank or dummy ammunition, specified in this Note 2.a., b. or c.

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

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

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

N.B. 1: For guidance and navigation equipment, see ML11.

N.B. 2: For Aircraft Missile Protection Systems (AMPS), see ML4.c.

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

Note 1: ML4.a. includes:
a. Smoke grenades, fire bombs, incendiary bombs and explosive devices;
b. Missile or rocket nozzles and re-entry vehicle nosetips.

N.B.: For grenade or canister ammunition for weapons or projectors specified in ML1. or ML2. and submunitions specially designed for ammunition, see ML3

Note 2: Certain items specified in ML4.a. may be subject to the MTCR Guidelines for Sensitive Missile-Relevant Transfers.

b. Equipment having all of the following:

1. Specially designed for military use; and
2. Specially designed for 'activities' relating to any of the following:
   a. Items specified by ML4.a.; or
   b. Improvised Explosive Devices (IEDs).

Technical Note:

For the purpose of ML4.b.2., 'activities' applies to handling, launching, laying, controlling, discharging, detonating, activating, powering with one-time operational output, decoying, jamming, sweeping, detecting, disrupting or disposing.

Note 1: ML4.b. includes:
a. Mobile gas liquefying equipment;
b. Buoyant electric conducting cable suitable for sweeping magnetic mines.

Note 2: ML4.b. does not apply to hand-held devices limited by design solely to the detection of metal objects and incapable of distinguishing between mines and other metal objects.

c. Aircraft Missile Protection Systems (AMPS).

Note: ML4.c. does not apply to AMPS having all of the following:
a. Any of the following missile warning sensors:
1. Passive sensors having peak response between 100-400 nm; or
2. Active pulsed Doppler missile warning sensors;
b. Countermeasures dispensing systems;
c. Flares, which exhibit both a visible signature and an infrared signature, for decoying surface-to-air missiles; and
d. Installed on "civil aircraft" and having all of the following:

1. *The AMPS is only operable in a specific "civil aircraft" in which the specific AMPS is installed and for which any of the following has been issued:*
   a. *A civil Type Certificate issued by civil aviation authorities of one or more Wassenaar Arrangement Participating States; or*
   b. *An equivalent document recognised by the International Civil Aviation Organisation (ICAO);*
2. *The AMPS employs protection to prevent unauthorised access to "software"; and*
3. *The AMPS incorporates an active mechanism that forces the system not to function when it is removed from the "civil aircraft" in which it was installed.*

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

a. Weapon sights, bombing computers, gun laying equipment and weapon control systems;

b. Other fire control, surveillance and warning equipment, and related systems, as follows:

   1. Target acquisition, designation, range-finding, surveillance or tracking systems;
   2. Detection, recognition or identification equipment;
   3. Data fusion or sensor integration equipment;

c. Countermeasure equipment for items specified by ML5.a. or ML5.b.;

   <u>Note</u>: *For the purposes of ML5.c., countermeasure equipment includes detection equipment.*

d. Field test or alignment equipment, specially designed for items specified by ML5.a., ML5.b. or ML5.c.

ML6. Ground vehicles and components, as follows:

<u>N.B.</u>: *For guidance and navigation equipment, see ML11.*

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

   <u>Note 1</u>: *ML6.a. includes:*
   a. Tanks and other military armed vehicles and military vehicles fitted with mountings for arms or equipment for mine laying or the launching of munitions specified by ML4;
   b. Armoured vehicles;
   c. Amphibious and deep water fording vehicles;
   d. Recovery vehicles and vehicles for towing or transporting ammunition or weapon systems and associated load handling equipment;
   e. Trailers.

   <u>Note 2</u>: *Modification of a ground vehicle for military use specified by ML6.a. entails a structural, electrical or mechanical change involving one or more components that are specially designed for military use. Such components include:*
   a. Pneumatic tyre casings of a kind specially designed to be bullet-proof;

b. Armoured protection of vital parts (e.g., fuel tanks or vehicle cabs);
c. Special reinforcements or mountings for weapons;
d. Black-out lighting.

b. Other ground vehicles and components, as follows:

1. Vehicles having all of the following:
   a. Manufactured or fitted with materials or components to provide ballistic protection equal to or better than level III (NIJ 0108.01, September 1985), or "equivalent standards";
   b. A transmission to provide drive to both front and rear wheels simultaneously, including those for vehicles having additional wheels for load bearing purposes whether driven or not;
   c. Gross Vehicle Weight Rating (GVWR) greater than 4,500 kg; and
   d. Designed or modified for off-road use;
2. Components having all of the following:
   a. Specially designed for vehicles specified in ML6.b.1.; and
   b. Providing ballistic protection equal to or better than level III (NIJ 0108.01, September 1985), or "equivalent standards".

N.B.: See also ML13.a.

Note 1: ML6. does not apply to civil vehicles designed or modified for transporting money or valuables.

Note 2: ML6. does not apply to vehicles that meet all of the following;
a. Were manufactured before 1946;
b. Do not have items specified by the Munitions List and manufactured after 1945, except for reproductions of original components or accessories for the vehicle; and
c. Do not incorporate weapons specified in ML1., ML2. or ML4. unless they are inoperable and incapable of discharging a projectile.

ML7. Chemical agents, "biological agents", "riot control agents", radioactive materials, related equipment, components and materials, as follows:

a. "Biological agents" or radioactive materials selected or modified to increase their effectiveness in producing casualties in humans or animals, degrading equipment or damaging crops or the environment;

b. Chemical warfare (CW) agents, including:

1. CW nerve agents:
   a. O-Alkyl (equal to or less than C_{10}, including cycloalkyl) alkyl (Methyl, Ethyl, n-Propyl or Isopropyl) - phosphonofluoridates, such as:
      1. Sarin (GB):O-Isopropyl methylphosphonofluoridate (CAS 107–44–8); and
      2. Soman (GD):O-Pinacolyl methylphosphonofluoridate (CAS 96–64–0);
   b. O-Alkyl (equal to or less than C_{10}, including cycloalkyl) N,N-dialkyl (Methyl, Ethyl, n-Propyl or Isopropyl) phosphoramidocyanidates, such as:
      1. Tabun (GA):O-Ethyl N,N-dimethylphosphoramidocyanidate (CAS 77–81–6);
   c. O-Alkyl (H or equal to or less than C_{10}, including cycloalkyl) S-2-dialkyl (Methyl, Ethyl, n-Propyl or Isopropyl)-aminoethyl alkyl (Methyl, Ethyl, n-Propyl or Isopropyl) phosphonothiolates and corresponding alkylated and protonated salts, such as:

1. VX: O-Ethyl S-2-diisopropylaminoethyl methyl phosphonothiolate (CAS 50782–69–9);

2. CW vesicant agents:
   a. Sulphur mustards, such as:
      1. 2-Chloroethylchloromethylsulphide (CAS 2625-76-5);
      2. Bis(2-chloroethyl) sulphide (CAS 505-60-2);
      3. Bis(2-chloroethylthio) methane (CAS 63869-13-6);
      4. 1,2-bis (2-chloroethylthio) ethane (CAS 3563-36-8);
      5. 1,3-bis (2-chloroethylthio) -n-propane (CAS 63905-10-2);
      6. 1,4-bis (2-chloroethylthio) -n-butane (CAS 142868-93-7);
      7. 1,5-bis (2-chloroethylthio) -n-pentane (CAS 142868-94-8);
      8. Bis (2-chloroethylthiomethyl) ether (CAS 63918-90-1);
      9. Bis (2-chloroethylthioethyl) ether (CAS 63918-89-8);
   b. Lewisites, such as:
      1. 2-chlorovinyldichloroarsine (CAS 541-25-3);
      2. Tris (2-chlorovinyl) arsine (CAS 40334-70-1);
      3. Bis (2-chlorovinyl) chloroarsine (CAS 40334-69-8);
   c. Nitrogen mustards, such as:
      1. HN1: bis (2-chloroethyl) ethylamine (CAS 538-07-8);
      2. HN2: bis (2-chloroethyl) methylamine (CAS 51-75-2);
      3. HN3: tris (2-chloroethyl) amine (CAS 555-77-1);

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

4. CW defoliants, such as:
   a. Butyl 2-chloro-4-fluorophenoxyacetate (LNF);
   b. 2,4,5-trichlorophenoxyacetic acid (CAS 93-76-5) mixed with 2,4-dichlorophenoxyacetic acid (CAS 94-75-7) (Agent Orange (CAS 39277-47-9));

c. CW binary precursors and key precursors, as follows:
   1. Alkyl (Methyl, Ethyl, n-Propyl or Isopropyl) Phosphonyl Difluorides, such as: DF: Methyl Phosphonyldifluoride (CAS 676-99-3);
   2. O-Alkyl (H or equal to or less than C_{10}, including cycloalkyl) O-2-dialkyl (Methyl, Ethyl, n-Propyl or Isopropyl)-aminoethyl alkyl (Methyl, Ethyl, n-Propyl or Isopropyl) phosphonites and corresponding alkylated and protonated salts, such as:
      QL: O-Ethyl O-2-di-isopropylaminoethyl methylphosphonite (CAS 57856-11-8);
   3. Chlorosarin: O-Isopropyl methylphosphonochloridate (CAS 1445-76-7);
   4. Chlorosoman: O-Pinacolyl methylphosphonochloridate (CAS 7040-57-5);

d. “Riot control agents”, active constituent chemicals and combinations thereof, including:
   1. α-Bromobenzeneacetonitrile, (Bromobenzyl cyanide) (CA) (CAS 5798-79-8);
   2. [(2-chlorophenyl) methylene] propanedinitrile, (o-Chlorobenzylidenemalononitrile) (CS) (CAS 2698-41-1);
   3. 2-Chloro-1-phenylethanone, Phenylacyl chloride (ω-chloroacetophenone) (CN) (CAS 532-27-4);
   4. Dibenz-(b,f)-1,4-oxazephine, (CR) (CAS 257-07-8);
   5. 10-Chloro-5,10-dihydrophenarsazine, (Phenarsazine chloride), (Adamsite), (DM) (CAS 578-94-9);

6. N-Nonanoylmorpholine, (MPA) (CAS 5299-64-9);

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

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

e. Equipment, specially designed or modified for military use, designed or modified for the dissemination of any of the following, and specially designed components therefor:

1. Materials or agents specified by ML7.a., ML7.b. or ML7.d.; or
2. CW agents made up of precursors specified by ML7.c.;

f. Protective and decontamination equipment, specially designed or modified for military use, components and chemical mixtures, as follows:

1. Equipment designed or modified for defence against materials specified by ML7.a., ML7.b. or ML7.d., and specially designed components therefor;
2. Equipment designed or modified for decontamination of objects contaminated with materials specified by ML7.a. or ML7.b., and specially designed components therefor;
3. Chemical mixtures specially developed or formulated for the decontamination of objects contaminated with materials specified by ML7.a. or ML7.b.;

Note: ML7.f.1. includes:
a. Air conditioning units specially designed or modified for nuclear, biological or chemical filtration;
b. Protective clothing.

N.B.: For civil gas masks, protective and decontamination equipment, see also 1A004. on the Dual-Use List.

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

Note: ML7.g. does not apply to personal radiation monitoring dosimeters.

N.B.: See also 1A004 on the Dual-Use List.

h. "Biopolymers" specially designed or processed for the detection or identification of CW agents specified by ML7.b., and the cultures of specific cells used to produce them;

i. "Biocatalysts" for the decontamination or degradation of CW agents, and biological systems therefor, as follows:

1. "Biocatalysts" specially designed for the decontamination or degradation of CW agents specified by ML7.b., and resulting from directed laboratory selection or genetic manipulation of biological systems;
2. Biological systems containing the genetic information specific to the production of "biocatalysts" specified by ML7.i.1., as follows:
   a. "Expression vectors";
   b. Viruses;
   c. Cultures of cells.

Note 1: ML7.b. and ML7.d. do not apply to the following:
a. Cyanogen chloride (CAS 506-77-4);

b. Hydrocyanic acid (CAS 74-90-8);
c. Chlorine (CAS 7782-50-5);
d. Carbonyl chloride (phosgene) (CAS 75-44-5);
e. Diphosgene (trichloromethyl-chloroformate) (CAS 503-38-8);
f. Not used since 2004
g. Xylyl bromide, ortho: (CAS 89-92-9), meta: (CAS 620-13-3), para: (CAS 104-81-4);
h. Benzyl bromide (CAS 100-39-0);
i. Benzyl iodide (CAS 620-05-3);
j. Bromo acetone (CAS 598-31-2);
k. Cyanogen bromide (CAS 506-68-3);
l. Bromo methylethylketone (CAS 816-40-0);
m. Chloro acetone (CAS 78-95-5);
n. Ethyl iodoacetate (CAS 623-48-3);
o. Iodo acetone (CAS 3019-04-3);
p. Chloropicrin (CAS 76-06-2).

Note 2: The cultures of cells and biological systems specified by ML7.h. and ML7.i.2. are exclusive and these sub-items do not apply to cells or biological systems for civil purposes, such as agricultural, pharmaceutical, medical, veterinary, environmental, waste management, or in the food industry.

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

N.B. 1: See also 1C011 on the Dual-Use List.

N.B. 2: For charges and devices, see ML4 and 1A008 on the Dual-Use List.

Note: ML8 does not apply to specially formulated pharmaceutical products containing ML8 materials.

Technical Notes:

1. For the purposes of ML8., 'mixture' refers to a composition of two or more substances with at least one substance being listed in the ML8 sub-items.

2. Any substance listed in the ML8 sub-items is subject to this list, even when utilised in an application other than that indicated. (e.g., TAGN is predominantly used as an explosive but can also be used either as a fuel or an oxidiser.)

3. For the purposes of ML8., particle size is the mean particle diameter on a weight or volume basis. International or equivalent national standards will be used in sampling and determining particle size.

a. "Explosives" as follows, and 'mixtures' thereof:

1. ADNBF (aminodinitrobenzofuroxan or 7-amino-4,6-dinitrobenzofurazane-1-oxide) (CAS 97096-78-1);
2. BNCP (cis-bis (5-nitrotetrazolato) tetra amine-cobalt (III) perchlorate) (CAS 117412-28-9);
3. CL-14 (diamino dinitrobenzofuroxan or 5,7-diamino-4,6-dinitrobenzofurazane-1-oxide) (CAS 117907-74-1);
4. CL-20 (HNIW or Hexanitrohexaazaisowurtzitane) (CAS 135285-90-4); chlathrates of CL-20 (see also ML8.g.3. and g.4. for its "precursors");
5. CP (2-(5-cyanotetrazolato) penta amine-cobalt (III) perchlorate) (CAS 70247-32-4);
6. DADE (1,1-diamino-2,2-dinitroethylene, FOX-7) (CAS 145250-81-3);
7. DATB (diaminotrinitrobenzene) (CAS 1630-08-6);
8. DDFP (1,4-dinitrodifurazanopiperazine);

9. DDPO (2,6-diamino-3,5-dinitropyrazine-1-oxide, PZO) (CAS 194486-77-6);
10. DIPAM (3,3′-diamino-2,2′,4,4′,6,6′-hexanitrobiphenyl or dipicramide) (CAS 17215-44-0);
11. DNGU (DINGU or dinitroglycoluril) (CAS 55510-04-8);
12. Furazans as follows:
    a. DAAOF (diaminoazoxyfurazan);
    b. DAAzF (diaminoazofurazan) (CAS 78644-90-3);
13. HMX and derivatives (see also ML8.g.5. for its "precursors"), as follows:
    a. HMX (Cyclotetramethylenetetranitramine, octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazine, 1,3,5,7-tetranitro-1,3,5,7-tetraza-cyclooctane, octogen or octogene) (CAS 2691-41-0);
    b. difluoroaminated analogs of HMX;
    c. K-55 (2,4,6,8-tetranitro-2,4,6,8-tetraazabicyclo [3,3,0]-octanone-3, tetranitrosemiglycouril or keto-bicyclic HMX) (CAS 130256-72-3);
14. HNAD (hexanitroadamantane) (CAS 143850-71-9);
15. HNS (hexanitrostilbene) (CAS 20062-22-0);
16. Imidazoles as follows:
    a. BNNII (Octahydro-2,5-bis(nitroimino)imidazo [4,5-d]imidazole);
    b. DNI (2,4-dinitroimidazole) (CAS 5213-49-0);
    c. FDIA (1-fluoro-2,4-dinitroimidazole);
    d. NTDNIA (N-(2-nitrotriazolo)-2,4-dinitroimidazole);
    e. PTIA (1-picryl-2,4,5-trinitroimidazole);
17. NTNMH (1-(2-nitrotriazolo)-2-dinitromethylene hydrazine);
18. NTO (ONTA or 3-nitro-1,2,4-triazol-5-one) (CAS 932-64-9);
19. Polynitrocubanes with more than four nitro groups;
20. PYX (2,6-Bis(picrylamino)-3,5-dinitropyridine) (CAS 38082-89-2);
21. RDX and derivatives, as follows:
    a. RDX (cyclotrimethylenetrinitramine, cyclonite, T4, hexahydro-1,3,5-trinitro-1,3,5-triazine, 1,3,5-trinitro-1,3,5-triaza-cyclohexane, hexogen or hexogene) (CAS 121-82-4);
    b. Keto-RDX (K-6 or 2,4,6-trinitro-2,4,6-triazacyclohexanone) (CAS 115029-35-1);
22. TAGN (triaminoguanidinenitrate) (CAS 4000-16-2);
23. TATB (triaminotrinitrobenzene) (CAS 3058-38-6) (see also ML8.g.7 for its "precursors");
24. TEDDZ (3,3,7,7-tetrabis(difluoroamine) octahydro-1,5-dinitro-1,5-diazocine);
25. Tetrazoles as follows:
    a. NTAT (nitrotriazol aminotetrazole);
    b. NTNT (1-N-(2-nitrotriazolo)-4-nitrotetrazole);
26. Tetryl (trinitrophenylmethylnitramine) (CAS 479-45-8);
27. TNAD (1,4,5,8-tetranitro-1,4,5,8-tetraazadecalin) (CAS 135877-16-6) (see also ML8.g.6. for its "precursors");
28. TNAZ (1,3,3-trinitroazetidine) (CAS 97645-24-4) (see also ML8.g.2. for its "precursors");

29. TNGU (SORGUYL or tetranitroglycoluril) (CAS 55510-03-7);
30. TNP (1,4,5,8-tetranitro-pyridazino[4,5-d]pyridazine) (CAS 229176-04-9);
31. Triazines as follows:
    a. DNAM (2-oxy-4,6-dinitroamino-s-triazine) (CAS 19899-80-0);
    b. NNHT (2-nitroimino-5-nitro-hexahydro-1,3,5-triazine) (CAS 130400-13-4);
32. Triazoles as follows:
    a. 5-azido-2-nitrotriazole;
    b. ADHTDN (4-amino-3,5-dihydrazino-1,2,4-triazole dinitramide) (CAS 1614-08-0);
    c. ADNT (1-amino-3,5-dinitro-1,2,4-triazole);
    d. BDNTA ([bis-dinitrotriazole]amine);
    e. DBT (3,3′-dinitro-5,5-bi-1,2,4-triazole) (CAS 30003-46-4);
    f. DNBT (dinitrobistriazole) (CAS 70890-46-9);
    g. NTDNA (2-nitrotriazole 5-dinitramide) (CAS 75393-84-9);
    h. NTDNT (1-N-(2-nitrotriazolo) 3,5-dinitrotriazole);
    i. PDNT (1-picryl-3,5-dinitrotriazole);
    j. TACOT (tetranitrobenzotriazolobenzotriazole) (CAS 25243-36-1);
33. "Explosives" not listed elsewhere in ML8.a. and having any of the following:
    a. Detonation velocity exceeding 8,700 m/s, at maximum density; or
    b. Detonation pressure exceeding 34 GPa (340 kbar);
34. Not used;
35. DNAN (2,4-dinitroanisole) (CAS 119-27-7);
36. TEX (4,10-Dinitro-2,6,8,12-tetraoxa-4,10-diazaisowurtzitane);
37. GUDN (Guanylurea dinitramide) FOX-12 (CAS 217464-38-5);
38. Tetrazines as follows:
    a. BTAT (Bis(2,2,2-trinitroethyl)-3,6-diaminotetrazine);
    b. LAX-112 (3,6-diamino-1,2,4,5-tetrazine-1,4-dioxide);
39. Energetic ionic materials melting between 343 K (70°C) and 373 K (100°C) and with detonation velocity exceeding 6,800 m/s or detonation pressure exceeding 18 GPa (180 kbar);
40. BTNEN (Bis(2,2,2-trinitroethyl)-nitramine) (CAS 19836-28-3);
41. FTDO (5,6-(3',4'-furazano)- 1,2,3,4-tetrazine-1,3-dioxide);
42. EDNA (Ethylenedinitramine) (CAS 505-71-5);
43. TKX-50 (Dihydroxylammonium 5,5'-bistetrazole-1,1'-diolate);

Note: *ML8.a. includes 'explosive co-crystals'.*

Technical Note:

An 'explosive co-crystal' is a solid material consisting of an ordered three dimensional arrangement of two or more explosive molecules, where at least one is specified by ML8.a.

b. "Propellants" as follows:
    1. Any solid "propellant" with a theoretical specific impulse (under standard conditions) of more than:
        a. 240 seconds for non-metallized, non-halogenized "propellant";
        b. 250 seconds for non-metallized, halogenized "propellant"; or
        c. 260 seconds for metallized "propellant";
    2. Not used;

3. "Propellants" having a force constant of more than 1,200 kJ/kg;
4. "Propellants" that can sustain a steady-state linear burning rate of more than 38 mm/s under standard conditions (as measured in the form of an inhibited single strand) of 6.89 MPa (68.9 bar) pressure and 294K (21°C);
5. Elastomer Modified Cast Double Base (EMCDB) "propellants" with extensibility at maximum stress of more than 5% at 233K (-40°C);
6. Any "propellant" containing substances specified by ML8.a.;
7. "Propellants", not specified elsewhere in the Munitions List, specially designed for military use;

c. "Pyrotechnics", fuels and related substances, as follows, and 'mixtures' thereof:
1. "Aircraft" fuels specially formulated for military purposes;

Note 1: ML8.c.1. does not apply to the following "aircraft" fuels: JP-4, JP-5, and JP-8.

Note 2: "Aircraft" fuels specified by ML8.c.1. are finished products, not their constituents.

2. Alane (aluminum hydride) (CAS 7784-21-6);
3. Boranes, as follows, and their derivatives:
   a. Carboranes;
   b. Borane homologues, as follows:
      1. Decaborane (14) (CAS 17702-41-9);
      2. Pentaborane (9) (CAS 19624-22-7);
      3. Pentaborane (11) (CAS 18433-84-6);
4. Hydrazine and derivatives, as follows (see also ML8.d.8. and d.9. for oxidising hydrazine derivatives):
   a. Hydrazine (CAS 302-01-2) in concentrations of 70% or more;
   b. Monomethyl hydrazine (CAS 60-34-4);
   c. Symmetrical dimethyl hydrazine (CAS 540-73-8);
   d. Unsymmetrical dimethyl hydrazine (CAS 57-14-7);

Note: ML8.c.4.a. does not apply to hydrazine 'mixtures' specially formulated for corrosion control.

5. Metal fuels, fuel 'mixtures' or "pyrotechnic" 'mixtures', in particle form whether spherical, atomized, spheroidal, flaked or ground, manufactured from material consisting of 99% or more of any of the following:
   a. Metals as follows and 'mixtures' thereof:
      1. Beryllium (CAS 7440-41-7) in particle sizes of less than 60 μm;
      2. Iron powder (CAS 7439-89-6) with particle size of 3 μm or less produced by reduction of iron oxide with hydrogen;
   b. 'Mixtures' containing any of the following:
      1. Zirconium (CAS 7440-67-7), magnesium (CAS 7439-95-4) or alloys of these in particle sizes of less than 60 μm; or
      2. Boron (CAS 7440-42-8) or boron carbide (CAS 12069-32-8) fuels of 85% purity or higher and particle sizes of less than 60 μm;

Note 1: ML8.c.5 applies to "explosives" and fuels, whether or not the metals or alloys are encapsulated in aluminium, magnesium, zirconium, or beryllium.

Note 2: ML8.c.5.b. only applies to metal fuels in particle form when they are mixed with other substances to form a 'mixture' formulated for military purposes such as liquid "propellant" slurries, solid "propellants", or "pyrotechnic" 'mixtures'.

Note 3: ML8.c.5.b.2. does not apply to boron and boron carbide enriched with boron-10 (20% or more of total boron-10 content.)

6. Military materials, containing thickeners for hydrocarbon fuels, specially formulated for use in flame throwers or incendiary munitions, such as metal stearates (e.g., octal (CAS 637-12-7)) or palmitates;
7. Perchlorates, chlorates and chromates, composited with powdered metal or other high energy fuel components;
8. Spherical aluminium powder (CAS 7429-90-5) with a particle size of 60 µm or less, manufactured from material with an aluminium content of 99% or more;
9. Titanium subhydride (TiH_n) of stoichiometry equivalent to n= 0.65-1.68;
10. Liquid high energy density fuels not specified by ML8.c.1., as follows:
    a. Mixed fuels, that incorporate both solid and liquid fuels (e.g., boron slurry), having a mass-based energy density of 40 MJ/kg or greater;
    b. Other high energy density fuels and fuel additives (e.g., cubane, ionic solutions, JP-7, JP-10), having a volume-based energy density of 37.5 GJ per cubic meter or greater, measured at 293 K (20°C) and one atmosphere (101.325 kPa) pressure;

    Note: ML8.c.10.b. does not apply to fossil refined fuels or biofuels, or fuels for engines certified for use in civil aviation.
11. "Pyrotechnic" and pyrophoric materials as follows:
    a. "Pyrotechnic" or pyrophoric materials specifically formulated to enhance or control the production of radiated energy in any part of the IR spectrum;
    b. Mixtures of magnesium, polytetrafluoroethylene (PTFE) and a vinylidene difluoride-hexafluoropropylene copolymer (e.g., MTV);
12. Fuel mixtures, "pyrotechnic" mixtures or "energetic materials", not specified elsewhere in ML8, having all of the following:
    a. Containing greater than 0.5% of particles of any of the following:
        1. Aluminium;
        2. Beryllium;
        3. Boron;
        4. Zirconium;
        5. Magnesium; or
        6. Titanium;
    b. Particles specified by ML8.c.12.a. with a size less than 200 nm in any direction; and
    c. Particles specified by ML8.c.12.a. with a metal content of 60% or greater;

    Note: ML8.c.12. includes thermites.

d. Oxidisers as follows, and 'mixtures' thereof:
    1. ADN (ammonium dinitramide or SR 12) (CAS 140456-78-6);
    2. AP (ammonium perchlorate) (CAS 7790-98-9);
    3. Compounds composed of fluorine and any of the following:

a. Other halogens;
b. Oxygen; or
c. Nitrogen;

Note 1: ML8.d.3. does not apply to chlorine trifluoride (CAS 7790-91-2).

Note 2: ML8.d.3. does not apply to nitrogen trifluoride (CAS 7783-54-2) in its gaseous state.

4. DNAD (1,3-dinitro-1,3-diazetidine) (CAS 78246-06-7);
5. HAN (hydroxylammonium nitrate) (CAS 13465-08-2);
6. HAP (hydroxylammonium perchlorate) (CAS 15588-62-2);
7. HNF (hydrazinium nitroformate) (CAS 20773-28-8);
8. Hydrazine nitrate (CAS 37836-27-4);
9. Hydrazine perchlorate (CAS 27978-54-7);
10. Liquid oxidisers comprised of or containing inhibited red fuming nitric acid (IRFNA) (CAS 8007-58-7);

Note: ML8.d.10. does not apply to non-inhibited fuming nitric acid.

e. Binders, plasticisers, monomers and polymers, as follows:
1. AMMO (azidomethylmethyloxetane and its polymers) (CAS 90683-29-7) (see also ML8.g.1. for its "precursors");
2. BAMO (3,3-bis(azidomethyl)oxetane and its polymers) (CAS 17607-20-4) (see also ML8.g.1. for its "precursors");
3. BDNPA (bis (2,2-dinitropropyl)acetal) (CAS 5108-69-0);
4. BDNPF (bis (2,2-dinitropropyl)formal) (CAS 5917-61-3);
5. BTTN (butanetrioltrinitrate) (CAS 6659-60-5) (see also ML8.g.8. for its "precursors");
6. Energetic monomers, plasticisers or polymers, specially formulated for military use and containing any of the following:
a. Nitro groups;
b. Azido groups;
c. Nitrate groups;
d. Nitraza groups; or
e. Difluoroamino groups;
7. FAMAO (3-difluoroaminomethyl-3-azidomethyl oxetane) and its polymers;
8. FEFO (bis-(2-fluoro-2,2-dinitroethyl) formal) (CAS 17003-79-1);
9. FPF-1 (poly-2,2,3,3,4,4-hexafluoropentane-1,5-diol formal) (CAS 376-90-9);
10. FPF-3 (poly-2,4,4,5,5,6,6-heptafluoro-2-tri-fluoromethyl-3-oxaheptane-1,7-diol formal);
11. GAP (glycidylazide polymer) (CAS 143178-24-9) and its derivatives;
12. HTPB (hydroxyl terminated polybutadiene) with a hydroxyl functionality equal to or greater than 2.2 and less than or equal to 2.4, a hydroxyl value of less than 0.77 meq/g, and a viscosity at 30°C of less than 47 poise (CAS 69102-90-5);
13. Alcohol functionalised poly(epichlorohydrin) with a molecular weight less than 10,000, as follows:
a. Poly(epichlorohydrindiol);
b. Poly(epichlorohydrintriol);

14. NENAs (nitratoethylnitramine compounds) (CAS 17096-47-8, 85068-73-1, 82486-83-7, 82486-82-6 and 85954-06-9);
15. PGN (poly-GLYN, polyglycidylnitrate or poly(nitratomethyl oxirane) (CAS 27814-48-8);
16. Poly-NIMMO (poly (nitratomethylmethyloxetane), poly-NMMO or poly(3- Nitratomethyl-3-methyloxetane)) (CAS 84051-81-0);
17. Polynitroorthocarbonates;
18. TVOPA (1,2,3-tris[1,2-bis(difluoroamino)ethoxy] propane or tris vinoxy propane adduct) (CAS 53159-39-0);
19. 4,5 diazidomethyl-2-methyl-1,2,3-triazole (iso- DAMTR);
20. PNO (Poly(3-nitrato oxetane));
21. TMETN (Trimethylolethane trinitrate) (CAS 3032-55-1);

f. "Additives" as follows:
1. Basic copper salicylate (CAS 62320-94-9);
2. BHEGA (bis-(2-hydroxyethyl) glycolamide) (CAS 17409-41-5);
3. BNO (butadienenitrileoxide) (CAS 9003-18-3);
4. Ferrocene derivatives as follows:
   a. Butacene (CAS 125856-62-4);
   b. Catocene (2,2-bis-ethylferrocenyl propane) (CAS 37206-42-1);
   c. Ferrocene carboxylic acids;
   d. n-butyl-ferrocene (CAS 31904-29-7);
   e. Other adducted polymer ferrocene derivatives;
   f. Ethyl ferrocene (CAS 1273-89-8);
   g. Propyl ferrocene;
   h. Pentyl ferrocene (CAS 1274-00-6);
   i. Dicyclopentyl ferrocene;
   j. Dicyclohexyl ferrocene;
   k. Diethyl ferrocene (CAS 1273-97-8);
   l. Dipropyl ferrocene;
   m. Dibutyl ferrocene (CAS 1274-08-4);
   n. Dihexyl ferrocene (CAS 93894-59-8);
   o. Acetyl ferrocene (CAS 1271-55-2)/1,1'-diacetyl ferrocene (CAS 1273-94-5);
5. Lead beta-resorcylate (CAS 20936-32-7) or copper beta-resorcylate (CAS 70983-44-7);
6. Lead citrate (CAS 14450-60-3);
7. Lead-copper chelates of beta-resorcylate or salicylates (CAS 68411-07-4);
8. Lead maleate (CAS 19136-34-6);
9. Lead salicylate (CAS 15748-73-9);
10. Lead stannate (CAS 12036-31-6);
11. MAPO (tris-1-(2-methyl)aziridinyl phosphine oxide) (CAS 57-39-6); BOBBA 8 (bis(2-methyl aziridinyl) 2-(2-hydroxypropanoxy) propylamino phosphine oxide); and other MAPO derivatives;
12. Methyl BAPO (bis(2-methyl aziridinyl) methylamino phosphine oxide) (CAS 85068-72-0);
13. N-methyl-p-nitroaniline (CAS 100-15-2);
14. 3-Nitraza-1,5-pentane diisocyanate (CAS 7406-61-9);
15. Organo-metallic coupling agents as follows:

a. Neopentyl[diallyl]oxy, tri[dioctyl]phosphato-titanate (CAS 103850-22-2); also known as titanium IV, 2,2[bis 2-propenolato-methyl, butanolato, tris (dioctyl) phosphato] (CAS 110438-25-0); or LICA 12 (CAS 103850-22-2);
b. Titanium IV, [(2-propenolato-1) methyl, n-propanolatomethyl] butanolato-1, tris[dioctyl] pyrophosphate or KR3538;
c. Titanium IV, [(2-propenolato-1)methyl, n-propanolatomethyl] butanolato-1, tris(dioctyl)phosphate;

16. Polycyanodifluoroaminoethyleneoxide;
17. Bonding agents as follows:
    a. 1,1R,1S-trimesoyl-tris(2-ethylaziridine) (HX-868, BITA) (CAS 7722-73-8);
    b. Polyfunctional aziridine amides with isophthalic, trimesic, isocyanuric or trimethyladipic backbone also having a 2-methyl or 2-ethyl aziridine group;

    Note: *Item ML.8.f.17.b. includes:*
    a. 1,1H-Isophthaloyl-bis(2-methylaziridine) (HX-752) (CAS 7652-64-4);
    b. 2,4,6-tris(2-ethyl-1-aziridinyl)-1,3,5-triazine (HX-874) (CAS 18924-91-9);
    c. 1,1'-trimethyladipoyl-bis(2-ethylaziridine) (HX-877) (CAS 71463-62-2).
18. Propyleneimine (2-methylaziridine) (CAS 75-55-8);
19. Superfine iron oxide (Fe_2O_3) (CAS 1317-60-8) with a specific surface area more than 250 m^2/g and an average particle size of 3.0 nm or less;
20. TEPAN (tetraethylenepentaamineacrylonitrile) (CAS 68412-45-3); cyanoethylated polyamines and their salts;
21. TEPANOL (tetraethylenepentaamineacrylonitrileglycidol) (CAS 68412-46-4); cyanoethylated polyamines adducted with glycidol and their salts;
22. TPB (triphenyl bismuth) (CAS 603-33-8);
23. TEPB (Tris (ethoxyphenyl) bismuth) (CAS 90591-48-3);

g. "Precursors" as follows:

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

1. BCMO (3,3-bis(chloromethyl)oxetane) (CAS 142173-26-0) (see also ML8.e.1. and ML8.e.2.);
2. Dinitroazetidine-t-butyl salt (CAS 125735-38-8) (see also ML8.a.28.);
3. HBIW (hexabenzylhexaazaisowurtzitane) (CAS 124782-15-6) (see also ML8.a.4.);
4. Not used;
5. TAT (1,3,5,7 tetraacetyl-1,3,5,7,-tetraaza cyclo-octane) (CAS 41378-98-7) (see also ML8.a.13.);
6. 1,4,5,8-tetraazadecalin (CAS 5409-42-7) (see also ML8.a.27.);
7. 1,3,5-trichlorobenzene (CAS 108-70-3) (see also ML8.a.23.);
8. 1,2,4-trihydroxybutane (1,2,4-butanetriol) (CAS 3068-00-6) (see also ML8.e.5.);
9. DADN (1,5-diacetyl-3,7-dinitro-1, 3, 5, 7-tetraaza-cyclooctane) (see also ML8.a.13).

h. 'Reactive material' powders and shapes, as follows:

1. Powders of any of the following materials, with a particle size less than 250 μm in any direction and not specified elsewhere by ML8:
    a. Aluminium;
    b. Niobium;
    c. Boron;
    d. Zirconium;
    e. Magnesium;
    f. Titanium;
    g. Tantalum;
    h. Tungsten;
    i. Molybdenum; or
    j. Hafnium;
2. Shapes, not specified by ML3, ML4, ML12 or ML16, fabricated from powders specified by ML8.h.1.

Technical Notes:

1. 'Reactive materials' are designed to produce an exothermic reaction only at high shear rates and for use as liners or casings in warheads.

2. 'Reactive material' powders are produced by, for example, a high energy ball milling process.

3. 'Reactive material' shapes are produced by, for example, selective laser sintering.

Note 1: ML8. does not apply to the following substances unless they are compounded or mixed with the "energetic material" specified by ML8.a. or powdered metals specified by ML8.c.:

a. Ammonium picrate (CAS 131-74-8);
b. Black powder;
c. Hexanitrodiphenylamine (CAS 131-73-7);
d. Difluoroamine (CAS 10405-27-3);
e. Nitrostarch (CAS 9056-38-6);
f. Potassium nitrate (CAS 7757-79-1);
g. Tetranitronaphthalene;
h. Trinitroanisol;
i. Trinitronaphthalene;
j. Trinitroxylene;
k. N-pyrrolidinone; 1-methyl-2-pyrrolidinone (CAS 872-50-4);
l. Dioctylmaleate (CAS 142-16-5);
m. Ethylhexylacrylate (CAS 103-11-7);
n. Triethylaluminium (TEA) (CAS 97-93-8), trimethylaluminium (TMA) (CAS 75-24-1), and other pyrophoric metal alkyls and aryls of lithium, sodium, magnesium, zinc or boron;
o. Nitrocellulose (CAS 9004-70-0);
p. Nitroglycerin (or glyceroltrinitrate, trinitroglycerine) (NG) (CAS 55-63-0);
q. 2,4,6-trinitrotoluene (TNT) (CAS 118-96-7);
r. Ethylenediaminedinitrate (EDDN) (CAS 20829-66-7);
s. Pentaerythritoltetranitrate (PETN) (CAS 78-11-5);
t. Lead azide (CAS 13424-46-9), normal lead styphnate (CAS 15245-44-0) and basic lead styphnate (CAS 12403-82-6), and primary explosives or priming compositions containing azides or azide complexes;
u. Triethyleneglycoldinitrate (TEGDN) (CAS 111-22-8);

v. 2,4,6-trinitroresorcinol (styphnic acid) (CAS 82-71-3);
w. Diethyldiphenylurea; (CAS 85-98-3); dimethyldiphenylurea; (CAS 611-92-7), methylethyldiphenylurea; [Centralites]
x. N,N-diphenylurea (unsymmetrical diphenylurea) (CAS 603-54-3);
y. Methyl-N,N-diphenylurea (methyl unsymmetrical diphenylurea) (CAS 13114-72-2);
z. Ethyl-N,N-diphenylurea (ethyl unsymmetrical diphenylurea) (CAS 64544-71-4);
aa. 2-Nitrodiphenylamine (2-NDPA) (CAS 119-75-5);
bb. 4-Nitrodiphenylamine (4-NDPA) (CAS 836-30-6);
cc. 2,2-dinitropropanol (CAS 918-52-5);
dd. Nitroguanidine (CAS 556-88-7) (see 1.C.11.d. on the Dual-Use List).

N.B.: See also ML908.

Note 2: ML8. does not apply to ammonium perchlorate (ML8.d.2.), NTO (ML8.a.18.) or catocene (ML8.f.4.b.), and meeting all of the following:
a. Specially shaped and formulated for civil-use gas generation devices;
b. Compounded or mixed, with non-active thermoset binders or plasticizers, and having a mass of less than 250 g;
c. Having a maximum of 80% ammonium perchlorate (ML8.d.2.) in mass of active material;
d. Having less than or equal to 4 g of NTO (ML8.a.18.); and
e. Having less than or equal to 1 g of catocene (ML8.f.4.b.).

Note 3: Former note 5 was deleted in 2008. Remaining Notes 6 and 7 were renumbered Notes 1 and 2 in 2012.

ML9. Vessels of war (surface or underwater), special naval equipment, accessories, components and other surface vessels, as follows:

N.B.: For guidance and navigation equipment, see ML11.

a. Vessels and components, as follows:
1. Vessels (surface or underwater) specially designed or modified for military use, regardless of current state of repair or operating condition, and whether or not they contain weapon delivery systems or armour, and hulls or parts of hulls for such vessels, and components therefor specially designed for military use;

Note: ML9.a.1. includes vehicles specially designed or modified for the delivery of divers.

2. Surface vessels, not specified in ML9.a.1., having any of the following, fixed or integrated into the vessel:
a. Automatic weapons specified by ML1., or weapons specified by ML2., ML4., ML12. or ML19., or 'mountings' or hard points for weapons having a calibre of 12.7 mm or greater;

Technical Note:

'Mountings' refers to weapon mounts or structural strengthening for the purpose of installing weapons.

b. Fire control systems specified by ML5.;
c. Having all of the following:
1. 'Chemical, Biological, Radiological and Nuclear (CBRN) protection'; and
2. 'Pre-wet or wash down system' designed for decontamination purposes; or

Technical Notes:

1. *'CBRN protection' is a self contained interior space containing features such as over-pressurisation, isolation of ventilation systems, limited ventilation openings with CBRN filters and limited personnel access points incorporating air-locks.*
2. *'Pre-wet or wash down system' is a seawater spray system capable of simultaneously wetting the exterior superstructure and decks of a vessel.*

d. Active weapon countermeasure systems specified by ML4.b., ML5.c. or ML11.a. and having any of the following:
1. 'CBRN protection';
2. Hull and superstructure, specially designed to reduce the radar cross section;
3. Thermal signature reduction devices, (e.g., an exhaust gas cooling system), excluding those specially designed to increase overall power plant efficiency or to reduce the environmental impact; or
4. A degaussing system designed to reduce the magnetic signature of the whole vessel;

b. Engines and propulsion systems, as follows, specially designed for military use and components therefor specially designed for military use:
1. Diesel engines specially designed for submarines;
2. Electric motors specially designed for submarines and having all of the following:
a. Power output of more than 0.75 MW (1,000 hp);
b. Quick reversing;
c. Liquid cooled; and
d. Totally enclosed;
3. Diesel engines having all of the following:
a. Power output of 37.3 kW (50 hp) or more; and
b. 'Non-magnetic' content in excess of 75% of total mass;

Technical Note:

For the purposes of ML9.b.3., 'non-magnetic' means the relative permeability is less than 2.

4. 'Air Independent Propulsion' (AIP) systems specially designed for submarines;

Technical Note:

'Air Independent Propulsion' (AIP) allows a submerged submarine to operate its propulsion system, without access to atmospheric oxygen, for a longer time than the batteries would have otherwise allowed. For the purposes of ML9.b.4., AIP does not include nuclear power.

c. Underwater detection devices, specially designed for military use, controls therefor and components therefor specially designed for military use;

d. Anti-submarine nets and anti-torpedo nets, specially designed for military use;

e. Not used since 2003;

f. Hull penetrators and connectors, specially designed for military use, that enable interaction with equipment external to a vessel, and components therefor specially designed for military use;

Note: *ML9.f. includes connectors for vessels which are of the single-conductor, multi-conductor, coaxial or waveguide type, and hull penetrators for vessels, both of which are capable of remaining impervious to leakage from without and of retaining required characteristics at marine depths exceeding 100 m; and fibre-optic connectors and optical hull penetrators, specially designed for "laser" beam transmission, regardless of depth. ML9.f. does not apply to ordinary propulsive shaft and hydrodynamic control-rod hull penetrators.*

g. Silent bearings having any of the following, components therefor and equipment containing those bearings, specially designed for military use:
   1. Gas or magnetic suspension;
   2. Active signature controls; or
   3. Vibration suppression controls;

h. Nuclear power generating equipment or propulsion equipment, specially designed for vessels specified in ML9.a. and components therefor specially designed or 'modified' for military use.

Technical Note:

For the purpose of ML9.h., 'modified' means any structural, electrical, mechanical, or other change that provides a non-military item with military capabilities equivalent to an item which is specially designed for military use.

Note: *ML9.h. includes "nuclear reactors".*

ML10. "Aircraft", "lighter-than-air vehicles", "Unmanned aerial vehicles" ("UAVs"), aero-engines and "aircraft" equipment, related equipment, and components, as follows, specially designed or modified for military use:

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

a. Manned "aircraft" and "lighter-than-air vehicles", and specially designed components therefor;

b. Not used;

c. Unmanned "aircraft" and "lighter-than-air vehicles", and related equipment, as follows, and specially designed components therefor:
   1. "UAVs", Remotely Piloted Air Vehicles (RPVs), autonomous programmable vehicles and unmanned "lighter-than-air vehicles";
   2. Launchers, recovery equipment and ground support equipment;
   3. Equipment designed for command or control;

      Note: *Certain items specified in ML10.c.1. may be subject to the MTCR Guidelines for Sensitive Missile-Relevant Transfers.*

d. Propulsion aero-engines and specially designed components therefor;

e. Airborne refuelling equipment specially designed or modified for any of the following, and specially designed components therefor:
   1. "Aircraft" specified by ML10.a.; or
   2. Unmanned "aircraft" specified by ML10.c.;

f. 'Ground equipment' specially designed for "aircraft" specified by ML10.a. or aero-engines specified by ML10.d.;

Note 1: ML10.f includes pressure refuelling equipment and equipment designed to facilitate operations in confined areas, including equipment located on board a ship.

Note 2: ML10.f. does *not apply to:*

1. *Towbars;*
2. *Protective mats and covers;*
3. *Ladders, steps and platforms;*
4. *Chocks, lashings and tie-down equipment*.

g. Aircrew life support equipment, aircrew safety equipment and other devices for emergency escape, not specified by ML10.a., designed for "aircraft" specified by ML10.a.;

Note: ML10.g. does not apply to aircrew helmets that do not incorporate, or have mountings or fittings for, equipment specified in the Munitions List.

N.B.: For helmets see also ML13.c.

h. Parachutes, paragliders and related equipment, as follows, and specially designed components therefor:

1. Parachutes not specified elsewhere in the Munitions List;
2. Paragliders;
3. Equipment specially designed for high altitude parachutists (e.g. suits, special helmets, breathing systems, navigation equipment);

i. Controlled opening equipment or automatic piloting systems, designed for parachuted loads.

Note 1: ML10.a. does not apply to "aircraft" and "lighter-than-air vehicles" or variants of those "aircraft", specially designed for military use and which are all of the following:

a. Not a combat "aircraft";
b. Not configured for military use and not fitted with equipment or attachments specially designed or modified for military use; and
c. Certified for civil use by the civil aviation authorities of one or more Wassenaar Arrangement Participating States.

Note 2: ML10.d. does not apply to:

a. Aero-engines designed or modified for military use which have been certified by civil aviation authorities of one or more Wassenaar Arrangement Participating States for use in "civil aircraft", or specially designed components therefor;
b. Reciprocating engines or specially designed components therefor, except those specially designed for "UAVs".

Note 3: For the purposes of ML10.a. and ML10.d., specially designed components and related equipment for non-military "aircraft" or aero-engines modified for military use applies only to those military components and to military related equipment required for the modification to military use.

Note 4: For the purposes of ML10.a., military use includes combat, military reconnaissance, assault, military training, logistics support, and transporting and airdropping troops or military equipment.

Note 5: ML10.a. does not apply to "aircraft" or "lighter-than-air vehicles" that meet all of the following:

a. Were first manufactured before 1946;
b. Do not incorporate items specified by the Munitions List, unless the items are required to meet safety or airworthiness standards of civil aviation authorities of one or more Wassenaar Arrangement Participating States; and
c. Do not incorporate weapons specified by the Munitions List, unless inoperable and incapable of being returned to operation.

Note 6: ML10.d. does not apply to propulsion aero-engines that were first manufactured before 1946.

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

a. Electronic equipment specially designed for military use;

Note 1: ML11.a. includes:

a. Electronic countermeasure and electronic counter-countermeasure equipment (i.e., equipment designed to introduce extraneous or erroneous signals into radar or radio communication receivers or otherwise hinder the reception, operation or effectiveness of adversary electronic receivers including their countermeasure equipment), including jamming and counter-jamming equipment;

b. Frequency agile tubes;

c. Electronic systems or equipment, designed either for surveillance and monitoring of the electro-magnetic spectrum for military intelligence or security purposes or for counteracting such surveillance and monitoring;

d. Underwater countermeasures, including acoustic and magnetic jamming and decoy, equipment designed to introduce extraneous or erroneous signals into sonar receivers;

e. Data processing security equipment, data security equipment and transmission and signalling line security equipment, using cryptographic functionality;

f. Identification, authentification and keyloader equipment and key management, manufacturing and distribution equipment;

g. Guidance and navigation equipment;

h. Digital troposcatter-radio communications transmission equipment;

i. Digital demodulators specially designed for signals intelligence;

j. "Automated Command and Control Systems".

Note 2: Certain items specified in ML11.a. may be subject to the MTCR Guidelines for Sensitive Missile-Relevant Transfers.

N.B.: For "software" associated with military "Software" Defined Radio (SDR), see ML21.

b. Jamming equipment designed or modified to hinder the reception, operation or effectiveness of positioning, navigation or timing services provided by "satellite navigation systems", and specially designed components therefor;

c. "Spacecraft" specially designed or modified for military use, and "spacecraft" components specially designed for military use.

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

a. Kinetic energy weapon systems specially designed for destruction or effecting mission-abort of a target;

b. Specially designed test and evaluation facilities and test models, including diagnostic instrumentation and targets, for dynamic testing of kinetic energy projectiles and systems.

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

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

a. Launch propulsion systems capable of accelerating masses larger than 0.1 g to velocities in excess of 1.6 km/s, in single or rapid fire modes;

b. Prime power generation, electric armour, energy storage (e.g., high energy storage capacitors), thermal management, conditioning, switching or fuel-handling equipment; and electrical interfaces between power supply, gun and other turret electric drive functions;

N.B.: See also 3A001.e.2. on the Dual-Use List for high energy storage capacitors.

c. Target acquisition, tracking, fire control or damage assessment systems;

d. Homing seeker, guidance or divert propulsion (lateral acceleration) systems for projectiles.

Note 2: ML12. applies to weapon systems using any of the following methods of propulsion:

a. Electromagnetic;

b. Electrothermal;

c. Plasma;

d. Light gas; or

e. Chemical (when used in combination with any of the above).

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

a. Metallic or non-metallic armoured plate, having any of the following:

1. Manufactured to comply with a military standard or specification; or
2. Suitable for military use;

N.B.: For body armour plates, see ML13.d.2.

b. Constructions of metallic or non-metallic materials, or combinations thereof, specially designed to provide ballistic protection for military systems, and specially designed components therefor;

c. Helmets and specially designed components and accessories therefor, as follows:

1. Helmets manufactured according to military standards or specifications, or comparable national standards;
2. Shells, liners, or comfort pads, specially designed for helmets specified in ML13.c.1.;
3. Add-on ballistic protection elements, specially designed for helmets specified in ML13.c.1.

N.B.: For other military helmet components or accessories, see the relevant ML entry.

d. Body armour or protective garments, and components therefor, as follows:

1. Soft body armour or protective garments, manufactured to military standards or specifications, or to their equivalents, and specially designed components therefor;

Note: For the purposes of ML13.d.1., military standards or specifications include, at a minimum, specifications for fragmentation protection.

2. Hard body armour plates providing ballistic protection equal to or greater than level III (NIJ 0101.06, July 2008), or "equivalent standards".

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

Note 2: ML13.c. does not apply to helmets that meet all of the following:

1. *Were first manufactured before 1970; and*
2. *Are neither designed or modified to accept, nor equipped with items specified by the Munitions List.*

Note 3: ML13.c. and ML13.d. do not apply to helmets, body armour or protective garments, when accompanying their user for the user's own personal protection.

Note 4: The only helmets specially designed for bomb disposal personnel that are specified by ML13.c. are those specially designed for military use.

Note 5: ML13.d.1. does not apply to protective eyewear.

N.B.: For laser protective eyewear, see ML17.o.

N.B. 1: See also 1A005 on the Dual-Use List.

N.B. 2: For "fibrous or filamentary materials" used in the manufacture of body armour and helmets, see 1C010 on the Dual-Use List.

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

Technical Note:

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

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

Note 2: ML14. does not apply to equipment specially designed for training in the use of hunting or sporting weapons.

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

a. Recorders and image processing equipment;

b. Cameras, photographic equipment and film processing equipment;

c. Image intensifier equipment;

d. Infrared or thermal imaging equipment;

e. Imaging radar sensor equipment;

f. Countermeasure or counter-countermeasure equipment, for the equipment specified by ML15.a. to ML15.e.

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

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

N.B.: *For the classification of weapons sights incorporating "first generation image intensifier tubes", see ML1., ML2. and ML5.a.*

N.B.: *See also 6A002.a.2. and 6A002.b. on the Dual-Use List.*

ML16. Forgings, castings and other unfinished products, specially designed for items specified by ML1. to ML4., ML6., ML9., ML10., ML12., ML19 or ML901 to ML910.

Note: *ML16. applies to unfinished products when they are identifiable by material composition, geometry or function.*

ML17. Miscellaneous equipment, materials and "libraries", as follows, and specially designed components therefor:

a. Diving and underwater swimming apparatus, specially designed or modified for military use, as follows:

1. Self-contained diving rebreathers, closed or semi-closed circuit;
2. Underwater swimming apparatus specially designed for use with the diving apparatus specified by ML17.a.1;

N.B.: *See also 8A002.q. on the Dual-Use List.*

b. Construction equipment specially designed for military use;

c. Fittings, coatings and treatments, for signature suppression, specially designed for military use;

d. Field engineer equipment specially designed for use in a combat zone;

e. "Robots", "robot" controllers and "robot" "end-effectors", having any of the following characteristics:

1. Specially designed for military use;
2. Incorporating means of protecting hydraulic lines against externally induced punctures caused by ballistic fragments (e.g., incorporating self-sealing lines) and designed to use hydraulic fluids with flash points higher than 839 K (566°C); or
3. Specially designed or rated for operating in an electro-magnetic pulse (EMP) environment;

Technical Note:

Electro-magnetic pulse does not refer to unintentional interference caused by electromagnetic radiation from nearby equipment (e.g., machinery, appliances or electronics) or lightning.

f. "Libraries" specially designed or modified for military use with systems, equipment or components, specified by the Munitions List;

g. Nuclear power generating equipment or propulsion equipment, not specified elsewhere, specially designed for military use and components therefor specially designed or 'modified' for military use;

Note: *ML17.g. includes "nuclear reactors".*

h. Equipment and material, coated or treated for signature suppression, specially designed for military use, not specified elsewhere in the Munitions List;

i. Simulators specially designed for military "nuclear reactors";

j. Mobile repair shops specially designed or 'modified' to service military equipment;

k. Field generators specially designed or 'modified' for military use;

l. ISO intermodal containers or demountable vehicle bodies (i.e., swap bodies), specially designed or 'modified' for military use;

m. Ferries, not specified elsewhere in the Munitions List, bridges and pontoons, specially designed for military use;

n. Test models specially designed for the "development" of items specified by ML4., ML6., ML9. or ML10.;

o. "Laser" protection equipment (e.g., eye or sensor protection) specially designed for military use;

p. "Fuel cells", not specified elsewhere in the Munitions List, specially designed or 'modified' for military use.

Technical Notes:

1. Not used;

2. For the purpose of ML17., 'modified' means any structural, electrical, mechanical, or other change that provides a non-military item with military capabilities equivalent to an item which is specially designed for military use.

ML18. 'Production' equipment, environmental test facilities and components, as follows:

a. Specially designed or modified 'production' equipment for the 'production' of products specified by the Munitions List, and specially designed components therefor;

b. Specially designed environmental test facilities and specially designed equipment therefor, for the certification, qualification or testing of products specified by the Munitions List.

Technical Note:

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

Note 1: ML18.a. and ML18.b. include the following equipment:

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

Note 2: Certain items specified in ML18 may be subject to the MTCR Guidelines for Sensitive Missile-Relevant Transfers.

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

a. "Laser" systems specially designed for destruction or effecting mission-abort of a target;

b. Particle beam systems capable of destruction or effecting mission-abort of a target;

c. High power Radio-Frequency (RF) systems capable of destruction or effecting mission-abort of a target;

d. Equipment specially designed for the detection or identification of, or defence against, systems specified by ML19.a. to ML19.c.;

e. Physical test models for the systems, equipment and components, specified by ML19.;

f. "Laser" systems specially designed to cause permanent blindness to unenhanced vision, i.e. to the naked eye or to the eye with corrective eyesight devices.

Note 1: DEW systems specified by ML19. include systems whose capability is derived from the controlled application of:

a. "Lasers" of sufficient power to effect destruction similar to the manner of conventional ammunition;

b. Particle accelerators which project a charged or neutral particle beam with destructive power;

c. High pulsed power or high average power radio frequency beam transmitters, which produce fields sufficiently intense to disable electronic circuitry at a distant target.

Note 2: ML19. includes the following when specially designed for DEW systems:

a. Prime power generation, energy storage, switching, power conditioning or fuel-handling equipment;

b. Target acquisition or tracking systems;

c. Systems capable of assessing target damage, destruction or mission-abort;

d. Beam-handling, propagation or pointing equipment;

e. Equipment with rapid beam slew capability for rapid multiple target operations;

f. Adaptive optics and phase conjugators;

g. Current injectors for negative hydrogen ion beams;

h. "Space-qualified" accelerator components;

i. Negative ion beam funnelling equipment;

j. Equipment for controlling and slewing a high energy ion beam;

k. "Space-qualified" foils for neutralising negative hydrogen isotope beams.

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

a. Equipment specially designed or configured to be installed in a vehicle for military ground, marine, airborne or space applications, capable of operating while in motion and of producing or maintaining temperatures below 103 K (-170°C);

Note: ML20.a. includes mobile systems incorporating or employing accessories or components manufactured from non-metallic or non-electrical conductive materials, such as plastics or epoxy-impregnated materials.

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

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

ML21. "Software" as follows:

a. "Software" specially designed or modified for any of the following:

1. "Development", "production", operation or maintenance of equipment specified by the Munitions List;
2. "Development" or "production" of materials specified by the Munitions List;
3. "Development", "production", operation or maintenance of "software" specified by the Munitions List;

Note: Certain items specified in ML21.a.1. may be subject to the MTCR Guidelines for Sensitive Missile-Relevant Transfers.

b. Specific "software", other than that specified by ML21.a., as follows:

1. "Software" specially designed for military use and specially designed for modelling, simulating or evaluating military weapon systems;
2. "Software" specially designed for military use and specially designed for modelling or simulating military operational scenarios;
3. "Software" for determining the effects of conventional, nuclear, chemical or biological weapons;
4. "Software" specially designed for military use and specially designed for Command, Communications, Control and Intelligence (C^3I) or Command, Communications, Control, Computer and Intelligence (C^4I) applications;
5. "Software" specially designed or modified for the conduct of military offensive cyber operations;

Note 1: ML21.b.5. includes "software" designed to destroy, damage, degrade or disrupt systems, equipment or "software", specified by the Munitions List, cyber reconnaissance and cyber command and control "software", therefor.

Note 2: ML21.b.5. does not apply to "vulnerability disclosure" or to "cyber incident response", limited to non-military defensive cybersecurity readiness or response.

c. "Software", not specified by ML21.a. or b., specially designed or modified to enable equipment not specified by the Munitions List to perform the military functions of equipment specified by the Munitions List.

N.B.: See systems, equipment or components specified by the Munitions List for general purpose "digital computers" with installed "software" specified by ML21.c.

ML22. "Technology" as follows:

a. "Technology", other than specified by ML22.b., which is "required" for the "development", "production", operation, installation, maintenance (checking), repair, overhaul or refurbishing of items specified by the Munitions List;

Note: Certain items specified in ML22.a. may be subject to the MTCR Guidelines for Sensitive Missile-Relevant Transfers.

b. "Technology" as follows:

1. "Technology" "required" for the design of, the assembly of components into, and the operation, maintenance and repair of, complete production installations for items specified by the Munitions List, even if the components of such production installations are not specified;

Note: Certain items specified in ML22.b.1. may be subject to the MTCR Guidelines for Sensitive Missile-Relevant Transfers.

2. "Technology" "required" for the "development" and "production" of small arms, even if used to produce reproductions of antique small arms;

3. Not used;

N.B.: See ML22.a. for "technology" previously specified by ML22.b.3.

4. Not used;

N.B.: See ML22.a. for "technology" previously specified by ML22.b.4.

5. "Technology" "required" exclusively for the incorporation of "biocatalysts", specified by ML7.i.1., into military carrier substances or military material.

Note 1: "Technology" "required" for the "development", "production", operation, installation, maintenance (checking), repair, overhaul or refurbishing of items specified by the Munitions List remains under control even when applicable to any item not specified by the Munitions List.

Note 2: ML22 does not apply to:

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

b. "Technology" that is "in the public domain", "fundamental research" or the minimum necessary information for patent applications;

c. "Technology" for magnetic induction for continuous propulsion of civil transport devices.

Note 3: ML22 does not apply to "technology" "required" for the operation, installation, maintenance (checking), repair, overhaul or refurbishing of items specified by ML901 to ML905.

ML901. Firearms, other than those specified by ML1 or ML2, including rifles, carbines, muskets, pistols, revolvers, shotguns and smooth-bore weapons, and specially designed components therefor.

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

Technical Note:

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

ML903. Not used.

ML904. Accessories, other than those specified in ML1.d., including silencers, special gun-mountings, magazines, weapon sights and flash suppressors, for the firearms specified in ML1 or ML901.

ML905. Air guns having any of the following characteristics and specially designed components therefor:

a. muzzle velocity exceeding 152.4 m/s (500 feet per second);

b. designed for competition target shooting; or

c. capable of fully automatic operation.

Technical Note:

Air guns discharge a projectile by the use of compressed air or gas and not by the explosive force of propellant combustion. Air guns include any air pistol or air rifle.

Note: ML905 does not include air gun accessories, air gun pellets or other air gun projectiles.

ML908. "Energetic materials" other than "energetic materials" specified in ML8, including high explosives specified by 1C239, but excluding those specially formulated for toys, novelty goods and fireworks.

ML909. Detonators or other equipment, other than those specified in ML4 or 1A007, for the initiation of "energetic materials" specified in ML908.

ML910. Charges and devices, other than those specified in ML4 or 1A008, containing "energetic materials" specified in ML908.

Note: ML901 to ML910 do not include any of the following:

a. nailing or stapling guns;
b. explosive powered fixing tools;
c. starting pistols, flare guns or other signalling devices designed for emergency or life-saving purposes;
d. line throwers;
e. tranquilliser guns;
f. guns that operate a captive bolt for the slaughter of animals;
g. devices for the casting of weighted nets;
h. underwater power-heads;
i. fire extinguisher cartridges;
j. hand-operated devices that use blank cartridges to propel objects for retrieval in connection with the training of dogs;
k. paintball guns;
l. air-soft guns (6mm or 8mm calibre);
m. air bag and life raft inflation gas generators;
n. thermite welding charges and associated igniters;
o. sidewall core guns designed for geological or mining purposes;
p. expandable casing perforation guns designed for geological or mining purposes;
q. oil well gas flare igniters;
r. bird-fright cartridges;
s. improvised explosive device disposal (IEDD) disruptor cartridges;
t. other cartridges or "explosive"/"pyrotechnic" charges specially designed for use with the items listed in this Note.

Part 2 - Dual Use List

Note 1: *Terms in "quotations" are defined terms. Refer to the 'Definitions of Terms' section.*

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

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 which are 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 assemblies of tubes), specially designed or prepared for use as fuel cladding in a "nuclear reactor", and in quantities exceeding 10 kg;
N.B.1: For zirconium pressure tubes see 0A001.e.
N.B.2: For calandria tubes see 0A001.h.

g. 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, for example, support columns for the core, fuel channels, calandria tubes, thermal shields, baffles, core grid plates, and diffuser plates;

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

i. Heat exchangers 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 apply to 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 reduction of heat loss and also for containment vessel protection.

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" and "special fissile materials", and specially designed or prepared equipment and components therefor, other than analytical instruments, as follows:

a. Plant specially designed for separating isotopes of "natural uranium", "depleted uranium", and "special fissile materials", as follows:

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

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

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

a. Maraging steel capable of an ultimate tensile strength of 1.95 GPa or more;

b. Aluminium alloys capable of an ultimate tensile strength of 0.46 GPa or more; or

c. Filamentary materials suitable for use in composite structures and having a "specific modulus" of 3.18 x 10^6 m or greater and a "specific tensile strength" of 7.62 x 10^4 m or greater;

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. Magnetic suspension bearings, specially designed or prepared, 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 in gas centrifuges.

Note: Bearings specified by 0B001.b.7.b. usually have the following characteristics:

1. *Designed to keep centered a rotor spinning at 600 Hz or more; and*
2. *Associated to a reliable electrical power supply and/or to an uninterruptible power supply (UPS) unit in order to function for more than one hour.*

8. Specially designed or prepared bearings comprising a pivot-cup assembly mounted on a damper;
9. Molecular pumps comprised of cylinders having internally machined or extruded helical grooves and internally machined bores;
10. Ring-shaped motor stators for multiphase AC hysteresis (or reluctance) motors for synchronous operation within a vacuum at a frequency of 600 Hz or greater and a power of 40 VA or greater;
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 to locate the bearings and with one or more flanges for mounting;
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 both 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 gas 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, 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 by 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 and assemblies thereof, 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;

Note: Vortex tubes may be equipped with nozzle-type appendages at either or both ends. The feed gas enters the vortex tube tangentially at one end or through swirl vanes or at numerous tangential positions along the periphery of the tube.

3. Compressors or gas blowers made of or protected by "materials resistant to corrosion by UF_6" / materials resistant to corrosion by carrier gas (hydrogen or helium) mixture.
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 153K (-120ºC) or less;
   b. Cryogenic refrigeration units capable of temperatures of 153 K (-120ºC) 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;

8. Not used;

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

1. Fast-exchange liquid-liquid pulse columns with stage residence time of 30 seconds or less and resistant to concentrated hydrochloric acid (e.g. made of or protected by suitable plastic materials such as fluorinated hydrocarbon polymers or glass);
2. Fast-exchange liquid-liquid centrifugal contactors with stage residence time of 30 seconds or less and resistant to concentrated hydrochloric acid (e.g. made of or protected by suitable plastic materials such as 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 seconds and capable of operating at temperatures in the range of 373 K (100°C) to 473 K (200°C);
2. Ion exchange columns (cylindrical) with a diameter greater than 1,000 mm, made of or protected by materials resistant to concentrated hydrochloric acid (e.g. titanium or fluorocarbon plastics) and capable of operating at temperatures in the range of 373 K (100°C) to 473 K (200°C) and pressures above 0.7 MPa;
3. Ion exchange reflux systems (chemical or electrochemical oxidation or reduction systems) for regeneration of the chemical reducing or oxidising agents used in ion exchange enrichment cascades;

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

1. Uranium metal vaporization 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;

N.B.: SEE ALSO 2A225.

3. Product and tails collector assemblies for 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 for the separation of uranium isotopes with a spectrum frequency stabiliser for operation over extended periods of time;

N.B.: SEE ALSO 6A005 AND 6A205.

h. Equipment and components, specially designed or prepared for 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 for the separation of uranium isotopes with a spectrum frequency stabiliser for operation over extended periods of time;

N.B.: SEE ALSO 6A005 AND 6A205.

7. Not used;

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 for ion production 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;

N.B.: SEE ALSO 3A227.

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

N.B.: SEE ALSO 3A226.

0B002 Specially designed or prepared auxiliary systems, equipment and components, as follows, for isotope separation plant specified by 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;

c. Solidification or liquefaction stations used to remove UF_6 from the enrichment process by compressing and converting UF_6 to a liquid or solid form;

d. Product or tails stations used for transferring UF_6 into containers;

e. Piping systems and header systems specially designed 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 per 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. Mass spectrometers 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% by weight or more, 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;

b. Equipment and components, as follows:

1. Water-hydrogen sulphide exchange towers with diameters 1.5 m or greater and capable of operating at pressures greater than or equal to 2 MPa (300 psi);

2. Single stage, low head (i.e. 0.2 MPa or 30 psi) 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 56 m^3/second (120,000 SCFM) when operating at pressures greater than or equal to 1.8 MPa (260 psi) suction and having seals designed for wet H_2S service;
3. Ammonia-hydrogen exchange towers greater than or equal to 35 m (114.3 ft) in height with diameters of 1.5 m (4.9 ft) to 2.5 m (8.2 ft) capable of operating at pressures greater than 15 MPa (2225 psi);
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 (450 psi) for heavy water production utilising the ammonia-hydrogen exchange process;
6. Infrared absorption analysers capable of on-line hydrogen/deuterium ratio analysis where deuterium concentrations are equal to or greater than 90% by weight;
7. Catalytic burners for the conversion of enriched deuterium gas into heavy water utilising the ammonia-hydrogen exchange process;
8. Complete heavy water upgrade systems, or columns therefor, for the upgrade of heavy water to reactor-grade deuterium concentration;
9. Ammonia synthesis converters or synthesis units specially designed or prepared for heavy water production utilising the ammonia-hydrogen exchange process.

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

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

- *a. Normally comes into direct contact with or directly processes or controls the production flow of nuclear materials;*
- *b. Seals the nuclear materials within the cladding;*
- *c. Checks the integrity of the cladding or the seal;*
- *d. Checks the finish treatment of the sealed fuel; or*
- *e. Is used for assembling reactor fuel 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. Irradiated fuel element decladding equipment and chopping machines, i.e. remotely operated equipment specially designed or prepared for use in a reprocessing plant specified by (a) above and intended to cut, chop, shred or shear irradiated "nuclear reactor" fuel assemblies, bundles or rods;*

c. Dissolver vessels or dissolvers employing mechanical devices specially designed or prepared for use in a reprocessing plant as identified above, intended for dissolution of irradiated nuclear fuel and which are capable of withstanding hot, highly corrosive liquid, and which can be remotely loaded, operated, and maintained;

d. Solvent extractors and solvent extraction equipment i.e. specially designed or prepared solvent extractors such as packed or pulse columns, miser settlers or centrifugal contactors for use in a plant for the reprocessing of irradiated fuel. Solvent extractors must be resistant to the corrosive effect of nitric acid. Solvent extractors are normally fabricated to extremely high standards (including special welding and inspection and quality assurance and quality control techniques) out of low carbon stainless steels, titanium, zirconium, or other high quality materials;

e. Chemical holding or storage vessels, i.e. specially designed or prepared holding or storage vessels for use in a plant for the reprocessing of irradiated fuel. The holding or storage vessels must be resistant to the corrosive effects of nitric acid. The holding or storage vessels are normally fabricated of materials such as low carbon stainless steels, titanium or zirconium, or other high quality materials. Holding or storage vessels may be designed for remote operation and maintenance;

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 Note 2 to 0C004) of at least two per cent;

2. A maximum diameter of 175 mm (7 in) for cylindrical vessels; or

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

f. Neutron measurement systems for process control, i.e. neutron measurement systems specially designed or prepared for the integration and use with automated process control systems in a plant for the reprocessing of irradiated fuel elements.

Note: Note f does not include neutron detection and measurement instruments that are designed for nuclear material accountancy and safeguarding or any other application not related to integration and use with automated process control systems in a plant for the reprocessing of irradiated fuel elements.

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 grams 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" plutonium-239, uranium-233, "uranium enriched in the isotopes 235 or 233", and any material containing the foregoing.

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

0C003 Deuterium, heavy water (deuterium oxide) or any other deuterium compounds, for use in a "nuclear reactor" specified by 0A001.a, in which the ratio of deuterium to hydrogen atoms exceeds 1:5,000.

0C004 Graphite having a purity level of less than 5 ppm (parts per million) 'boron equivalent' and with a density greater than 1.50 g/cm^3 for use in a "nuclear reactor" specified by 0A001.a., in quantities exceeding 1 kg.

N.B.: SEE ALSO 1C107.

Note 1: *For the purpose of export control, the Government will determine whether or not the exports of graphite meeting the above specifications are for "nuclear reactor" use.*

Note 2: *In 0C004, 'boron equivalent' (BE) may be determined experimentally or is calculated 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 x concentration of element Z in ppm;

where CF is the conversion factor:

$$\frac{\sigma_z A_B}{\sigma_B A_Z}$$

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

0C005 Specially prepared compounds or powders for the manufacture of gaseous diffusion barriers, resistant to corrosion by UF_6 (e.g. nickel or alloy containing 60 weight per cent or more nickel, aluminium oxide and fully fluorinated hydrocarbon polymers), having a purity of 99.9% by weight or more and a particle size less than 10 μm measured by American Society for Testing and Materials (ASTM) B330 standard and a high degree of particle size uniformity.

0D Software

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

0E Technology

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

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 by 1C009.b. or 1C009.c.;

b. Not used;

c. Not used;

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

N.B.: SEE ALSO 1A202, 9A010 and 9A110.

a. Made from any of the following:
   1. An organic "matrix" and "fibrous or filamentary materials" specified by 1C010.c. or 1C010.d.; or
   2. Prepregs or preforms specified by 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 10.15×10^6 m; and
      b. A "specific tensile strength" exceeding 17.7×10^4 m; or
   2. Materials specified by 1C010.c.

Note 1: 1A002 does not apply to "composite" structures or laminates made from epoxy resin impregnated carbon "fibrous or filamentary materials" for the repair of "civil aircraft" structures or laminates, having all of the following:
a. An area not exceeding 1 m^2;
b. A length not exceeding 2.5 m; and
c. A width exceeding 15 mm.

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

Note 3: 1A002.b.1. does not apply to finished or 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 apply to finished items specially designed for a specific application.

Note 5: 1A002.b.1. does not apply to 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 apply to manufactures when coated or laminated with copper and designed for the production of electronic printed circuit boards.

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

1A004 Protective and detection equipment and components, other than those specified in Munitions List, as follows:

N.B.: SEE ALSO 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 Notes:

Note 1. For the purposes of 1A004.a., full face masks are also known as gas masks.

Note 2. Filter canisters include filter cartridges.

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

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

c. Nuclear, biological and chemical (NBC) 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;

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 purpose 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 apply to equipment specially designed for laboratory use.

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

Note: 1A004 does not apply to:

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 agents, 'simulants' or "riot control agents", even if such equipment or components are used in civil industries such as mining, quarrying, agriculture, pharmaceuticals, medical, veterinary, environmental, waste management, or the food industry.

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

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:

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".

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

N.B.2.: For body armour manufactured to military standards or specifications, see entry ML13.d.

Note 1: 1A005 does not apply to body armour or protective garments, when accompanying their user for the user's own personal protection.

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

Note 3: 1A005 does not apply to 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:

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.

N.B.: For equipment specially designed for military use for the disposal of IEDs, see also ML4.

Note: 1A006 does not apply to equipment when accompanying its operator.

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

N.B.: SEE ALSO MUNITIONS LIST, 3A229 AND 3A232.

a. Explosive detonator firing sets designed to drive explosive detonators specified by 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 Notes:

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

2. For the purpose 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;

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

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

2. A width of 10 mm or more;

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

d. Cutters, other than those specified by 1A008.b., and severing tools, having a Net Explosive Quantity (NEQ) greater than 3.5 kg.

Technical Note:

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

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

1A202 Composite structures, other than those specified by 1A002, in the form of tubes and having both of the following characteristics:

N.B.: SEE ALSO 9A010 AND 9A110.

a. An inside diameter of between 75 mm and 400 mm; and

b. Made with any of the "fibrous or filamentary materials" specified by 1C010.a. or b. or 1C210.a. or with carbon prepreg materials specified by 1C210.c.

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

1A226 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 for the production or inspection of "composite" structures or laminates specified by 1A002. or "fibrous or filamentary materials" specified by 1C010., as follows, and specially designed components and accessories therefor:

N.B.: SEE ALSO 1B101 AND 1B201.

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

b. 'Tape-laying 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;

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, for weaving, interlacing or braiding fibres, to manufacture "composite" structures;

Technical Note:

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

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

1. Equipment for converting polymeric fibres (such as polyacrylonitrile, rayon, pitch or polycarbosilane) into carbon fibres or silicon carbide fibres, including special equipment to strain the fibre during heating;
2. Equipment for the chemical vapour deposition of elements or compounds, on heated filamentary substrates, to manufacture silicon carbide fibres;
3. Equipment for the wet-spinning of refractory ceramics (such as aluminium oxide);
4. Equipment for converting aluminium containing precursor fibres into alumina fibres by heat treatment;

e. Equipment for producing prepregs specified by 1C010.e. by the hot melt method;

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

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

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

Technical Note:

For the purposes of 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.

Technical Notes:

1. *For the purposes of 1B001., 'primary servo positioning' axes control, under computer program direction, the position of the end effector (i.e., head) in space relative to the work piece at the correct orientation and direction to achieve the desired process.*
2. *For the purposes of 1B001., 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 by 1C002.c.2.

N.B.: 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 by 1B003.a. or for engines specified by 1B003.b.

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

N.B.: SEE ALSO 1B201.

Note: Components and accessories specified by 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/tow-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 can be coordinated and programmed in two or more axes, designed for the manufacture of composite airframe and “missile” structures;

Note: *For the purposes of 1B101.a. and 1B101.b., the following definitions apply:*

1. 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.

2. ‘Fibre/tow-placement machines’ and ‘tape-laying machines’ are machines that perform similar processes that use computer-guided heads to lay one or several ‘filament bands’ onto a mould to create a part or a structure. These machines have the ability to cut and restart individual ‘filament band’ courses during the laying process.

3. ‘Fibre/tow-placement machines’ have the ability to place one or more ‘filament bands’ having widths less than or equal to 25.4 mm. This refers to the minimum width of material the machine can place, regardless of the upper capability of the machine.

4. ‘Tape-laying machines’ have the ability to place one or more ‘filament bands’ having widths less than or equal to 304.8 mm, but cannot place ‘filaments bands’ with a width equal to or less than 25.4 mm. This refers to the minimum width of material the machine can place, regardless of the upper capability of the machine.

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 by 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 by 1B002, and components as follows:

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

a. Metal powder “production equipment” usable for the “production”, in a controlled environment, of spherical, spheroidal or atomised materials specified by 1C011.a., 1C011.b., 1C111.a.1., 1C111.a.2. or in the Munitions List;

b. Specially designed components for “production equipment” specified by 1B002 or 1B102.a.

Note: 1B102 includes:

a. Plasma generators (high frequency arc-jet) usable for obtaining sputtered or spherical metallic powders with organisation of the process in an argon-water environment;

b. Electroburst equipment usable for obtaining sputtered or spherical metallic powders with organisation 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 by 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 by 1C011.a., 1C011.b., 1C111 or in the Munitions List;

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

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

Note 1: For equipment specially designed for the production of military goods, see the Munitions List.

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

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

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

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

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

Technical Note:

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

1B118 Continuous mixers with provision for mixing under vacuum in the range of zero to 13.326 kPa and with a temperature control capability of the mixing chamber and having any of the following, and specially designed components therefor:

a. Two or more mixing/kneading shafts; or

b. A single rotating shaft which oscillates and having kneading teeth/pins on the shaft as well as inside the casing of the mixing chamber.

1B119 Fluid energy mills usable for grinding or milling substances specified by 1C011.a., 1C011.b., 1C111 or in the Munitions List, and specially designed components therefor.

1B201 Filament winding machines, other than those specified by 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 by 1B201.a.;

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

1B225 Electrolytic cells for fluorine production with an output capacity greater than 250 g of fluorine per hour.

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

Note: *1B226 includes separators:*
a. Capable of enriching stable isotopes;
b. With the ion sources and collectors both in the magnetic field and those configurations in which they are external to the field.

1B227 Not used.

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

a. Designed for operation with internal temperatures of 35 K (-238°C) or less;

b. Designed for operation at an internal pressure of 0.5 to 5 MPa;

c. Constructed of either:
   1. Stainless steel of the 300 series with low sulphur content and with an austenitic ASTM (or equivalent standard) grain size number of 5 or greater; or
   2. Equivalent materials which are both cryogenic and H_2-compatible; and

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

Technical Note:

The term '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.

1B229 Not used.

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 of 35 K (-238°C) or less; and

b. Designed for a throughput of hydrogen gas of 1000 kg/h or greater.

1B233 Lithium isotope separation facilities or plants, and 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 component parts therefor;

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

N.B.: SEE ALSO 0B001 FOR LITHIUM ISOTOPE SEPARATION EQUIPMENT AND COMPONENTS FOR THE PLASMA SEPARATION PROCESS THAT ARE DIRECTLY APPLICABLE TO URANIUM ISOTOPE SEPARATION.

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:

a. Designed to fully contain an explosion equivalent to 2 kg of 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.

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:

N.B.: 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 apply to:

a. Hair type absorbers, constructed of natural or synthetic fibres, with non-magnetic loading to provide absorption;

b. Absorbers having no magnetic loss and whose incident surface is non-planar in shape, including pyramids, cones, wedges and convoluted surfaces;

c. Planar absorbers, having all of the following:

1. Made from any of the following:

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

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

Technical Note:

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);

e. Planar absorbers having no magnetic loss and fabricated from 'open-cell foam' plastic material with a density of 0.15 grams/cm^3 or less.

Technical Note:

For the purposes of 1C001.a Note 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 2000 nm (frequencies exceeding 150 THz but less than 370 THz);

Note: 1C001.b. does not apply to materials, specially designed or formulated for any of the following applications:
a. "Laser" marking of polymers; or
b. "Laser" welding of polymers.

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

1. Polyaniline;
2. Polypyrrole;
3. Polythiophene;
4. Poly phenylene-vinylene; or
5. Poly thienylene-vinylene.

Technical Note:

For the purposes of IC002., 'bulk electrical conductivity' and 'sheet (surface) resistivity' should be determined using ASTM D-257 or national equivalents.

Note: 1C001.c. does not apply to materials in a liquid form.

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

N.B.: SEE ALSO 1C202.

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

Technical Notes:

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 by 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);
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;
        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’; or
h. ‘Plasma atomisation’; and

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

d. Alloyed materials having all of the following:
1. Made from any of the composition systems specified by 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. *‘For the purposes of 1C002. Technical Notes, ‘solidify rapidly’ is a process involving the solidification of molten material at cooling rates exceeding 1000 K/sec.*

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
3. Any of the following:
   a. A strip thickness of 0.02 mm or less; or
   b. An electrical resistivity of 2×10^{-4} ohm cm or more.

Technical Note:

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 0.28×10^{-4} mm^2 (6 μm in diameter for circular 'filaments');

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

1. A "critical temperature" at zero magnetic induction exceeding 9.85 K (-263.31°C); and
2. Remaining in the "superconductive" state at a temperature of 4.2 K (-268.96°C) when exposed to a magnetic field oriented in any direction perpendicular to the longitudinal axis of conductor and corresponding to a magnetic induction of 12 T with critical current density exceeding 1,750 A/mm^2 on overall cross-section of the conductor;

c. “Superconductive” “composite” conductors consisting of one or more “superconductive” ‘filaments’ which remain “superconductive” above 115 K (-158.16°C).

Technical Note:

For the purpose of 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;

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.

Technical Note:

For the purpose of 1C006:

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

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

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

4. ‘Thermal stability’ is determined by the following test procedure or national equivalents:

Twenty ml of the fluid under test is placed in a 46 ml type 317 stainless steel chamber containing one each of 12.5 mm (nominal) diameter balls of M-10 tool steel, 52100 steel and naval bronze (60% Cu, 39% Zn, 0.75% Sn);

The chamber is purged with nitrogen, sealed at atmospheric pressure and the temperature raised to and maintained at 644 ± 6 K (371 ± 6°C) for six hours;

The specimen will be considered thermally stable if, on completion of the above procedure, all of the following conditions are met:

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

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

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

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

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

N.B.: SEE ALSO 1C107.

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 made from any of the following materials:

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

2. Si-C-N; or

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

b. Fibres being all of the following:

1. Made from any of the following materials:

a. Si-N;

b. Si-C;

c. Si-Al-O-N; or

d. Si-O-N; and

2. Having a "specific tensile strength" exceeding 12.7 x 10^3m;

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

N.B.: For items previously specified by 1C007.c. see 1C007.c.1.b.

d. Not used;

N.B.: For items previously specified by 1C007.d. see 1C007.c.2.

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

1. Polydiorganosilanes;

2. Polysilazanes;
3. Polycarbosilazanes;

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.

f. Not used;

N.B.: For items previously specified by 1C007.f. see 1C007.c.1.a.

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 513 K (240°C);

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

N.B.: For non-"fusible" aromatic polyimides in film, sheet, tape or ribbon form, see 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 by 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:

N.B.: SEE ALSO 1C210 AND 9C110.

Technical Notes:

1. For the purpose 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 equivalent.

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. A "specific modulus" exceeding 12.7 x 10^6 m; and

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

Note: 1C010.a. does not apply to polyethylene.

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

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

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

Note: 1C010.b. does not apply to:

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

1. An area not exceeding 1 m^2;

2. A length not exceeding 2.5 m; and

3. A width exceeding 15 mm.

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

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 x 10^6 m; or

b. Not specified in 1C010.c.1.a. and having a "specific modulus" exceeding 5.6 x 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 apply to:

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

b. Molybdenum and molybdenum alloy fibres;

c. Boron fibres;

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

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

1. Composed of any of the following:
   a. Polyetherimides specified by 1C008.a.; or
   b. Materials specified by 1C008.d. to 1C008.f.; or
2. Composed of materials specified by 1C010.d.1.a. or 1C010.d.1.b. and 'commingled' with other fibres specified by 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 by 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 by 1C008 or 1C009.b.;
   b. 'Dynamic Mechanical Analysis glass transition temperature (DMA T_g)' equal to or exceeding 453 K (180ºC) and having a phenolic resin; or
   c. 'Dynamic Mechanical Analysis glass transition temperature (DMA T_g)' equal to or exceeding 505 K (232ºC) and having a resin or pitch, not specified by 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 apply to:

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 by 1C008. or 1C009.b.

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 Tg)' 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:

N.B.: SEE ALSO MUNITIONS LIST 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;

Note: The metals or alloys specified by 1C011.a. also refer to metals or alloys encapsulated in aluminium, magnesium, zirconium or beryllium.

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 by 1C011.a. also refer to 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 by 1C011.b. also refer to the metals or alloys are encapsulated in aluminium, magnesium, zirconium or beryllium.

c. Guanidine nitrate;

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

N.B.: SEE ALSO MUNITIONS LIST CONTROLS FOR METAL POWDERS MIXED WITH OTHER SUBSTANCES TO FORM A MIXTURE FORMULATED FOR MILITARY PURPOSES.

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 apply to:

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

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

Technical Note:

For the purposes of 1C012. Note, 'effective grams' for plutonium isotope is defined as the isotope weight in grams.

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

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

Technical Note:

For the purposes of 1C012.b., 'previously separated' is the application of any process intended to increase the concentration of the controlled isotope.

1C101 Materials and devices for reduced observables such as radar reflectivity, ultraviolet/infrared signatures and acoustic signatures, other than those specified by 1C001, usable in 'missiles', 'missile' subsystems or unmanned aerial vehicles specified by 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 by 9A004 or sounding rockets specified by 9A104.

1C107 Graphite and ceramic materials, other than those specified by 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;

N.B.: See also 0C004.

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

N.B.: 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 by 9A004 or sounding rockets specified by 9A104;

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

e. Reinforced silicon-carbide ceramic composites, usable for nose tips, re-entry vehicles and nozzle flaps usable in "missiles", space launch vehicles specified by 9A004 or sounding rockets specified by 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 3000°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'.

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

Technical Notes:

1. In 1C107.f., 'missiles' means complete rocket systems and "unmanned aerial vehicles" capable of a range exceeding 300 km.

2. In 1C107.f., 'Ultra High Temperature Ceramics (UHTC)' includes:

1. Titanium diboride (TiB2);
2. Zirconium diboride (ZrB2);
3. Niobium diboride (NbB2);
4. Hafnium diboride (HfB2);
5. Tantalum diboride (TaB2);
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 by 1C011, as follows:

a. Propulsive substances:

1. Spherical or spheroidal aluminium powder, other than that specified in the Munitions List, 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 2591:1988 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 Munitions List, with at least 90% of the total particles by particle volume or weight 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 of any of the following:

a. Zirconium (CAS 7440-67-7) or zirconium alloys consisting of 97% by weight or more of zirconium;

b. Beryllium (CAS 7440-41-7) or beryllium alloys consisting of 97% by weight or more of beryllium;

c. Magnesium (CAS 7439-95-4) magnesium alloys consisting of 97% by weight or more of magnesium; or

d. Boron (CAS 7440-42-8) or boron alloys consisting of 85% by weight or more of boron;

Note: In a multimodal particle distribution (e.g. mixtures of different grain sizes) in which one or more modes are controlled, the entire powder mixture is controlled.

Technical Note:

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

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 MUNITIONS LIST FOR Inhibited Red Fuming Nitric Acid (IRFNA);

f. SEE MUNITIONS LIST AND 1C238 FOR Compounds composed of fluorine and one or more of other halogens, oxygen or nitrogen;

4. Hydrazine derivatives as follows:

N.B.: SEE ALSO MUNITIONS LIST.

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;

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;

l. 2-hydroxyethylhydrazine nitrate (HEHN);

m. See Munitions List for Hydrazinium perchlorate;

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

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 Munitions List, usable in 'missiles' or unmanned aerial vehicles specified by 9A012 or 9A112.a:

a. Mixed fuel that incorporates 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 apply to 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 by 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. 1.2-Dimethylaminoethylazide (DMAZ) (CAS 86147-04-8);

b. Polymeric substances:

1. Carboxy-terminated polybutadiene (including carboxyl-terminated polybutadiene) (CTPB);
2. Hydroxy-terminated polybutadiene (included hydroxyl-terminated polybutadiene) (HTPB) (CAS 69102-90-5), other than that specified in the Munitions List;
3. Polybutadiene-acrylic acid (PBAA);
4. Polybutadiene-acrylic acid-acrylonitrile (PBAN);
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).

c. Other propellant additives and agents:

1. SEE MUNITIONS LIST FOR Carboranes, decaboranes, pentaboranes and derivatives thereof;
2. Triethylene glycol dinitrate (TEGDN) (CAS 111-22-8);
3. 2-Nitrodiphenylamine (CAS 119-75-5);
4. Trimethylolethane trinitrate (TMETN) (CAS 3032-55-1);
5. Diethylene glycol dinitrate (DEGDN) (CAS 693-21-0);
6. Ferrocene derivatives as follows:
   a. See Munitions List for catocene;
   b. Ethyl ferrocene (CAS 1273-89-8);
   c. n-Propyl ferrocene (CAS 1273-92-3) / iso-propyl ferrocene (CAS 12126-81-7);
   d. See Munitions List for n-butyl ferrocene;
   e. Pentyl ferrocene (CAS 1274-00-6);
   f. Dicyclopentyl ferrocene;
   g. Dicyclohexyl ferrocene;
   h. Diethyl ferrocene (CAS 1273–97–8);
   i. Dipropyl ferrocene;
   j. Dibutyl ferrocene (CAS 1274-08-4);
   k. Dihexyl ferrocene (CAS 93894-59-8);
   l. Acetyl ferrocene (CAS 1271–55–2) / 1,1'-diacetyl ferrocene (CAS 1273–94–5);
   m. See Munitions List for ferrocene Carboxylic acids;
   n. See Munitions List for butacene;
   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 apply to 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 Munitions List.

Note: For propellants and constituent chemicals for propellants not specified by 1C111, see the Munitions List.

1C116 Maraging steels having an ultimate tensile strength of 1,500 MPa or greater, measured at 293 K (20°C), in the form of sheet, plate or tubing with a wall or plate thickness equal to or less than 5 mm.

N.B.: SEE ALSO 1C216.

Technical Note:

Maraging steels are iron alloys generally characterised by high nickel, very low carbon content and the use of substitutional elements or precipitates to produce strengthening and age-hardening of the alloy.

1C117 Materials for the fabrication of 'missile' 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 weight percent chromium and 4.5 - 7.0 weight percent nickel;

2. Having a titanium content of greater than 0.10 weight percent; and

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

b. Having any of the following forms:

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

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

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

1C202 Alloys, other than those specified by 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 by 1C010.a., b. or e., as follows:

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

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

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

c. Thermoset resin impregnated continuous "yarns", "rovings", "tows" or "tapes" with a width of 15 mm or less (prepregs), made from carbon or glass 'fibrous or filamentary materials' specified by 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 by 1C116, 'capable of' an ultimate tensile strength of 1,950 MPa or more, at 293 K (20°C).

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

Technical Note:

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

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

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

Technical Note:

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

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

a. In forms with a hollow cylindrical symmetry (including cylinder segments) with an inside diameter between 100 mm and 300 mm; and

b. A mass greater than 20 kg.

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

1C227 Calcium having both of the following characteristics:

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

b. Containing less than 10 parts per million by weight of boron.

1C228 Magnesium having both of the following characteristics:

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

b. Containing less than 10 parts per million by weight of boron.

1C229 Bismuth having both of the following characteristics:

a. A purity of 99.99% or greater by weight; and

b. Containing less than 10 ppm (parts per million) by weight of silver.

1C230 Beryllium metal, alloys containing more than 50% beryllium by weight, beryllium compounds, manufactures thereof, and waste or scrap of any of the foregoing, other than that specified in the Munitions List controls.

N.B.: SEE ALSO MUNITIONS LIST CONTROLS.

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 apply to 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 apply to thermoluminescent dosimeters.

Technical Note:

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

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

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

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

Note: 1C235 does not apply to 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 (Actinum 225, Actinum 227, Californium 253, Curium 240, Curium 241, Curium 242, Curium 243, Curium 244, Einsteinium 253, Einsteinium 254, Gadolinium 148, Plutonium 236, Plutonium 238, Polonium 208, Polonium 209, Polonium 210, Radium 223, Thorium 227, Thorium 228, Uranium 230 or Uranium 232) 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 apply to a product or device containing less than 3.7 GBq (100 millicuries) of activity.

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

Note: 1C237 does not apply to 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 Munitions List, 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 by 0C005, as follows:

a. Nickel powder having both of the following characteristics:

1. A nickel purity content of 99.0% or greater by weight; and

2. A mean particle size of less than 10 micrometres measured by American Society for Testing and Materials (ASTM) B330 standard;

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

Note: *1C240 does not apply to the following:*

a. Filamentary nickel powders;

b. Single porous nickel sheets with an area of 1,000 cm^2 per sheet or less.

Technical Note:

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

N.B.: SEE 0C005 FOR NICKEL POWDERS SPECIALLY PREPARED FOR THE MANUFACTURE OF GASEOUS DIFFUSION BARRIERS.

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, 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 20kg.

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

N.B.: SEE ALSO MUNITIONS LIST AND 1C450.

1. Thiodiglycol (CAS 111-48-8);

2. Phosphorus oxychloride (CAS 10025-87-3);

3. Dimethyl methylphosphonate (CAS 756-79-6);

4. **SEE MUNITIONS LIST 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);
22. Ethyl phosphonyl dichloride (CAS 1066-50-8);
23. **SEE MUNITIONS LIST 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 MUNITIONS LIST FOR O-Ethyl-2-diisopropylaminoethyl methyl phosphonite (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);
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. Thiophosphoryl chloride (CAS 3982-91-0);
65. Oxalyl chloride (CAS 79-37-8);
66. Diethylamine (CAS 109-89-7);
67. N,N-Diisopropylaminoethanethiol hydrochloride (CAS 41480-75-5);
68. Methyl dichlorophosphate (CAS 677-24-7);
69. Ethyl dichlorophosphate (CAS 1498-51-7);
70. Methyl difluorophosphate (CAS 22382-13-4);
71. Ethyl difluorophosphate (CAS 460-52-6);
72. Diethyl chlorophosphite (CAS 589-57-1);
73. Methyl chlorofluorophosphate (CAS 754-01-8);
74. Ethyl chlorofluorophosphate (CAS 762-77-6);
75. N,N-Dimethylformamidine (CAS 44205-42-7);
76. N,N-Diethylformamidine (CAS 90324-67-7);
77. N,N-Dipropylformamidine (CAS 48044-20-8);
78. N,N-Diisopropylformamidine (CAS 857522-08-8);
79. N,N-Dimethylacetamidine (CAS 2909-14-0);
80. N,N-Diethylacetamidine (CAS 14277-06-6);
81. N,N-Dipropylacetamidine (CAS 1339586-99-0);
82. N,N-Dimethylpropanamidine (CAS 56776-14-8);
83. N,N-Diethylpropanamidine (CAS 84764-73-8);
84. N,N-Dipropylpropanamidine (CAS 1341496-89-6);
85. N,N-Dimethylbutanamidine (CAS 1340437-35-5);
86. N,N-Diethylbutanamidine (CAS 53510-30-8);
87. N,N-Dipropylbutanamidine (CAS 1342422-35-8);

88. N,N-Diisopropylbutanamidine (CAS 1315467-17-4);

89. N,N-Dimethylisobutanamidine (CAS 321881-25-8);

90. N,N-Diethylisobutanamidine (CAS 1342789-47-2);

91. N,N-Dipropylisobutanamidine (CAS 1342700-45-1).

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

Note 2: For exports to "States Party to the Chemical Weapons Convention", 1C350 does not apply to "chemical mixtures" containing one or more of the chemicals specified by 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 .67 in which no individually specified chemical constitutes more than 30% by the weight of the mixture.

Note 3: 1C350 does not apply to "chemical mixtures" containing one or more of the chemicals specified by 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, .65, .66, .68, .69, .70, .71, .72, .73, .74, .75, .76, .77, .78, .79, .80, .81, .82, .83,.84, .85, .86, .87, .88, .89, .91, and .92 in which no individually specified chemical constitutes more than 30% by the weight of the mixture.

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

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

a. Viruses, whether natural, enhanced or modified, either in the form of "isolated live cultures" or as material including living material which has been deliberately inoculated or contaminated with such cultures, as follows:

1. Andes virus;
2. Chapare virus;
3. Chikungunya virus;
4. Choclo virus;
5. Crimean-Congo haemorrhagic fever virus;
6. Not used;
7. Dobrava-Belgrade virus;
8. Eastern equine encephalitis virus;
9. Ebolavirus (all members of the Ebolavirus genus);
10. Guanarito virus;
11. Hantaan virus;
12. Hendra virus (Equine morbillivirus);
13. Japanese encephalitis virus;
14. Junin virus;
15. Kyasanur Forest disease virus;
16. Laguna Negra virus;
17. Lassa fever virus;

18. Louping ill virus;
19. Lujo virus;
20. Lymphocytic choriomeningitis virus;
21. Machupo virus;
22. Marburgvirus (all members of the Marburgvirus genus);
23. Monkeypox virus;
24. Murray Valley encephalitis virus;
25. Nipah virus;
26. Omsk haemorrhagic fever virus;
27. Oropouche virus;
28. Powassan virus;
29. Rift Valley fever virus;
30. Rocio virus;
31. Sabia virus;
32. Seoul virus;
33. Sin Nombre virus;
34. St Louis encephalitis virus;
35. Tick-borne encephalitis virus (Far Eastern subtype);
36. Variola virus;
37. Venezuelan equine encephalitis virus;
38. Western equine encephalitis virus;
39. Yellow fever virus;
40. Reconstructed 1918 influenza virus;
41. Severe acute respiratory syndrome-related coronavirus (SARS-related coronavirus);
42. Suid herpesvirus 1 (Pseudorabies virus; Aujeszky's disease);
43. Middle East respiratory syndrome-related coronavirus (MERS-CoV);

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. Chlamydophila psittaci (formerly known as Chlamydia psittaci);
6. Clostridium botulinum;
7. Clostridium argentinense (formerly known as Clostridium botulinum Type G), botulinum neurotoxin producing strains;
8. Clostridium baratii, botulinum neurotoxin producing strains;
9. Clostridium butyricum, botulinum neurotoxin producing strains;
10. Francisella tularensis;
11. Burkholderia mallei (Pseudomonas mallei);
12. Burkholderia pseudomallei (Pseudomonas pseudomallei);

13. Salmonella typhi;
14. Shigella dysenteriae;
15. Vibrio cholerae;
16. Yersinia pestis;
17. Clostridium perfringens, epsilon toxin producing types;

    Note: *Limiting this control to epsilon toxin-producing strains of Clostridium perfringens therefore exempts from control the transfer of other Clostridium perfringens strains to be used as positive control cultures for food testing and quality control.*

18. 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).*

19. Coxiella burnetii;
20. Rickettsia prowazekii;

d. "Toxins", as follows, and "sub-unit of toxins" thereof:
    1. Botulinum toxins;
    2. Clostridium perfringens alpha, beta 1, beta 2, epsilon and iota toxins;
    3. Conotoxins;
    4. Ricin (CAS 9009-86-3);
    5. Saxitoxin (CAS 35523-89-8);
    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);
    8. Tetrodotoxin;
    9. Not used since 2022;
    10. Microcystins (Cyanoginosins);
    11. Aflatoxins;
    12. Abrin;
    13. Not used since 2022;
    14. Diacetoxyscirpenol toxin;
    15. T-2 toxin;
    16. HT-2 toxin;
    17. Modeccin;
    18. Volkensin;
    19. Viscum Album Lectin 1 (Viscumin);
    20. Brevetoxins;
    21. Gonyautoxins;
    22. Nodularins;
    23. Palytoxin;

Note 1: 1C351.d does not apply to "immunotoxins".

Note 2: 1C351.d. does not apply to botulinum toxins or conotoxins in product form meeting all of the following criteria:

a. Are pharmaceutical formulations designed for human administration in the treatment of medical conditions;

b. Are pre-packaged for distribution as medical products;

c. 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 apply to "vaccines" or "immunotoxins".

1C352 Animal pathogens, as follows:

a. Viruses, whether natural, enhanced or modified, either in the form of "isolated live cultures" or as material including living material which has been deliberately inoculated or contaminated with such cultures, as follows:

1. African swine fever virus;
2. Avian influenza virus, which are:
    a. Uncharacterised; or
    b. Defined in Annex I(2) EC Directive 2005/94/EC (O.J. 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;
3. Bluetongue virus;
4. Foot-and-mouth disease virus;
5. Goatpox virus;
6. Herpes virus (Aujeszky's disease);
7. Swine fever virus (Hog cholera virus);
8. Rabies virus and all other members of the Lyssavirus genus;
9. Newcastle disease virus;
10. Peste-des-petits ruminants virus;
11. Porcine Teschovirus;
12. Rinderpest virus;
13. Sheeppox virus;
14. Teschen disease virus;
15. Vesicular stomatitis virus;
16. Lumpy skin disease virus;
17. African horse sickness virus;

18. Swine vesicular disease virus.

b. Mycoplasmas, 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. Mycoplasma mycoides subspecies mycoides SC (small colony);

2. Mycoplasma capricolum subspecies capripneumoniae (strain F38);

Note: 1C352 does not apply to "vaccines".

1C353 Any 'genetically-modified organism' which contains, or 'genetic element' that codes for any of the following:

a. Any gene, genes, translated product, or translated products, specific to any listed virus; or

b. Any gene or genes specific to any listed bacterium or fungus, and which:

1. In itself or through its transcribed or translated products represents a significant hazard to human, animal or plant health; or

2. Could 'endow or enhance pathogenicity'; or

c. Any listed toxins or their sub-units.

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 synthesized 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. 1C353 does not apply to 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.

4. '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: 1C353 applies to the viruses, bacteria, fungi and toxins listed in 1C351, 1C352 and 1C354.

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 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 axonopodis pv. citri (Xanthomonas campestris pv. citri A) [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, 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]);
5. Puccinia striiformis (syn. Puccinia glumarum);
6. Magnaporthe oryzae (Pyricularia oryzae);
7. Peronosclerospora philippinensis (Peronosclerospora sacchari);
8. Sclerophthora rayssiae var. zeae;
9. Synchytrium endobioticum;
10. Tilletia indica;
11. Thecaphora solani.

1C450 Toxic chemicals and toxic chemical precursors, as follows, and "chemical mixtures" containing one or more thereof:

N.B.: SEE ALSO ENTRY 1C350, 1C351.d. AND MUNITIONS LIST.

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 MUNITIONS LIST 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: 1C450 does not apply to "chemical mixtures" containing one or more of the chemicals specified by entries 1C450.a.1., a.2. and a.3. in which no individually specified chemical constitutes more than 1% by the weight of the mixture.

Note 2: Not used since 2019.

Note 3: 1C450 does not apply to "chemical mixtures" containing one or more of the chemicals specified by 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 apply to 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 Munitions List or in 1C350, containing a phosphorus atom to which is bonded one methyl, ethyl or propyl (normal or iso) group but not further carbon atoms;

   Note: 1C450.b.1 does not apply to Fonofos: O-Ethyl S-phenyl ethylphosphonothiolothionate (CAS 944-22-9).

2. N,N-Dialkyl [methyl, ethyl or propyl (normal or iso)] phosphoramidic dihalides, other than N,N-Dimethylaminophosphoryl dichloride;

   N.B.: 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 by 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 by 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 by 1C350;

   Note: 1C450.b.5. does not apply to 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 which is specified by 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 apply to "chemical mixtures" containing one or more of the chemicals specified by 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 apply to "chemical mixtures" containing one or more of the chemicals specified by 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 apply to "chemical mixtures" containing one or more of the chemicals specified by 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 apply to products identified as consumer goods packaged for retail sale for personal use or packaged for individual use.

1D Software

1D001 "Software" specially designed or modified for the "development", "production" or "use" of equipment specified by 1B001 to 1B003, 1B234 or 1B235.

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 by 1A004.c. or 1A004.d.

1D101 "Software" specially designed or modified for the operation or maintenance of goods specified by 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 by 1B201.

1E Technology

1E001 "Technology" according to the General Technology Note for the "development" or "production" of equipment or materials specified by 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;

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 either of the following:

1. Zirconia with an average particle size equal to or less than 1 µm and no more than 10% of the particles larger than 5 µm; 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 by 1E002.c.1;

Note: 1E002.c.2. does not apply to "technology" for abrasives.

d. Not used;

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

f. "Technology" for the repair of "composite" structures, laminates or materials specified by 1A002 or 1C007.c.;

Note: 1E002.f. does not apply to "technology" for the repair of "civil aircraft" structures using carbon "fibrous or filamentary materials" and epoxy resins, contained in "aircraft" manufacturers' manuals.

g. "Libraries" specially designed or modified to enable equipment to perform the functions of equipment specified by 1A004.c. or 1A004.d.

1E101 "Technology" according to the General Technology Note for the "use" of goods specified by 1A102, 1B101, 1B102, 1B115 to 1B119, 1C101, 1C107, 1C111 to 1C118, 1D101 or 1D103.

1E102 "Technology" according to the General Technology Note for the "development" of "software" specified by 1D001, 1D101 or 1D103.

1E103 "Technology" for the regulation of temperature, pressure or atmosphere in autoclaves or hydroclaves, when used for the "production" of "composites" or partially processed "composites".

1E104 "Technology" relating to the "production" of pyrolytically derived materials formed on a mould, mandrel or other substrate from precursor gases which decompose in the 1,573 K (1,300°C) to 3,173 K (2,900°C) temperature range at pressures of 130 Pa to 20 kPa.

Note: 1E104 includes "technology" for the composition of precursor gases, flow-rates and process control schedules and parameters.

1E201 "Technology" according to the General Technology Note for the "use" of goods specified by 1A202, 1A225 to 1A228, 1B201, 1B225 to 1B235, 1C202, 1C210, 1C216, 1C225 to 1C241 or 1D201.

1E202 "Technology" according to the General Technology Note for the "development" or "production" of goods specified by 1A202 or 1A225 to 1A228.

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

2A Systems, Equipment and Components

N.B.: For quiet running bearings, see the Munitions List.

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

N.B.: 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 apply to tapered roller bearings.

Technical Notes:

For the purposes of 2A001.a.:

1. *'Ring' - annular part of a radial rolling bearing incorporating one or more raceways (ISO 5593:1997).*
2. *'Rolling element' - 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 by 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 bore 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 (150 ml) and 8,000 cm^3 (8 litres); 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);

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 co-ordinated simultaneously for "contouring control" is the number of axes along or around which, during processing of the workpiece, simultaneous and interrelated motions are performed between the workpiece and a tool. This does not include any additional axes along or around which other relative 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 International Standard ISO 841:2001, Industrial automation systems and integration - Numerical control of machines - Coordinate system and motion nomenclature.*

4. *For the purposes of this category, 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;*
   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 by 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 2B., measurement uncertainty for the "unidirectional positioning repeatability" of machine tools, as defined in the International Standard ISO 230-2:2014 or national equivalents, shall not be considered.*
7. *For the purpose of 2.B., 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.*
8. *Removed from NZSGL 2023*
9. *For the purposes of 2B201, measurement uncertainty for the positioning accuracy of machine tools, as defined in the International Standard ISO 230/2:2014 or national equivalents, shall not be considered.*

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:

N.B.: SEE ALSO 2B201.

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

Note 2: 2B001 does not apply to special purpose machine tools limited to the manufacture of any of the following:
   a. Crankshafts or camshafts;
   b. Tools or cutters;
   c. Extruder worms; or
   d. Engraved or facetted jewellery parts.
   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.

N.B.: 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
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 apply to turning machines specially designed for producing contact lenses, having all of the following:

a. Machine controller limited to using ophthalmic based software for part programming data input; and

b. No vacuum chucking.

Note 2: 2B001.a. does not apply to 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 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;
   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; or
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 TIR; and
    b. Angular deviation of slide movement (yaw, pitch and roll) less (better) than 2 seconds of arc, TIR over 300 mm of travel;

c. Machine tools for grinding having any of the following:
    1. Having all of the following:
        a. "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 apply to 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. Having two or more rotary axes and all of the following:
        a. Can be coordinated simultaneously for "contouring control"; and
        b. A positioning "accuracy" of less (better) than 0.003°;

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

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

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 Note:

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 pressurised 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 (R_c = 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 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:

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

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

b. 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.

N.B.: For specially designed dies, moulds and tooling see 1B003, 9B009 and the Munitions List.

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

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

N.B.: SEE ALSO 2B105.

1. 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 allowing for the *in situ* measurement of any of the following:

1. Coating thickness on the substrate and rate control; or
2. Optical characteristics.

Note: 2B005.a., 2B005.b., 2B005.e., 2B005.f. and 2B005.g. do not apply to chemical vapour deposition, cathodic arc, sputter deposition, ion plating or ion implantation equipment, specially designed for cutting or machining tools.

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);

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.

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.

1. 'Non-contact type measuring systems' with a 'resolution' equal to or less (better) than 0.2 µm within a measuring range up to 0.2 mm;

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; or

Technical Note:

For the purposes of 2B006.b., 'resolution' is the least increment of a measuring device; on digital instruments, the least significant bit.

4. "Electronic assemblies" specially designed to provide feedback capability in systems specified by 2B006.b.3.;

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 apply to 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 by 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:

N.B.: SEE ALSO 2B207.

a. Not used since 2017;

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

Note: 2B007.b. does not apply to "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 (Si) without operational degradation; or

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 since 2017;

b. Not used since 2017;

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:

N.B.: SEE ALSO 2B109 AND 2B209.

a. Two or more controlled axes of which at least two can be coordinated simultaneously for "contouring control"; and

b. A roller force more than 60 kN.

Technical Note:

For the purpose 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 by 2B004, having all of the following:

N.B.: SEE ALSO 2B204.

a. Maximum working pressure of 69 MPa or greater;

b. Designed to achieve and maintain a controlled thermal environment of 873 K (600°C) or greater; and

c. Possessing a chamber cavity with an inside diameter of 254 mm or greater.

2B105 Chemical vapour deposition (CVD) furnaces, other than those specified by 2B005.a., designed or modified for the densification of carbon-carbon composites.

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

N.B.: SEE ALSO 2B209.

a. Flow-forming machines having all of the following:

1. According to the manufacturer's technical specification, can be equipped with "numerical control" units or a computer control, even when not equipped with such units; and

2. With more than two axes which can be coordinated simultaneously for "contouring control";

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

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

Technical Note:

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

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

a. Vibration test systems employing feedback or closed loop techniques and incorporating a digital controller, capable of vibrating a system at an acceleration equal to or greater than 10 g rms between 20 Hz and 2 kHz while imparting forces equal to or greater than 50 kN, measured 'bare table';

b. Digital controllers, combined with specially designed vibration test software, with a 'real-time control bandwidth' greater than 5 kHz designed for use with vibration test systems specified by 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 vibration test systems specified by 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 vibration systems specified by 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 by 2B004, 2B005.a., 2B104 or 2B105, designed or modified for densification and pyrolysis of structural composite rocket nozzles and re-entry vehicle nose tips.

2B119 Balancing machines and related equipment, as follows:

N.B.: SEE ALSO 2B219.

a. Balancing machines having all the following characteristics:

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

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

b. Indicator heads designed or modified for use with machines specified by 2B119.a.

Technical Note:

Indicator heads are sometimes known as balancing instrumentation.

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

a. Two axes or more;

b. 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 apply to 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 by 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 by 2B120, having all the following characteristics:

a. Two axes or more; and

b. A positioning "accuracy" equal to or less (better) than 5 arc second.

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

2B122 Centrifuges capable of imparting accelerations above 100 g and designed or modified to incorporate slip rings or integrated non-contact devices capable of transferring electrical power, signal information, or both.

Note: *Centrifuges specified by 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 by 2B001, as follows, for removing or cutting metals, ceramics or "composites", which, according to the manufacturer's technical specification, can be equipped with electronic devices for simultaneous "contouring control" in two or more axes:

a. Machine tools for turning, that have positioning accuracies with all compensations available better (less) than 6 µm according to ISO 230/2:2014 along any linear axis (overall positioning) for machines capable of machining diameters greater than 35 mm;

Note: *2B201.a. does not apply to 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 characteristics:

1. Positioning accuracies with "all compensations available" equal to or less (better) than 6 µm according to ISO 230/2:2014 or national equivalents along any linear axis; or

2. Two or more contouring rotary axes;

Note: 2B201.b. does not apply to 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.

c. 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 230/2:2014 or national equivalents along any linear axis; or

2. Two or more contouring rotary axes.

Note: 2B201.c. does not apply to the following grinding machines:

a. Cylindrical external, internal, and external-internal grinding machines having all of the following characteristics:

1. Limited to a maximum workpiece capacity of 150 mm 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 230/2:2014 or national equivalents.

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

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

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

2B204 "Isostatic presses", other than those specified by 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 by 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 by 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/1000) 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, environment) and with all compensations available shall be compared to the 1.7 + L/ 800 µm threshold.

b. Linear displacement measuring instruments, as follows:

1. Non-contact type measuring systems with a "resolution" equal to or better (less) than 0.2 µm within a measuring range up to 0.2 mm;
2. Linear variable differential transformer (LVDT) systems having both of the following characteristics:
   a. Having any of the following:
      1. "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
      2. "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
   b. Drift equal to or better (less) than 0.1% per day at a standard ambient test room temperature ± 1 K (± 1ºC);
3. Measuring systems having both of the following characteristics:
   a. Containing a laser; and
   b. Capable of maintaining for at least 12 hours, over a temperature range of ± 1 K (± 1ºC) around a standard temperature and a standard pressure:
      1. A "resolution" over their full scale of 0.1 µm or better; and
      2. With a "measurement uncertainty" equal to or better (less) than (0.2 + L/2000) µm (L is the measured length in millimeters);

Note: Item 2B206.b.3. does not apply to 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.

Technical Note:

In Item 2B206.b. 'linear displacement' means the change of distance between the measuring probe and the measured object.

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

Note: Item 2B206.c. does not apply to optical instruments, such as autocollimators, using collimated light (e.g., laser light) to detect angular displacement of a mirror.

d. 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°.

Note 1: 2B206 includes machine tools, other than those specified by 2B201, that can be used as measuring machines if they meet or exceed the criteria specified for the measuring machine function.

Note 2: A machine specified by 2B206 is controlled if it exceeds the control threshold anywhere within its operating range.

Technical Note:

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 by 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 by 2B207.a.

2B209 Flow forming machines, spin forming machines capable of flow forming functions, other than those specified by 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, and power supplies therefor, as follows:

N.B.: SEE ALSO 3B.

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

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

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

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

a. Arc remelt 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 by 2B227.a. or b.

d. Plasma torches specially designed for the furnaces specified by 2B227.b. having both of the following characteristics:

1. Operating at a power greater than 50kW; and

2. Capable of operating above 1473 K (1200°C);

e. Electron beam guns specially designed for the furnaces specified by 2B227.b. operating at a power greater than 50kW.

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

a. Rotor assembly equipment for assembly of gas centrifuge rotor tube sections, baffles, and end caps;

Note: 2B228.a. includes precision mandrels, clamps, and shrink fit machines.

b. Rotor straightening equipment for alignment of gas centrifuge rotor tube sections to a common axis;

Technical Note:

In 2B228.b. such equipment normally consists of precision measuring probes linked to a computer that subsequently controls the action of, for example, pneumatic rams used for aligning the rotor tube sections.

c. Bellows-forming mandrels and dies for producing single-convolution bellows.

Technical Note:

In 2B228.c. the bellows have all of the following characteristics:

1. *Inside diameter between 75 mm and 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 characteristics:

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 measuring at 13 kPa.

Technical Note:

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

2B231 Vacuum pumps having all of the following characteristics:

a. Input throat size equal to or greater than 380 mm;

b. Pumping speed equal to or greater than 15 m^3/s; and

c. Capable of producing an ultimate vacuum better than 13 mPa.

Technical Notes:

1. The pumping speed is determined at the measurement point with nitrogen gas or air.

2. The ultimate vacuum is determined at the input of the pump with the input of the pump blocked off.

2B232 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.

Note: This item does not apply to guns specially designed for high velocity weapon systems.

2B233 Bellows-sealed scroll-type compressors and bellows-sealed scroll-type vacuum pumps having all of the following characteristics:

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.

Technical Notes:

1. *In a scroll compressor or vacuum pump, crescent-shaped pockets of gas are trapped between one or more pairs of intermeshed spiral vanes, or scrolls, one of which moves while the other remains stationary. The moving scroll orbits the stationary scroll; it does not rotate. As the moving scroll orbits the stationary scroll, the gas pockets diminish in size (i.e., they are compressed) as they move toward the outlet port of the machine.*
2. *In a bellows-sealed scroll compressor or vacuum pump, the process gas is totally isolated from the lubricated parts of the pump and from the external atmosphere by a metal bellows. One end of the bellows is attached to the moving scroll and the other end is attached to the stationary housing of the pump.*
3. *Fluoropolymers include, but are not limited to, the following materials:*
   a. *Polytetrafluoroethylene (PTFE),*
   b. *Fluorinated Ethylene Propylene (FEP),*
   c. *Perfluoroalkoxy (PFA),*
   d. *Polychlorotrifluoroethylene (PCTFE); and*
   e. *Vinylidene fluoride-hexafluoropropylene copolymer.*

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:
   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 by 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:
   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;

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;

g. Valves and components, as follows:
   1. Valves, having both of the following:
      a. A 'nominal size' greater than 10 mm or 3/8" (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 25.4 mm or 1" (DN 25 or NPS 1) and equal to or less than 100 mm or 4" (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 ISO6708:1995. Nominal Pipes Sizes (NPS) are in accordance with ASME 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);
   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); 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:

   For the purposes of 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 ML7 or 1C350, or chemical munitions, 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 designed for items specified by 2B350.a.3. or 2B350.c.3., having all of the following, and specially designed components therefor:

1. Designed for mechanical attachment to the glass-lining; and

2. Metallic surfaces that come in direct contact with the chemical(s) being processed which are made from tantalum or tantalum alloys.

Note: *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.*

Technical Notes:

1. For the purposes of 2B350.d., 2B350.e., 2B350.h., and 2B350.i., '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 monitoring systems and their dedicated detecting components, other than those specified by 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 by 1C350, at concentrations of less than 0.3 mg/m^3; or

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

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

N.B.: SEE ALSO 9A350 FOR SPRAYING AND FOGGING SYSTEMS.

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 by 2B352.a.1., 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 thereof, 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 capacity of 20 litres or more;

2. Components designed for fermenters specified by 2B352.b.1., as follows:

a. Cultivation chambers designed to be sterilised or disinfected in situ;

b. Cultivation chamber holding devices; or

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. Fermenters include bioreactors (including single-use (disposable) bioreactors), chemostats and continuous-flow systems.

2. 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 all the following characteristics:

1. Flow rate exceeding 100 litres per hour;

2. Components of polished stainless steel or titanium;

3. One or more sealing joints within the steam containment area; and

4. Capable of in-situ steam sterilisation in a closed state;

Technical Note:

Centrifugal separators include decanters.

d. Cross (tangential) flow filtration equipment and related components, as follows:

1. Cross (tangential) flow filtration equipment capable of separation of micro-organisms, viruses, toxins or cell cultures having all the following characteristics:

a. A total filtration area equal to or greater than 1 square metre; 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.

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 square metres for each component and designed for use in cross (tangential) flow filtration equipment specified by 2B352.d.;

Note: 2B352.d. does not apply to reverse osmosis equipment or hemodialysis equipment, as specified by the manufacturer.

e. Steam, gas or vapour sterilisable freeze-drying equipment with a condenser capacity exceeding 10 kg of ice in 24 hours and less than 1,000 kg of ice in 24 hours;

f. Protective and containment equipment, as follows:

1. Protective full or half suits, or hoods dependent upon a tethered external air supply and operating under positive pressure;

Note: 2B352.f.1. does not apply to 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 of 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 cubic metre or greater;
   2. Nose-only exposure apparatus or closed animal restraint tubes designed for use with such apparatus, utilising directed aerosol flow and having capacity for exposure of 12 or more rodents, or 2 or more animals other than rodents;

h. Spray drying equipment capable of drying toxins or pathogenic microorganisms having all of the following characteristics:
   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 micrometers with existing fittings or by minimal modification of the spray-dryer with atomization nozzles enabling generation of the required particle size; and
   3. Capable of being sterilised or disinfected in situ;

i. Nucleic acid assemblers and synthesizers, which are partly or entirely automated, and designed to generate continuous nucleic acids greater than 1.5 kilobases in length with error rates less than 5% in a single run.

2B901 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 1,273.15K (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 2B901.c.

Technical Notes

For the purposes of 2B901:

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 by 2D002, as follows:

a. "Software" specially designed or modified for the "development" or "production" of equipment specified by 2A or 2B.

b. "Software" specially designed or modified for the "use" of equipment specified by 2A001.c., 2B001, or 2B003 to 2B009.

Note: 2D001 does not apply to 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 a device or such devices or systems to function as a "numerical control" unit, capable of co-ordinating simultaneously more than four axes for "contouring control".

Note 1: 2D002 does not apply to "software" specially designed or modified for the operation of items not specified in Category 2.

Note 2: 2D002 does not apply to "software" for items specified by 2B002. See 2D001 and 2D003 for "software" for items specified by 2B002.

Note 3: 2D002 does not apply to "software" that is exported with, and the minimum necessary for the operation of, items not specified by Category 2.

2D003. "Software", designed or modified for the operation of equipment specified by 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 by 2B104, 2B105, 2B109, 2B116, 2B117 or 2B119 to 2B122.

N.B.: SEE ALSO 9D004.

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

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

Note: Item 2D202 does not apply to 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 by 1D003, specially designed for "use" of equipment specified by 2B351.

2D352 "Software", designed for nucleic acid assemblers and synthesizers, specified by 2B352.i, that is capable of designing and building functional genetic elements from digital sequence data.

2D901 "Software", not specified elsewhere, "specially designed" or modified for the "development" or "production" of equipment specified in 2B901.

2E Technology

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

Note: 2E001 includes "technology" for the integration of probe systems into coordinate measurement machines specified by 2B006.a.

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

2E003 Other "technology", as follows:

a. Not used since 2017;

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.

2. Not used since 2020.

N.B.: For 'technology' for *metal-working manufacturing processes for gas turbine engines and components, see 9E003. and ML22.*

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

d. Not used since 2017;

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 2E301.

N.B.: This table should be read to specify the "technology" of a particular Coating Process only when the Resultant Coating in column 3 is in a paragraph directly across from the relevant Substrate under column 2. For example, Chemical Vapour Deposition (CVD) coating process technical data are included for the application of silicides to carbon-carbon, ceramic and metal "matrix" "composites" substrates, but are not included for the application of silicides to 'cemented tungsten carbide' (16), 'silicon carbide' (18) substrates. In the second case, the resultant coating is not listed in the paragraph under column 3 directly across from the paragraph under column 2 listing 'cemented tungsten carbide' (16), 'silicon carbide' (18).

2E101 "Technology" according to the General Technology Note for the "use" of equipment or "software" specified by 2B104, 2B109, 2B116, 2B119 to 2B122 or 2D101.

2E201 "Technology" according to the General Technology Note for the "use" of equipment or "software" specified by 2B007.b., 2B007.c., 2A225, 2A226, 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 by 2B350 to 2B352.

2E901 "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 by 1C007 from corrosion; and
2. Designed to operate at temperatures exceeding 1,373.15 K (1,100°C).

Technical Note

For the purposes of 2E901, 'coating systems' consist of one or more layers (e.g., bond, interlayer, top coat) of material deposited on the substrate.

2E902 "Technology", not specified elsewhere, "specially designed" or modified for the "development" or "production" of equipment specified in 2B901.

TABLE — DEPOSITION TECHNIQUES

Column 1 Coating Process		**Column 2 Substrate**	**Column 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)

Column 1 Coating Process		Column 2 Substrate	Column 3 Resultant Coating
		Ceramics (19) and Low-expansion glasses (14)	Dielectric layers (15)
		Corrosion resistant steel (7)	MCrAlX (5) Modified zirconia (12) Mixtures thereof (4)
		Carbon-carbon, Ceramic and Metal "matrix" "composites"	Silicides Carbides Refractory metals Mixtures thereof (4) Dielectric layers (15) Boron nitride
		Cemented tungsten carbide (16), Silicon carbide (18)	Carbides Tungsten Mixtures thereof (4) Dielectric layers (15)
		Molybdenum and Molybdenum alloys	Dielectric layers (15)
		Beryllium and Beryllium alloys	Dielectric layers (15) Borides Beryllium
		Sensor window materials (9)	Dielectric layers (15)
		Titanium alloys (13)	Borides Nitrides
B.2.	Ion assisted resistive heating Physical Vapour Deposition (PVD) (Ion Plating)	Ceramics (19) and Low-expansion glasses (14)	Dielectric layers (15) Diamond-like carbon (17)
		Carbon-carbon, Ceramic and Metal "matrix" "composites"	Dielectric layers (15)
		Cemented tungsten carbide (16), Silicon carbide (18)	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" Vaporisation	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 (18)	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)

Column 1 Coating Process		Column 2 Substrate	Column 3 Resultant Coating
B.4.	Physical Vapour Deposition (PVD): Cathodic Arc Discharge	"Superalloys"	Alloyed silicides Alloyed aluminides (2) MCrAlX (5)
		Polymers (11) and Organic "matrix" "composites"	Borides Carbides Nitrides Diamond-like carbon (17)
C.	Pack cementation (see A above for out-of-pack cementation) (10)	Carbon-carbon, Ceramic and Metal "matrix" "composites"	Silicides Carbides Mixtures thereof (4)
		Titanium alloys (13)	Silicides Aluminides Alloyed aluminides (2)
		Refractory metals and alloys (8)	Silicides Oxides
D.	Plasma spraying	"Superalloys"	MCrAlX (5) Modified zirconia (12) Mixtures thereof (4) Abradable Nickel-Graphite Abradable materials containing Ni-Cr-Al Abradable Al-Si-Polyester Alloyed aluminides (2)
		Aluminium alloys (6)	MCrAlX (5) Modified zirconia (12) Silicides Mixtures thereof (4)
		Refractory metals and alloys (8)	Aluminides Silicides Carbides
		Corrosion resistant steel (7)	MCrAlX (5) Modified zirconia (12) Mixtures thereof (4)
		Titanium alloys (13)	Carbides Aluminides Silicides Alloyed aluminides (2) Abradable Nickel-Graphite Abradable materials containing Ni-Cr-Al Abradable Al-Si-Polyester
E.	Slurry Deposition	Refractory metals and alloys (8)	Fused silicides Fused aluminides except for resistance heating elements
		Carbon-carbon, Ceramic and Metal "matrix" "composites"	Silicides Carbides Mixtures thereof (4)

Column 1 Coating Process		Column 2 Substrate	Column 3 Resultant Coating
F.	Sputter Deposition	"Superalloys"	Alloyed silicides Alloyed aluminides (2) Noble metal modified aluminides (3) MCrAlX (5) Modified zirconia (12) Platinum Mixtures thereof (4)
		Ceramics (19) and Low-expansion glasses (14)	Silicides Platinum Mixtures thereof (4) Dielectric layers (15) Diamond-like carbon (17)
		Titanium alloys (13)	Borides Nitrides Oxides Silicides Aluminides Alloyed aluminides (2) Carbides
		Carbon-carbon, Ceramic and Metal "matrix" "composites"	Silicides Carbides Refractory metals Mixtures thereof (4) Dielectric layers (15) Boron nitride
		Cemented tungsten carbide (16), Silicon carbide (18)	Carbides Tungsten Mixtures thereof (4) Dielectric layers (15) Boron nitride
		Molybdenum and Molybdenum alloys	Dielectric layers (15)
		Beryllium and Beryllium alloys	Borides Dielectric layers (15) Beryllium
		Sensor window materials (9)	Dielectric layers (15) Diamond-like carbon (17)
		Refractory metals and alloys (8)	Aluminides Silicides Oxides Carbides
G.	Ion Implantation	High temperature bearing steels	Additions of Chromium Tantalum or Niobium (Columbium)
		Titanium alloys (13)	Borides Nitrides
		Beryllium and Beryllium alloys	Borides
		Cemented tungsten carbide (16)	Carbides Nitrides

TABLE — DEPOSITION TECHNIQUES: NOTES

1. The term ‘coating process’ includes coating repair and refurbishing as well as original coating.

2. The term ‘alloyed aluminide coating’ includes single or multiple-step coatings in which an element or elements are deposited prior to or during application of the aluminide coating, even if these elements are deposited by another coating process. It does not, however, include the multiple use of single-step pack cementation processes to achieve alloyed aluminides.

3. The term ‘noble metal modified aluminide’ coating includes multiple-step coatings in which the noble metal or noble metals are laid down by some other coating process prior to application of the aluminide coating.

4. The term ‘mixtures thereof’ includes infiltrated material, graded compositions, co-deposits and multilayer deposits and are obtained by one or more of the coating processes specified in the Table.

5. ‘MCrAlX’ refers to a coating alloy where M equals cobalt, iron, nickel or combinations thereof and X equals hafnium, yttrium, silicon, tantalum in any amount or other intentional additions over 0.01% by weight in various proportions and combinations, except:
   a. CoCrAlY coatings which contain less than 22% by weight of chromium, less than 7% by weight of aluminium and less than 2% 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. ‘Refractory metals and alloys’ include the following metals and their alloys: niobium (columbium), molybdenum, tungsten and tantalum.

9. ‘Sensor window materials’, as follows: alumina, silicon, germanium, zinc sulphide, zinc selenide, gallium arsenide, diamond, gallium phosphide, sapphire and the following metal halides: sensor window materials of more than 40 mm diameter for zirconium fluoride and hafnium fluoride.

10. Category 2 does not include “technology” for single-step pack cementation of solid airfoils.

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 included:

    magnetic disk drives and heads, equipment for the manufacture of disposables, valves for faucets, acoustic diaphragms for speakers, engine parts for automobiles, cutting tools, punching-pressing dies, office automation equipment, microphones 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.

   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 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;

   N.B.: *This definition does not include random cathodic arc deposition with non-biased substrates.*

5. Ion Plating is a special modification of a general TE-PVD process in which a plasma or an ion source is used to 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.*

   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 or sputter deposition.

3A Systems, Equipment and Components

Note 1: The status of equipment and components described in 3A other than those described in 3A001.a.3. to 3A001.a.10., or 3A001.a.12. to 3A001.a.14., 3A001.b.12., 3A901 or 3A904, which are specially designed for or which have the same functional characteristics as other equipment is determined by the status of the other equipment.

Note 2: The status of integrated circuits described in 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 status of the other equipment.

N.B.: When the manufacturer or applicant cannot determine the status of the other equipment, the status of the integrated circuits is determined in 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 components and specially designed components therefor, as follows:

a. General purpose integrated circuits, as follows:

Note: Integrated circuits include the following types:

a. "Monolithic integrated circuits";
b. "Hybrid integrated circuits";
c. "Multichip integrated circuits";
d. "Film type integrated circuits", including silicon-on-sapphire integrated circuits;
e. "Optical integrated circuits".
f. "Three dimensional integrated circuits".
g. "Monolithic Microwave Integrated Circuits" ("MMICs").

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 apply to Metal Insulator Semiconductors (MIS).

2. "Microprocessor microcircuits", "microcomputer microcircuits", microcontroller microcircuits, storage integrated circuits manufactured from a compound semiconductor, analogue-to-digital converters, digital-to-analogue converters, electro-optical or "optical integrated circuits" designed for "signal processing", field programmable logic devices, custom integrated circuits for which either the function is unknown or the 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 'nonvolatile memories', having any of the following:

   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.

   a. Rated for operation at an ambient temperature above 398 K (125°C);

   b. Rated for operation at an ambient temperature below 218 K (-55°C); or

   c. Rated for operation over the entire ambient temperature range from 218 K (-55°C) to 398 K (125°C);

   Note: 3A001.a.2. does not apply to integrated circuits designed for civil automobile or railway train applications.

   N.B.: For cryogenic CMOS integrated circuits not specified by 3A001.a.2., see 3A901.

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 and digital-to-analogue converter integrated circuits, as follows:

   a. ADCs having any of the following:

      N.B. SEE ALSO 3A101.

      1. A resolution of 8 bit or more, but less than 10 bit, with a "sample rate" greater than 1.3 Giga Samples Per Second (GSPS);

      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;

N.B.: For integrated circuits that contain analogue-to-digital converters and 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" 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. Digital-to-Analogue Converters (DAC) 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.

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 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.: For integrated circuits having field programmable logic devices that are combined with an analogue-to-digital converter, see 3A001.a.14.

   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. Not used since 2023.

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;
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.
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. A resolution of 8 bit or more, but less than 10 bit, with a "sample rate" greater than 1.3 Giga Samples Per Second (GSPS);
        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 analogue-to-digital converter 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.*

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 apply to "vacuum electronic devices" designed or rated for operation in any frequency bands and having all of the following:

a. Does not exceed 31.8 GHz; and

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

Note 2: 3A001.b.1. does not apply to 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 element with a turn on time to rated 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, 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/cm² or a pulsed (non-continuous) current density at rated operating conditions exceeding 10 A/cm²;

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 Circuit" ("MMIC") amplifiers that are any of the following:

N.B.: 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 0.1n W (-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;

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 apply to "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 by 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 status of a transistor in 3A001.b.3.a. through 3A001.b.3.e. whose rated operating frequency includes frequencies listed in more than one frequency range, as defined by 3A001.b.3.a. through 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.

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 greater than 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; or

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.

Note 1: Not used.

Note 2: The status of an item whose rated operating frequency includes frequencies listed in more than one frequency range, as defined by 3A001.b.4.a. through 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 90 GHz;
   b. Designed to extend the operating range of signal generators as follows:
      1. Beyond 90 GHz;
      2. To an output power greater than 100 mW (20 dBm) anywhere within the frequency range exceeding 43.5 GHz but not exceeding 90 GHz;
   c. Designed to extend the operating range of network analysers as follows:
      1. Beyond 110 GHz;
      2. To an output power greater than 31.62 mW (15 dBm) anywhere within the frequency range exceeding 43.5 GHz but not exceeding 90 GHz;
      3. To an output power greater than 1 mW (0 dBm) anywhere within the frequency range exceeding 90 GHz but not exceeding 110 GHz; or
   d. Designed to extend the frequency range of microwave test receivers beyond 110 GHz.
8. Microwave power amplifiers containing "vacuum electronic devices" specified by 3A001.b.1. and having all of the following:
   a. Operating frequencies above 3 GHz;
   b. An average output power density to mass ratio exceeding 80 W/kg; and
   c. A volume of less than 400 cm^3;

   Note: 3A001.b.8. does not apply to equipment designed or rated for operation in any frequency band which is "allocated by the ITU" for radio-communications services, but not for radio-determination.

9. Microwave Power Modules (MPMs) 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;

   Technical Notes:

   For the purposes of 3A002.b.9.:

   1. To calculate the volume in 3A001.b.9.b., the following example is provided: for a maximum rated power of 20 W, the volume would be: 20 W x 10 cm^3/W = 200 cm^3.

   2. The' turn-on time' in 3A001.b.9.a. refers to the time from fully-off to fully operational, i.e., it includes the warm-up time of the MPM.

10. Oscillators or oscillator assemblies, 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 synthesiser' "electronic assemblies" having a "frequency switching time" as specified by 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 synthesiser' 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.

N.B.: 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*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 ≤ 15cm*GHz*N/f_{GHz}] where N is the number of transmit or transmit/receive channels; and
    d. An electronically variable phase shifter per channel.

    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.4.12.c. for transmit/receive or transmit modules that have a rated operation range extending downward to 2.7 GHz and below [d≤15cm*GHz*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;

Note: *3A001.c. does not apply to acoustic wave devices that are limited to a single band pass, low pass, high pass or notch filtering, or resonating function.*

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;

b. ‘Secondary cells’ having an ‘energy density’ exceeding 350 Wh/kg at 20°C;

Technical Notes:

1. For the purpose 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 purpose 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 purpose 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 purpose 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 purpose 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 ampere (A) divided by the mass in kilograms. ‘Continuous power density’ is also referred to as specific power.

Note: 3A001.e.1. does not apply to batteries, including single-cell batteries.

2. High energy storage capacitors as follows:

N.B.: SEE ALSO 3A201.a. AND MUNITIONS LIST.

a. Capacitors with a repetition rate of less than 10 Hz (single shot capacitors) and having all of the following:

1. A voltage rating equal to or more than 5 kV;
2. An energy density equal to or more than 250 J/kg; and
3. A total energy equal to or more than 25 kJ;

b. Capacitors with a repetition rate of 10 Hz or more (repetition rated capacitors) and having all of the following:

1. A voltage rating equal to or more than 5 kV;
2. An energy density equal to or more than 50 J/kg;
3. A total energy equal to or more than 100 J; and
4. A charge/discharge cycle life equal to or more than 10,000;

3. “Superconductive” electromagnets and solenoids, specially designed to be fully charged or discharged in less than one second and having all of the following:

N.B.: SEE ALSO 3A201.b.

Note: 3A001.e.3. does not apply to “superconductive” electromagnets or solenoids specially designed for Magnetic Resonance Imaging (MRI) medical equipment.

a. Energy delivered during the discharge exceeding 10 kJ in the first second;

b. Inner diameter of the current carrying windings of more than 250 mm; and

c. Rated for a magnetic induction of more than 8 T or "overall current density" in the winding of more than 300 A/mm^2;

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

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

1. A maximum turn-on current rate of rise (di/dt) greater than 30,000 A/μs and off-state voltage greater than 1,100 V; or

2. A maximum turn-on current rate of rise (di/dt) greater than 2,000 A/μs and having all of the following:

a. An off-state peak voltage equal to or greater than 3,000 V; and

b. A peak (surge) current equal to or greater than 3,000 A.

Note 1: 3A001.g. includes:

a. Silicon Controlled Rectifiers (SCRs)

b. Electrical Triggering Thyristors (ETTs)

c. Light Triggering Thyristors (LTTs)

d. Integrated Gate Commutated Thyristors (IGCTs)

e. Gate Turn-off Thyristors (GTOs)

f. MOS Controlled Thyristors (MCTs)

g. Solidtrons

Note 2: 3A001.g. does not apply to thyristor devices and 'thyristor modules' incorporated into equipment designed for civil railway or "civil aircraft" applications.

Technical Note:

For the purposes of 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:

a. Junction Field Effect Transistors (JFETs)
b. Vertical Junction Field Effect Transistors (VJFETs)
c. Metal Oxide Semiconductor Field effect Transistors (MOSFETs)
d. Double Diffused Metal Oxide Semiconductor Field Effect Transistor (DMOSFET)
e. Insulated Gate Bipolar Transistor (IGBT)
f. High Electron Mobility Transistors (HEMTs)
g. Bipolar Junction Transistors (BJTs)
h. Thyristors and Silicon Controlled Rectifiers (SCRs)
i. Gate Turn-Off Thyristors (GTOs)
j. Emitter Turn-Off Thyristors (ETOs)
k. PiN Diodes
l. Schottky Diodes

Note 3: 3A001.h. does not apply to switches, diodes, or 'modules', incorporated into equipment designed for civil automobile, civil railway or "civil aircraft" applications.

Technical Note:

For the purposes of 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.

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;

N.B. For waveform digitizers and transient recorders, see 3A002.h.

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.

7. Real-time oscilloscopes having 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 for any input 3dB bandwidth of 60 GHz or greater per channel;

Note: 3A002.a.7. does not apply to equivalent-time sampling oscilloscopes.

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 Displayed Average Noise Level (DANL) less (better) than -150 dBm/Hz anywhere within the frequency range exceeding 43.5 GHz but not exceeding 90 GHz;
3. "Signal analysers" having a frequency exceeding 90 GHz;
4. "Signal analysers" having all of the following:
   a. 'Real-time bandwidth' exceeding 170 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 15 µs or less; or
      2. A 'frequency mask trigger' function with 100% probability of trigger (capture) for signals having a duration of 15 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.*
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 apply to 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;
   2. An output power exceeding 100 mW (20 dBm) anywhere within the frequency range exceeding 43.5 GHz but not exceeding 90 GHz;
   3. A "frequency switching time" as specified by 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; or
      e. Less than 100 µs for any frequency change exceeding 2.2 GHz within the frequency range exceeding 37 GHz but not exceeding 90 GHz;
      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 90 GHz;

4. 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 90 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 90 GHz; or

   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.

5. An 'RF modulation bandwidth' of digital baseband signals as specified by 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 550 GHz withing the frequency range exceeding 75 GHz but not exceeding 90 GHz

   Technical Note:

   For the purposes of 3.A002.d.5., 'RF modulation bandwidth' is the Radio Frequency (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 3b902modulation bandwidth'.

6. A maximum frequency exceeding 90 GHz;

Note 1: For the purposes of 3A002.d., signal generators include arbitrary waveform and function generators.

Note 2: 3A002.d. does not apply to equipment in which the output frequency is either produced by the addition or subtraction of two or more crystal oscillator frequencies, or by an addition or subtraction followed by a multiplication of the result.

Technical Notes:

1. For the purposes of 3A002.d., the maximum frequency of an arbitrary waveform or function generator is calculated by dividing the sample rate, in samples/second, by a factor of 2.5.

2. For the purposes of 3A002.d.1., '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.

e. Network analysers having any of the following:

1. An output power exceeding 31.62 mW (15 dBm) anywhere within the operating frequency range exceeding 43.5 GHz but not exceeding 90 GHz;
2. An output power exceeding 1 mW (0 dBm) anywhere within the operating frequency range exceeding 90 GHz but not exceeding 110 GHz;
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 x 10^{-11}/month; or
3. Non-"space-qualified" and having all of the following:
   a. Being a rubidium standard;
   b. Long-term stability less (better) than 1 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. A resolution of 8 bit or more, but less than 10 bit, with a "sample rate" greater than 1.3 Giga Samples Per Second (GSPS);
   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;

N.B. Digital data recorders, oscilloscopes, "signal analysers", signal generators, network analysers and microwave test receivers, are

specified by 3A002.a.6., 3A002.a.7., 3A002.c., 3A002.d., 3A002.e. and 3A002.f., respectively.

Technical Note:

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 by 3A001, as follows:

a. Analogue-to-digital converters, usable in "missiles", designed to meet military specifications for ruggedised equipment;

b. Accelerators capable of delivering electromagnetic radiation produced by bremsstrahlung from accelerated electrons of 2 MeV or greater, and systems containing those accelerators.

Note: 3A101.b. above does not specify equipment specially designed for medical purposes.

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 by 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 apply to 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 apply to accelerators that are component parts of devices designed for purposes other than electron beam or X-ray radiation (electron microscopy, for example) nor those designed for medical purposes:

Technical Notes:

1. The 'figure of merit' K is defined as:

$$K = 1.7 \times 10^3 V^{2.65} Q$$

where:

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, usable as a variable frequency or fixed frequency motor drive, other than those specified by 0B001.b.13., having all of the following characteristics:

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 1: Item 3A225 only applies to frequency changers intended for specific industrial machinery and/or consumer goods (machine tools, vehicles, etc.) if the frequency changers can meet the characteristics above when removed, and subject to General Note 3.

Note 2: For the purpose of export control, the Government will determine whether or not a particular frequency changer meets the characteristics above, taking into account hardware and software constraints.

Technical Note:

1. *Frequency changers in 3A225 are also known as converters or inverters.*
2. *The characteristics specified by item 3.A.1. may be met by certain equipment marketed such as: Generators, Electronic Test Equipment, AC Power Supplies, Variable Speed Motor Drives, Variable Speed Drives (VSDs), Variable Frequency Drives (VFDs), Adjustable Frequency Drives (AFDs), or Adjustable Speed Drives (ASDs).*

N.B.: "Software" specially designed to enhance or release the performance of frequency changers or generators to meet the characteristics above is controlled in 3D202.

N.B.: SEE 0B001 FOR FREQUENCY CHANGERS AND GENERATORS SPECIALLY DESIGNED OR PREPARED FOR THE GAS CENTRIFUGE PROCESS.

3A226 High-power direct current power supplies, other than those specified by 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 by 0B001.j.5., having both of the following characteristics:

a. Capable of continuously producing, over a time period of 8 hours, 20 kV or greater with current output of 1 A or greater; and

b. Current or voltage stability better than 0.1% over a time period of 8 hours.

3A228 Switching devices, as follows:

a. Cold-cathode tubes, whether gas filled or not, operating similarly to a spark gap, having all of the following characteristics:
   1. Containing three or more electrodes;
   2. Anode peak voltage rating of 2.5 kV or more;
   3. Anode peak current rating of 100 A or more; and
   4. Anode delay time of 10 µs or less;

   Note: 3A228 includes gas krytron tubes and vacuum sprytron tubes.

b. Triggered spark-gaps having both of the following characteristics:
   1. An anode delay time of 15 µs or less; and
   2. Rated for a peak current of 500 A or more;

c. Modules or assemblies with a fast switching function, other than those specified by 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:

N.B.: SEE ALSO MUNITIONS LIST.

N.B.: See 1A007.a. for explosive detonator firing sets.

a. Not used;

b. Modular electrical pulse generators (pulsers) having all of the following characteristics:
   1. Designed for portable, mobile, or ruggedised-use;
   2. Not used;
   3. Capable of delivering their energy in less than 15 µs into loads of less than 40 ohms;
   4. Having an output greater than 100 A;
   5. Not used;
   6. No dimension greater than 300 mm;
   7. Weight less than 30 kg; and
   8. Specified for use over an extended temperature range 223 K (-50ºC) to 373 K (100ºC) or specified as suitable for aerospace applications.

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.

   Note: 3A229.b. includes xenon flash-lamp drivers.

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.b. ‘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. Having any of the following:

1. Utilising electrostatic acceleration to induce a tritium-deuterium nuclear reaction; or

2. Utilising 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 by 1A007, as follows:

N.B.: SEE ALSO MUNITIONS LIST.

N.B.: See 1A007.b. for detonators.

a. Not used;

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

Note: 3A232 does not apply to detonators using only primary explosives, such as lead azide.

3A233 Mass spectrometers, other than those specified by 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 ionized by an electron beam; and

2. One or more cold traps that can be cooled to a temperature of 193 K (-80°C) or less in order to trap analyte molecules that are not ionized by the electron beam;

e. Not used.

f. Mass spectrometers equipped with a microfluorination ion source designed for actinides or actinide fluorides.

Technical Notes:

1. Item 3A233.d. describes mass spectrometers that are typically used for isotopic analysis of UF_6 gas samples.

2. Electron bombardment mass spectrometers in Item 3A233.d. are also known as electron impact mass spectrometers or electron ionization mass spectrometers.

3. In item 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 this entry, a closed-loop gaseous helium cryogenic vacuum pump is not a cold trap.

3A235 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.

3A901 Complementary Metal Oxide Semiconductor (CMOS) integrated circuits, not specified by 3A001.a..2, designed to operate at an ambient temperature equal to or less (better) than 4.5 K (-268.65°C).

Technical Note:

1. For the purposes of 3A901., CMOS integrated circuits are also referred to as cryogenic CMOS or cryoCMOS

3A902 Integrated circuits having one or more digital processing units having a 'Total Processing Performance' ('TPP') of 6,000 or more.

N.B. For "digital computers" and "electronic assemblies" containing integrated circuits specified in 3A902., see 4A902

Technical Notes:

For the purposes of 3A902:

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 the 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).

2. *The rate of the '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 300 tera FLOPS (or 2 x 150 'MacTOPS') 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 3A902.*

3. *For integrated circuits, specified in 3A902, that provide processing of both sparse and dense matrices, the 'TPP' values are the values for processing of dense matrices (eg, without sparsity).*

3A903 Parametric signal amplifiers having all of the following:

a. Designed for operation at an ambient temperature below 1 K (-272.15ºC);

b. Designed for operation at any frequency from 2GHz 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 (-272.15ºC)

Note: Parametric signal amplifiers include Travelling Wave Parametric Amplifiers (TWPAs)

Technical Note

For the purposes of 3A903, parametric signal amplifiers may also be referred to as Quantum-limited amplifiers (QLAs).

3A904 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:

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, or nitrogen;
3. Molecular beam epitaxial growth equipment using gas or solid sources;

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 optimized 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 by 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 apply to automatic robotic wafer handling systems specially designed for parallel wafer processing.

Technical Notes:

1. For the purpose of 3B001.e., '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.

2. For the purpose of 3B001.e., 'sequential multiple wafer processing' means the capability to process each wafer in different 'semiconductor process tools', such as by transferring each wafer from one tool to a second tool and on to a third tool with the automatic loading multi-chamber central wafer handling systems.

f. Lithography equipment as follows:
1. Align and expose step and repeat (direct step on wafer) or step and scan (scanner) equipment for wafer processing using photo-optical or X-ray methods and having any of the following:
a. A light source wavelength shorter than 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:

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

where the K factor = 0.35

2. Imprint lithography equipment capable of producing features of 45 nm or less;

Note: 3B001.f.2. includes:

a. Micro contact printing tools
b. Hot embossing tools
c. Nano-imprint lithography tools
d. Step and flash imprint lithography (S-FIL) tools.

3. Equipment specially designed for mask making having all of the following:
   a. A deflected focused 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 by 3A001;

h. Multi-layer masks with a phase shift layer not specified by 3B001.g. and designed to be used by lithography equipment having a light source wavelength less than 245 nm;

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

N.B. For masks and reticles, specially designed for optical sensors, see 6B002.

i. Imprint lithography templates designed for integrated circuits specified by 3A001;

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.

Technical Note:

For the purposes of 3B001.j., 'extreme Ultraviolet' ('EUV') refers to electromagnetic spectrum wavelengths greater than 5 nm and less than 124 nm.

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 by 3A001.b.3.;

b. Not used;

c. For testing items specified by 3A001.b.2.

3B901 Equipment designed for dry etching having any of the following:

a. 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

b. Equipment designed or modified for anisotropic dry etching, having all of the following:

1. Radio Frequency (RF) power source(s) with at least one pulsed RF output;

2. One or more fast gas switching valve(s) with switching time less than 300 milliseconds; and

3. Electrostatic chuck with twenty of more individually controllable variable temperature elements.

Note 1: *3B901. Includes etching by 'radicals', ions, sequential reactions or non sequential reactions.*

Note 2: *3B901 includes etching using RF pulse excited plasma, pulsed duty cycle excited plasma, pulsed voltage on electrodes modified plasma, cyclic injections and purging of gases combined with a plasma, plasma atomic layer etching or plasma quasiatomic layer etching.*

Technical Notes:

1. *For the purposes of 3B901, 'silicon germanium -to-silicon (SiGe:Si) etch electivity' is measured for a Ge concentration of greater than or equal to 30% ($Si_{0.70}$ $Ge_{0.30}$).*

2. *For the purposes of 3B901 'radical' is defined as an atom, molecule or ion that has an unpaired electron in an open electron shell configuration.*

3B902 'Extreme Ultraviolet' 'EUV' masks and 'EUV' reticles, designed for integrated circuits, not specified by 3B001.g, and having a mask "substrate blank" specified by 3B001.j.

Technical Note

For the purposes of 3B902., masks or reticles with a mounted pellicle are considered masks and reticles.

3B903 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 30nm;

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. Collection and storage of images having more than $2x10^8$ pixels;

e. FOV overlap of less than 5 percent in vertical and horizontal directions;

f. Stitching overlap of FOV less than 50 nm; and

g. Accelerating voltage more than 21kV.

Note 1: *3B903 includes SEM equipment designed for chip design recovery.*

Note 2: *3B903 does not control SEM equipment designed to accept a Semiconductor Equipment and Materials International (SEMI) standard wafer carrier, such as 200 mm or larger Front Opening Unified Pod (FOUP).*

3B904 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 consisting of a "substrate" having stacked epitaxially grown multiple layers of any of the following:

a. Silicon (Si);

b. Germanium (Ge);

c. Silicon carbide (SiC); or

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

Note: *3C001.d. does not apply to 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.*

e. Gallium Oxide (Ga_2O_3); or

f. Diamond.

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 by 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 a purity (metal basis) better than 99.999%;

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

Note: 3C003 only applies to compounds whose metallic, partly metallic or non-metallic element is directly linked to carbon in the organic part of the molecule.

3C004 Hydrides of phosphorus, arsenic or antimony, having a purity better than 99.999%, even diluted in inert gases or hydrogen.

Note: 3C004 does not apply to 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.

b. Polycrystalline "substrates" or polycrystalline ceramic "substrates", having resistivities greater than 10,000 ohm-cm at 20°C and having at least one nonepitaxial single-crystal layer of silicon (Si), silicon carbide (SiC), gallium nitride (GaN), aluminium nitride (AlN), or aluminium gallium nitride (AlGaN) gallium oxide (Ga_2O_3) or diamond on the surface of the "substrate".

3C006 Materials, not specified by 3C001, consisting of a "substrate" specified by 3C005. with at least one epitaxial layer of silicon carbide, gallium nitride, aluminium nitride or aluminium gallium nitride, gallium oxide (Ga_2O_3) or diamond.

3C901 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.

3C902 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.

3C903 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

3C903 includes "substrates", lumps, ingots, boules and preforms.

3D Software

3D001 "Software" specially designed for the "development" or "production" of equipment specified by 3A001.b. to 3A002.h. or 3B.

3D002 "Software" specially designed for the "use" of equipment specified by 3B001.a. to f. or 3B002.

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 the equipment specified by 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. 'Electronic Computer-Aided Design' ('ECAD') is a category of "software" tools used for designing, analysing, optimising, and validating the performance of integrated circuit or printed circuit board.

2 'Register Transfer Level' ('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 'Geometrical Database Standard II' ('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 by 3A101.b.

3D201 "Software" specially designed or modified for the "use" of equipment specified by 3A225.

3D202 "Software" or encryption keys/codes specially designed to enhance or release the performance characteristics of equipment not controlled in 3A225. so that it meets or exceeds the characteristics specified by 3A225.

3D203 "Software" specially designed to enhance or release the performance characteristics of equipment controlled in 3A225.

3D901 "Software" specially designed for the "use" of equipment specified by 3B901.

3D902 "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 Notes:
For the purposes of 3D902: 'Graphic Design System II' ('GDSII') is a database file format for data exchange of integrated circuit artwork or integrated circuit layout artwork.

3D903 "Software", not specified elsewhere, specially designed or modified for the "development" or "production" of items specified in 3A903, 3B901, 3B902, 3B903, and 3B904.

3E Technology

3E001 "Technology" according to the General Technology Note for the "development" or "production" of equipment, materials or "software" specified by 3A, 3B, 3C or 3D201. to 3D203.;

Note 1: *3E001. does not apply to "technology" for equipment or components specified by 3A003.*

Note 2: *3E001. does not apply to "technology" for integrated circuits specified by 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: *3E001. does not apply to 'Process Design Kits' ('PDKs') unless they include libraries implementing functions or technologies for items specified by 3A001.*

Technical Note:

For the purposes of 3E001 Note 3, 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').

3E002 "Technology" according to the General Technology Note other than that specified by 3E001 for the "development" or "production" of a "microprocessor microcircuit", "microcomputer microcircuit" or microcontroller microcircuit core, having an arithmetic logic unit with an access width of 32 bits or more and any of the following features or characteristics:

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

Technical Note:

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 arithmetic logic unit 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").

Note 1: 3E002 does not apply to "technology" for multimedia extensions.

Note 2: 3E002 does not apply to "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.

Technical Notes:

1. For the purpose of 3E002.a. and 3E002.b., 'floating-point' is defined by IEEE-754.

2. For the purpose 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.

3E003 Other "technology" for the "development" or "production" of the following:

a. Vacuum microelectronic devices;

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

Note: 3E003.b. does not apply to "technology" for high electron mobility transistors (HEMT) operating at frequencies lower than 31.8 GHz and hetero-junction bipolar transistors (HBT) operating at frequencies lower than 31.8 GHz.

c. "Superconductive" electronic devices;

d. Substrates of films of diamond for electronic components;

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

f. Substrates of silicon carbide for electronic components;

g. "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 purpose 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 by 3A101., 3A102. or 3D101..

3E102 "Technology" according to the General Technology Note for the "development" of "software" specified by 3D101.

3E201 "Technology" according to the General Technology Note for the "use" of equipment or "software" specified by 3A201., 3A225. to 3A235. or 3D201. to 3D203.

3E901 "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: 3E901 includes 'process recipes'.

Note 2: 3E901 does not apply for tool qualification or maintenance.

Note 3: 3E901 does not control "Process Design Kits" ("PDKs") unless they include libraries implementing functions or technologies for items specified by 3A001.

Technical Notes:

1. For the purposes of 3E901, a 'process recipe' is a set of conditions and parameters for a particular process step.

2. For the purposes of 3E901, 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').

3. For the purposes of 3E901, 'Gate-All-Around Field-Effect Transistor' ('GAAFET') 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.

N.B.: This definition includes nanosheet or nanowire field-effect and surrounding gate transistors and other 'GAAFET' semiconductor channel element structures.

3E902 “Technology” according to the General Technology Note for the “development” or “production” of items controlled by 3A901, 3A902, 3A903, 3A904, 3B901, 3B902, 3B903, 3B904, 3C901, 3C902, or 3C903.

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

Note 2: Control units which directly interconnect the buses or channels of central processing units, 'main storage' or disk controllers are not regarded as telecommunications equipment described in Category 5, Part 1 (Telecommunications).

N.B.: For the control status of "software" specially designed for packet switching, see 5D001.

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:

N.B.: 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 apply to computers specially designed for civil automobile, railway train or "civil aircraft" applications.

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

a. Total Dose 5×10^3 Gy (Si);

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

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

Note: 4A001.a.2. does not apply to computers specially designed for "civil aircraft" applications.

b. Not used.

4A002 Not used.

4A003 "Digital computers", "electronic assemblies", and related equipment therefor, as follows and specially designed components therefor:

Note 1: 4A003. includes the following:
a. 'Vector processors';
b. Array processors;
c. Digital signal processors;
d. Logic processors;

e. Equipment designed for "image enhancement".

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);

c. "Electronic assemblies" specially designed or modified for enhancing performance by aggregation of processors so that the "APP" of the aggregation exceeds the limit specified by 4A003.b.;

Note 1: 4A003.c. applies only to "electronic assemblies" and programmable interconnections not exceeding the limit specified by 4A003.b. when shipped as unintegrated "electronic assemblies".

Note 2: 4A003.c. does not apply to "electronic assemblies" specially designed for a product or family of products whose maximum configuration does not exceed the limit specified by 4A003.b.

d. Not used;

e. Not used;

N.B.: For "electronic assemblies", modules or equipment, performing analogue-to-digital conversions, see 3A002.h.

f. Not used;

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

Note: 4A003.g. does not apply to internal interconnection equipment (e.g. backplanes, buses), passive interconnection equipment, "network access controllers" or "communications channel controllers".

4A004 Computers as follows and specially designed related equipment, "electronic assemblies" and components therefor:

a. 'Systolic array computers';

b. ‘Neural computers’;

c. ‘Optical computers’.

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 by 4A001.a.1., which are ruggedised and designed or modified for use in space launch vehicles specified by 9A004. or sounding rockets specified by 9A104.

4A102 “Hybrid computers” specially designed for modelling, simulation or design integration of space launch vehicles specified by 9A004. or sounding rockets specified by 9A104.

Note: This control only applies when the equipment is supplied with “software” specified by 7D103. or 9D103.

4A901 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 $1x10^{-4}$;
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 $1x10^{-3}$;
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 $2x10^{-3}$;
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 $3x10^{-3}$;
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 $4x10^{-3}$

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 $5x10^{-3}$;

7. Quantum computers supporting 1,100 or more, but fewer than 2000, 'fully controlled', 'connected' and 'working' 'physical qubits', and having a 'C-NOT error' of less than or equal to $6x10^{-3}$

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 4A901.a.;

c. Quantum control components and quantum measurement devices, specially designed for items specified in 4A901.a.;

Note 1: *4A901 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 by 4A901 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 by 4A901.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: *4A901.c. applies to items designed for calibrating, initialising, manipulating or measuring the resident qubits of a quantum computer.*

Technical Notes:

For the purposes of 4A901:

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.*

4A902 Computers, "electronic assemblies" and "components" containing one or more integrated circuits described in 3A902.

Technical Note

For the purposes of 4A902., computers include "digital computers," hybrid computers, and analog computers.

4B Test, Inspection and Production Equipment

None.

4C Materials

None.

4D Software

Note: The 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 by 4A or 4D;

b. "Software", other than that specified by 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.

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 apply to "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 by 4D004.; or

2. "Intrusion software".

4D901 "Software" specially designed or modified for the "development" or "production" of items specified in 4A901.b or 4A901.c or 4A902.

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 by 4A001 to 4A005, 4A101, 4A102, or 4D001 to 4D004;

b. "Technology" according to the General Technology Note, other than that specified by 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.;

c. "Technology" for the "development" of "intrusion software".

Note 1: 4E001.a. and 4E001.c. do not apply to "vulnerability disclosure" or "cyber incident response".

Note 2: Note 1 does not diminish national authorities' rights 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 per second

Abbreviations used in this Technical Note

n number of processors in the "digital computer"

i processor number (i,...n)

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

F_i processor frequency

R_i peak floating point calculating rate

W_i architecture adjustment factor

Outline of "APP" calculation method

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

   Note: In determining FPO, include only 64-bit or larger floating point additions and 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:

$$R_i = \frac{FPO_i}{t_i}$$

3. Calculate "APP":

$$APP = W_1 \times R_1 + W_2 \times R_2 + ... + W_n \times R_n$$

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 by 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.*

4E901 Technology as follows:

a. "Technology" for the "development" or "production" of items specified in 4A901.b., 4A901.c., or 4D901.

b. "Technology" for the use of "software" controlled by 4D901.

4E902 "Technology" according to the General Technology Note for the "use" of the equipment specified in 4A902.

Category 5 - Telecommunications and Information Security

Part 1—TELECOMMUNICATIONS

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

N.B.: 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. applies only to electronic equipment.

Note 2: 5A001.a.2. and 5A001.a.3. do not apply to equipment designed or modified for use on board satellites.

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

1. Being underwater untethered communications systems having any of the following:
   a. An acoustic carrier frequency outside the range from 20 kHz to 60 kHz;
   b. Using an electromagnetic carrier frequency below 30 kHz;
   c. Using electronic beam steering techniques; or
   d. Using "lasers" or light-emitting diodes (LEDs), with an output wavelength greater than 400 nm and less than 700 nm, in a "local area network";
2. Being radio equipment operating in the 1.5 MHz to 87.5 MHz band and having all of the following:
   a. Automatically predicting and selecting frequencies and "total digital transfer rates" per channel to optimise the transmission; and

b. Incorporating a linear power amplifier configuration having a capability to support multiple signals simultaneously at an output power of 1 kW or more in the frequency range of 1.5 MHz or more but less than 30 MHz, or 250 W or more in the frequency range of 30 MHz or more but not exceeding 87.5 MHz, over an "instantaneous bandwidth" of one octave or more and with an output harmonic and distortion content of better than -80 dB;

3. Being radio equipment employing "spread spectrum" techniques, including "frequency hopping" techniques, other than those specified by 5A001.b.4. and having any of the following:
   a. User programmable spreading codes; or
   b. A total transmitted bandwidth which is 100 or more times the bandwidth of any one information channel and in excess of 50 kHz;

      Note: 5A001.b.3.b. does not apply to radio equipment specially designed for use with civil cellular radio-communications systems.

      Note: 5A001.b.3 does not apply to equipment designed to operate at an output power of 1 W or less.

4. Being radio equipment employing ultra-wideband modulation techniques, having user programmable 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 apply to 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 x 10^9 N/m^2 or more;

N.B.: For underwater umbilical cables, see 8A002.a.3.

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 apply to 'electronically steerable phased array antennae' for landing systems with instruments meeting ICAO standards covering Microwave Landing Systems (MLS).

Note 2: 5A001.d. does not apply to 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 by 5A001.f.1., designed for the extraction of client device or subscriber identifiers (e.g., IMSI, TIMSI or 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;
   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. RF monitoring equipment designed or modified to identify the operation of items specified by 5A001.f.1., 5A001.f.2. or 5A001.f.3.;

Note: 5A001.f.1. and 5A001.f.2. do not apply to 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 THE MUNITIONS LIST.

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 apply to 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 by 5A001.f., designed or modified for prematurely activating or preventing the initiation of IEDs;
   2. Equipment using techniques designed to enable radio communications in the same frequency channels on which co-located equipment specified by 5A001.h.1. is transmitting.

N.B.: SEE ALSO THE MUNITIONS LIST.

i. Not used

N.B.: See 5A001.f. for items previously specified by 5A001.i.

j. 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 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

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 apply to 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 apply to:

a. Equipment designed or modified for manned aircraft or satellites;

b. Ground based equipment designed or modified for terrestrial or marine applications;

c. Equipment designed for commercial, civil or 'Safety of Life' (e.g. data integrity, flight safety) GNSS services.

5B1 Test, Inspection and Production Equipment

5B001 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", "production" or "use" of equipment, functions or features, specified by 5A001;

Note: 5B001.a. does not apply to optical fibre characterisation 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 1750 nm;

b. Not used;

c. Not used;

d. Employing analogue techniques and having a bandwidth exceeding 2.5 GHz;

Note: 5B001.b.2.d. does not apply to 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 by 5A001;

b. Not used;

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

   Note: 5D001.d.2.b. does not apply to "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 by 5D001.a. or 5D001.c., specially designed or modified for monitoring or analysis by law enforcement, 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

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 by international standards (including but not limited to ETSI TS 101 331, ETSI TS 101 671, 3GPP TS 33.108) or national equivalents.*

2. Mapping of the relational network or tracking the movement of targeted individuals based on the results of searches on content of communication or metadata or searches as described in 5D001.e.1.

Note: 5D001.e. does not apply to "software" specially designed or modified for any of the following:

a. Billing purposes;
b. Network Quality of Service (QoS);
c. Quality of Experience (QoE);
d. Mediation devices; or
e. Mobile payment or banking use.

5D101 "Software" specially designed or modified for the "use" of equipment specified by 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 by 5A001 or "software" specified by 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 satellites;
2. "Technology" for the "development" or "use" of "laser" communication techniques with the capability of automatically acquiring and tracking signals and maintaining communications through exoatmosphere or sub-surface (water) media;
3. "Technology" for the "development" of digital cellular radio base station receiving equipment whose reception capabilities that allow multi-band, multi-channel, multi-mode, multi-coding algorithm or multi-protocol operation can be modified by changes in "software";
4. "Technology" for the "development" of "spread spectrum" techniques, including "frequency hopping" techniques;

Note: 5E001.b.4. does not apply to "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;

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 apply to "technology" for commercial TV systems.

N.B.: For "technology" for the "development" or "production" of non-telecommunications equipment employing a laser, see 6E.

3. Equipment employing "optical switching" and having a switching time less than 1 ms;

4. Radio equipment having any of the following:

a. Quadrature-Amplitude-Modulation (QAM) techniques above level 1,024;

b. Operating at input or output frequencies exceeding 31.8 GHz; or

Note: 5E001.c.4.b. does not apply to "technology" for equipment designed or modified for operation in any frequency band which is "allocated by the ITU" for radio-communications services, but not for radio-determination.

c. Operating in the 1.5 MHz to 87.5 MHz band and incorporating adaptive techniques providing more than 15 dB suppression of an interfering signal; 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 10 W (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 5 W (37 dBm) at any frequency exceeding 8.5 GHz up to and including 16 GHz;
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 by 5A101.

Part 2 — "INFORMATION SECURITY"

Note 1: *Not used.*

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

Note 3: *Cryptography Note*

5A002., 5D002.a.1., 5D002.b. and 5D002.c.1. do not apply to items as follows:

a. Items meeting 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;
3. Designed for installation by the user without further substantial support by the supplier; and
4. Not used
5. When necessary, details of the items are accessible and will be provided, upon request, to the appropriate authority in the exporter's country in order to ascertain compliance with conditions described in paragraphs 1. to 3. above;

b. Hardware components or 'executable software', of existing items described in paragraph a. of this Note, that have been designed for these existing items, and 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 appropriate authority in the exporter's country, details of the component or 'executable software', and details of relevant end-items are accessible and will be provided to the authority upon request, in order to ascertain compliance with conditions described above.*

Technical Note:

For the purpose 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 paragraph 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.*
2. *In determining eligibility of paragraph a. of Note 3, national 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

CRYPTOGRAPHIC "INFORMATION SECURITY"

5A002 "Information security" systems, equipment and components therefor, as follows:

N.B.: For "satellite navigation system" receiving equipment containing or employing decryption see 7A005., and for related decryption "software" and "technology", see 7D005 and 7E001.

a. Designed or modified to use 'cryptography for data confidentiality' having a 'described security algorithm', where that cryptographic capability is usable, has been activated, or can be activated by any means other than secure "cryptographic activation", as follows:

1. Items having "information security" as a primary function;
2. Digital communication or networking systems, equipment or components, not specified in paragraph 5A002.a.1.;
3. Computers, other items having information storage or processing as a primary function, and components therefor, not specified in paragraphs 5A002.a.1. or 5A002.a.2.;

   N.B.: For operating systems, see also 5D002.a.1. and 5D002.c.1.
4. Items, not specified in paragraphs 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 by Category 5 – Part 2.

Technical Notes:

1. For the purposes of 5A002.a., 'cryptography for data confidentiality' means "cryptography" that employs digital techniques and performs any cryptographic function 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; or
   g. Key management in support of any function described in paragraph a. to f. above.

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;
   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 paragraph 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 cryptographic capability for data confidentiality specified by 5A002.a. is usable without "cryptographic activation".

Note 2: 5A002.a. does not apply to 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 cryptographic capability meets all of the following:

1. It is restricted for use in any of the following:

a. Equipment or systems not described by 5A002.a.1. to 5A002.a.4.;

b. Equipment or systems not using 'cryptography for data confidentiality' having a 'described security algorithm'; or

c. Equipment or systems excluded from 5.A.2.a. by entries b. to f. of this Note; 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 cryptographic capability is not user-accessible;

Technical Note:

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

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

Technical Note:

For the purposes of 5A002.a. Note a.1.b.2 'readers/writers' include equipment that communicates with smart cards or electronically readable documents through a network.

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

Technical Note

For the purposes of 5A002.a. Note b., 'money transactions' includes the collection and settlement of fares or credit functions.

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

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 for civil use, that implement only published or commercial cryptographic standards (except for anti-piracy functions, which may be non-published) and also meet the provisions of paragraphs a.2. to a.4. of the Cryptography Note (Note 3 in Category 5 – Part 2), that have been customised for a specific civil industry application with features that do not affect the cryptographic functionality of these original non-customised devices;*

f. *Items, where the "information security" functionality is limited to wireless "personal area network" functionality implementing only published or commercial cryptographic standards;*

g. *Mobile telecommunications Radio Access Network (RAN) equipment designed for civil use, which also meet the provisions of paragraphs a.2. to a.4. of the Cryptography Note (Note 3 in Category 5 – Part 2), having an RF output power limited to 0.1W (20 dBm) or less, and supporting 16 or fewer concurrent users;*

h. *Routers, switches, gateways or relays, where the "information security" functionality 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 "information security" functionality meets all of the following:

1. Uses only published or commercial cryptographic standards; and

2. Is any of the following:

a. Integral to a CPU that meets the provisions of Note 3 in Category 5 – Part 2;

b. Integral to an operating system that is not specified by 5.D.2.; or

c. Limited to "OAM" of the equipment; or

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 "information security" functionality 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 by paragraph j.1.a. above; and

2. The "information security" functionality is limited to supporting the 'connected civil industry application' of devices specified by paragraph j.1.a. above, or the tasks of "OAM" of this networking equipment or of other items specified by paragraph j. of this Note; and

2. Where the "information security" functionality 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 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 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 by Category 5 – Part 2 into an item specified by 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 by 5A002.a. of an item already specified by 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, not specified by 5A002.d., including the hopping code for “frequency hopping” systems.

NON-CRYPTOGRAPHIC “INFORMATION SECURITY”

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. applies only to physical layer security. For the purpose of 5.A.3.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.

DEFEATING, WEAKENING OR BYPASSING “INFORMATION SECURITY”

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 by 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 apply to 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 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 by 5A002., 5A003., 5A004. or 5B002.b.;

b. Measuring equipment specially designed to evaluate and validate the "information security" functions of the equipment specified by 5A002., 5A003. or 5A004., or of "software" specified by 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 by 5A002. or "software" specified by 5D002.c.1.;

2. Equipment specified by 5A003. or "software" specified by 5D002.c.2.; or

3. Equipment or "software", as follows:

a. Equipment specified by 5A004.a. or "software" specified by 5D002.c.3.a.;

b. Equipment specified by 5A004.b. or "software" specified by 5D002.c.3.b.;

b. "Software" having the characteristics of a 'cryptographic activation token' specified by 5A002.b.;

c. "Software" having the characteristics of, or performing or simulating the functions of, any of the following:

1. Equipment specified by 5A002.a., 5A002.c., 5A002.d. or 5A002.e.;

Note: 5D002.c.1. does not apply to "software" limited to the tasks of "OAM" implementing only published or commercial cryptographic standards.

2. Equipment specified by 5A003.; or

3. Equipment, as follows:

a. Equipment specified by 5A004.a.;

b. Equipment specified by 5A004.b.

Note: 5D002.c.3.b. does not apply to "intrusion software".

d. Not used.

N.B.: See 5D002.b. for items formerly specified in 5D002.d.

5E2 Technology

5E002 "Technology" as follows:

a. "Technology" according to the General Technology Note for the "development", "production" or "use" of equipment specified by 5A002., 5A003., 5A004. or 5B002., or of "software" specified by 5D002.a. or 5D002.c.;

Note: 5E002.a. does not apply to "technology" for items specified by 5A004.b., 5D002.a.3.b. or 5D002.c.3.b.

b. "Technology" having the characteristics of a 'cryptographic activation token' specified by 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.

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 apply to equipment as follows:

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

b. Acoustic beacons, as follows:

1. Acoustic emergency beacons;

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

a. Acoustic seabed survey equipment as follows:

1. Surface vessel survey equipment designed for 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 Notes:

1. 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. For the purposes of 6A001.a.1.a., 'enhancement' includes the ability to compensate by external means.

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
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 by 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 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 maximum 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:

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

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

Note 1: The control status of acoustic projectors, including transducers, specially designed for other equipment is determined by the control status of the other equipment not specified by 6A001.

Note 2: 6A001.a.1.c. does not apply to electronic sources which direct the sound vertically only, or mechanical (e.g. air gun or vapour-shock gun) or chemical (e.g. explosive) sources.

Note 3: Piezoelectric elements specified by 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 10 kHz; 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 10 kHz; 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;

N.B.: See 6A001.a.1.c.1. for items previously specified by 6A001.a.1.c.2.

3. Side-lobe suppression exceeding 22 dB;

d. Acoustic systems and equipment, designed to determine the position of surface vessels or underwater vehicles and having all 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 underwater vehicle;

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

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

N.B.: 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 applies to 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;
3. Having any of the following sensing elements:
   a. Optical fibres;
   b. 'Piezoelectric polymer films' other than polyvinylidene-fluoride (PVDF) and its co-polymers {P(VDF-TrFE) and P(VDF-TFE)}; or
   c. 'Flexible piezoelectric composites';
   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' 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' 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;
   Technical Note:
   For the purposes of 6A001.a.2.b.2., 'able to be modified' in 6A001.a.2.b. means having provisions to allow a change of the wiring or interconnections to alter hydrophone group spacing or operating depth limits. These provisions are: spare wiring exceeding 10% of the number of wires, hydrophone group spacing adjustment blocks or internal depth limiting devices that are adjustable or that control more than one hydrophone group.
3. Heading sensors specified by 6A001.a.2.d.;
4. Longitudinally reinforced array hoses;
5. An assembled array of less than 40 mm in diameter; or
6. Not used;
7. Hydrophone characteristics specified by 6A001.a.2.a.;
8. Accelerometer-based hydro-acoustic sensors specified by 6A001.a.2.g.;

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

d. Heading sensors having all of the following:

1. An "accuracy" of better than 0.5°; and

2. Designed to operate at depths exceeding 35 m or having an adjustable or removable depth sensing device in order to operate at depths exceeding 35 m;

N.B.: For inertial heading systems, see 7A003.c.

e. Bottom or bay cable systems, having any of the following:

1. Incorporating hydrophones specified by 6A001.a.2.a.; or

2. Incorporating multiplexed hydrophone group signal modules having all of the following characteristics:

a. Designed to operate at depths exceeding 35 m or having an adjustable or removable depth sensing device in order to operate at depths exceeding 35 m; and

b. Capable of being operationally interchanged with towed acoustic hydrophone array modules;

3. Incorporating accelerometer-based hydro-acoustic sensors specified by 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' 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 apply to particle velocity sensors or geophones.

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 sea bed, as follows:

1. Correlation-velocity sonar log equipment having any of the following characteristics:

a. Designed to operate at distances between the carrier and the sea bed exceeding 500 m; or

b. Having speed "accuracy" better than 1% of speed;

2. Doppler-velocity sonar log equipment having speed "accuracy" better than 1% of speed.

Note 1: 6A001.b. does not apply to depth sounders limited to any of the following:

a. Measuring the depth of water;

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

c. Fish finding.

Note 2: 6A001.b. does not apply to equipment specially designed for installation on surface vessels.

c. Not used.

6A002 Optical sensors or equipment and components therefor, as follows:

N.B.: 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;

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 apply to non-imaging photomultiplier tubes having an electron sensing device in the vacuum space limited solely to any of the following:*

a. A single metal anode; or

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

Technical Note:

For the purposes of 6A002.a.2., 'charge multiplication' is a form of electronic image amplification and is 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".

a. Image intensifier tubes having all of the following:

1. A peak response in the wavelength range exceeding 400 nm but not exceeding 1,050 nm;

2. Electron image amplification using any of the following:

a. A microchannel plate with a hole pitch (centre-to-centre spacing) of 12 µm or less; or

b. An electron sensing device with a non-binned pixel pitch of 500 µm or less, specially designed or modified to achieve 'charge multiplication' other than by a microchannel plate; and

3. Any of the following photocathodes:

a. Multialkali photocathodes (e.g., S-20 and S-25) having a luminous sensitivity exceeding 350 µA/lm;

b. GaAs or GaInAs photocathodes; or

c. Other "III/V compound" semiconductor photocathodes having a maximum "radiant sensitivity" exceeding 10 mA/W;

b. Image intensifier tubes having all of the following:

1. A peak response in the wavelength range exceeding 1,050 nm but not exceeding 1,800 nm;

2. Electron image amplification using any of the following:

a. A microchannel plate with a hole pitch (centre-to-centre spacing) of 12 µm or less; or

b. An electron sensing device with a non-binned pixel pitch of 500 µm or less, specially designed or modified to achieve 'charge multiplication' other than by a microchannel plate; and

3. "III/V compound" semiconductor (e.g., GaAs or GaInAs) photocathodes and transferred electron photocathodes, having a maximum "radiant sensitivity" exceeding 15 mA/W;

c. Specially designed components as follows:

1. Microchannel plates having a hole pitch (centre-to-centre spacing) of 12 µm or less;

2. An electron sensing device with a non-binned pixel pitch of 500 μm or less, specially designed or modified to achieve 'charge multiplication' other than by a microchannel plate;

3. "III/V compound" semiconductor (e.g., GaAs or GaInAs) photocathodes and transferred electron photocathodes;

Note: 6A002.a.2.c.3. does not apply to compound semiconductor photocathodes designed to achieve a maximum "radiant sensitivity" of any of the following:

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

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

3. Non-"space-qualified" "focal plane arrays" as follows:

N.B.: 'Microbolometer' non-"space-qualified" "focal plane arrays" are only specified by 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 apply to:

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

b. Pyroelectric detectors using any of the following:

1. Triglycine sulphate and variants;

2. Lead-lanthanum-zirconium titanate and variants;

3. Lithium tantalate;

4. Polyvinylidene fluoride and variants; or

5. Strontium barium niobate and variants.

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

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

2. Any of the following:

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

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

Technical Note:
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;

a. Non-"space-qualified" "focal plane arrays" having all of the following:
   1. Individual elements with a peak response within the wavelength range exceeding 900 nm but not exceeding 1,050 nm; and
   2. Any of the following:
      a. A response "time constant" of less than 0.5 ns; or
      b. Specially designed or modified to achieve 'charge multiplication' and having a maximum "radiant sensitivity" exceeding 10 mA/W;

b. Non-"space-qualified" "focal plane arrays" having all of the following:
   1. Individual elements with a peak response in the wavelength range exceeding 1,050 nm but not exceeding 1,200 nm; and
   2. Any of the following:
      a. A response "time constant" of 95 ns or less; or
      b. Specially designed or modified to achieve 'charge multiplication' and having a maximum "radiant sensitivity" exceeding 10 mA/W;

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

   N.B.: Silicon and other material based 'microbolometer' non-"space-qualified" "focal plane arrays" are only specified by 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 apply to "focal plane arrays" (not to exceed 32 elements) having detector elements limited solely to germanium material.

   Technical Note:

For the purposes of 6A002.a.3.d., 'cross-scan direction' is defined as the axis parallel to the linear array of detector elements and the 'scan direction' is defined as the axis perpendicular to the linear array of detector elements.

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

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

Technical Note:
For the purposes of 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 apply to "monospectral imaging sensors" with a peak response in the wavelength range exceeding 300 nm but not exceeding 900 nm and only incorporating any of the following non-"space-qualified" detectors or non-"space-qualified" "focal plane arrays":
a. Charge Coupled Devices (CCD) not designed or modified to achieve 'charge multiplication'; or
b. Complementary Metal Oxide Semiconductor (CMOS) devices not designed or modified to achieve 'charge multiplication'.

c. 'Direct view' imaging equipment incorporating any of the following:

1. Image intensifier tubes specified by 6A002.a.2.a. or 6A002.a.2.b.;
2. "Focal plane arrays" specified by 6A002.a.3.; or
3. Solid state detectors specified by 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 apply to equipment as follows, when incorporating other than GaAs or GaInAs photocathodes:

a. Industrial or civilian intrusion alarm, traffic or industrial movement control or counting systems;
b. Medical equipment;
c. Industrial equipment used for inspection, sorting or analysis of the properties of materials;
d. Flame detectors for industrial furnaces;
e. Equipment specially designed for laboratory use.

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: 6A002.d.3. does not apply to encapsulated optical sensing fibres specially designed for bore hole sensing applications.

e. Not used.

f. 'Read-out integrated circuits' ('ROIC') specially designed for "focal plane arrays" specified by 6A002.a.3.

   Note: 6A002.f. does not apply to 'read-out integrated circuits' 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" ("FPA") 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:

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

Note: Instrumentation cameras, specified by 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 since 2017;
2. Not used since 2017;
3. Electronic streak cameras having temporal resolution 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;
6. Plug-ins having all of the following characteristics:
   a. Specially designed for instrumentation cameras which have modular structures and which are specified by 6A003.a.; and
   b. Enabling these cameras to meet the characteristics specified by 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 apply to 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 4×10^6 "active pixels" per solid state array for monochrome (black and white) cameras;
      2. More than 4×10^6 "active pixels" per solid state array for colour cameras incorporating three solid state arrays; or
      3. More than 12×10^6 "active pixels" for solid state array colour cameras incorporating one solid state array; and
   b. Having any of the following:
      1. Optical mirrors specified by 6A004.a.;
      2. Optical control equipment specified by 6A004.d.; or
      3. The capability for annotating internally generated 'camera tracking data';

Technical Note:

1. For the purpose 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 purpose 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 apply to scanning cameras, and scanning camera systems, specially designed for any of the following:
   a. Industrial or civilian photocopiers;
   b. Image scanners specially designed for civil, stationary, close proximity scanning applications (e.g. reproduction of images or print contained in documents, artwork or photographs); or
   c. Medical equipment.

3. Imaging cameras incorporating image intensifier tubes specified by 6A002.a.2.a. or 6A002.a.2.b.;
4. 'Imaging cameras' incorporating "focal plane arrays" having any of the following:
   a. Incorporating "focal plane arrays" specified by 6A002.a.3.a. to 6A002.a.3.e.;
   b. Incorporating "focal plane arrays" specified by 6A002.a.3.f.; or
   c. Incorporating "focal plane arrays" specified by 6A002.a.3.g.;

   Note 1: 'Imaging cameras' specified by 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 apply to imaging cameras incorporating linear "focal plane arrays" with 12 elements or fewer, not employing time-delay-and-integration within the element and designed for any of the following:
   a. Industrial or civilian intrusion alarm, traffic or industrial movement control or counting systems;
   b. Industrial equipment used for inspection or monitoring of heat flows in buildings, equipment or industrial processes;
   c. Industrial equipment used for inspection, sorting or analysis of the properties of materials;
   d. Equipment specially designed for laboratory use; or
   e. Medical equipment.

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

a. A maximum frame rate equal to or less than 9 Hz;

b. Having all of the following:

1. Having a minimum horizontal or vertical 'Instantaneous-Field-of-View (IFOV)' of at least 2 mrad (milliradians);

Technical Note:

For the purposes of 6A003.b.4. Note 3.b.a, 'Instantaneous Field of View (IFOV)' specified by 6A003.b.4. Note 3.b. is the lesser figure of the 'Horizontal IFOV' or the Vertical IFOV'.

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

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

2. Incorporating a fixed focal-length lens that is not designed to be removed;

3. Not incorporating a 'direct view' display; and

Technical Note:

For the purposes of 6004.3.b.4. Note 3.b.3., 'Direct view' refers to an imaging camera operating in the infrared spectrum that presents a visual image to a human observer using a near-to-eye micro display incorporating any light-security mechanism.

4. Having any of the following:

a. No facility to obtain a viewable image of the detected field-of-view; or

b. The camera is designed for a single kind of application and designed not to be user modified; or

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

Note 4: 6A003.b.4.c. does not apply to 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; and

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;

c. Limited by design to have a maximum "radiant sensitivity" of 10 mA/W or less for wavelengths exceeding 760 nm, having all of the following:

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

2. Incorporates an active mechanism that forces the camera not to function when the response limiting mechanism is removed; and

3. Not specially designed or modified for underwater use; or

d. Having all of the following:

1. Not incorporating a 'direct view' or electronic image display;

2. Has no facility to output a viewable image of the detected field of view;

3. The "focal plane array" is only operable when installed in the camera for which it was intended; and

4. The "focal plane array" incorporates an active mechanism that forces it to be permanently inoperable when removed from the camera for which it was intended.

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

5. Imaging cameras incorporating solid-state detectors specified by 6A002.a.1.

6A004 Optical equipment and components, as follows:

a. Optical mirrors (reflectors) as follows:

Technical Note:

For the purpose of 6A004.a., Laser Induced Damage Threshold (LIDT) is measured according to ISO 21254-1:2011.

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 "CW laser"; or

2. Greater than 2 J/cm^2 using 20 ns "laser" pulses at 20 Hz repetition rate;

Technical Note:

For the purposes of 6A004.a.1.:

'Deformable mirrors' are mirrors having any of the following:

a. A single continuous optical reflecting surface which is dynamically deformed by the application of individual torques or forces to compensate for distortions in the optical waveform incident upon the mirror; or

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

'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;

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.2. and 6A004.a.3. do not apply to mirrors specially designed to direct solar radiation for terrestrial heliostat installations.

4. Mirrors specially designed for beam steering mirror stages specified by 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 by 6A004.c.1. or 6A004.c.3.;
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 listed in 6A004.e.2. unless the optical element was designed or manufactured with the intent to meet, or exceed, the control parameter.

Note: 6A004.e. does not apply to 'aspheric optical elements' having any of the following:

a. Largest optical-aperture dimension less than 1 m and focal length to aperture ratio equal to or greater than 4.5:1;

b. Largest optical-aperture dimension equal to or greater than 1 m and focal length to aperture ratio equal to or greater than 7:1;

c. Designed as Fresnel, flyeye, stripe, prism or diffractive optical elements;

d. Fabricated from borosilicate glass having a coefficient of linear thermal expansion greater than 2.5 x 10^{-6} /K at 25°C; or

e. An x-ray optical element having inner mirror capabilities (e.g., tube-type mirrors).

N.B.: For 'aspheric optical elements' specially designed for lithography equipment, see 3B001.

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 by 0B001.g.5. or 0B001.h.6., components and optical equipment, as follows:

N.B.: SEE ALSO 6A205.

Note 1: Pulsed "lasers" include those that run in a continuous wave (CW) mode with pulses superimposed.

Note 2: Excimer, semiconductor, chemical, CO, CO_2, and 'non-repetitive pulsed' Nd:glass "lasers" are only specified by 6A005.d.

Technical Note:

For the purposes of 6A005 Note 2.: 'non-repetitive pulsed' refers to "lasers" that produce either a single output pulse or that have a time interval between pulses exceeding one minute.

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 apply to "lasers" as follows:

a. Ruby with output energy below 20 J;

b. Nitrogen;

c. Krypton.

Note 6: 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 of 1.3 or higher.

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 apply to 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;
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 1,000 W; or
      2. Having all of the following:
         a. Output power exceeding 500 W; and
         b. Spectral bandwidth less than 40 GHz; or
   b. 'Multiple transverse mode' output and any of the following:
      1. 'Wall-plug efficiency' exceeding 18% and output power exceeding 1,000 W; or
      2. Output power exceeding 2 kW;

      Note 1: *6A005.a.6.b. does not apply to 'multiple transverse mode', industrial "lasers" with output power exceeding 2 kW and not exceeding 6 kW with a total mass greater than 1,200 kg. For the purpose of this note, total mass includes all components required to operate the "laser", e.g., "laser", power supply, heat exchanger, but excludes external optics for beam conditioning or delivery.*

      Note 2: *6A005.a.6.b. does not apply to 'multiple transverse mode', industrial "lasers" having any of the following:*

         a. Not used since 2018;

         b. Output power exceeding 1 kW but not exceeding 1.6 kW and having a BPP exceeding 1.25 mm•mrad;

         c. Output power exceeding 1.6 kW but not exceeding 2.5 kW and having a BPP exceeding 1.7 mm•mrad;

d. Output power exceeding 2.5 kW but not exceeding 3.3 kW and having a BPP exceeding 2.5 mm•mrad;

e. Output power exceeding 3.3 kW but not exceeding 6 kW and having a BPP exceeding 3.5 mm•mrad;

f. Not used since 2018;

g. Not used since 2018;

h. Output power exceeding 6 kW but not exceeding 8 kW and having a BPP exceeding 12 mm•mrad; or

i. Output power exceeding 8 kW but not exceeding 10 kW and having a BPP exceeding 24 mm•mrad.

Technical Note:

For the purposes of 6A005, 'wall-plug efficiency' is defined as the ratio of "laser" output power (or "average output power") to total electrical input power required to operate the "laser", including the power supply/conditioning and thermal conditioning/heat exchanger.

7. Output wavelength exceeding 1,150 nm but not exceeding 1,555 nm and any of the following:
   a. 'Single transverse mode' and output power exceeding 50 W; or
   b. 'Multiple transverse mode' and output power exceeding 80 W;
8. Output wavelength exceeding 1,555 nm but not exceeding 1,850 nm, and 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 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:
   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 apply to 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;
    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

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 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;

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 apply to dye “lasers” or other liquid lasers, having a multimode output and a wavelength of 150 nm or more but not exceeding 600 nm and all of the following:
1. Output energy less than 1.5 J per pulse or a “peak power” less than 20 W; and
2. Average or CW output power less than 20 W.

2. Output wavelength of 600 nm or more but not exceeding 1,400 nm, and any of the following:
a. Output energy exceeding 1 J per pulse and “peak power” exceeding 20 W; or
b. Average or CW output power exceeding 20 W; or

3. Output wavelength exceeding 1,400 nm and any of the following:
    a. Output energy exceeding 50 mJ per pulse and "peak power" exceeding 1 W; or
    b. Average or CW output power exceeding 1 W;

d. Other "lasers", not specified by 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.*

        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;
        b. Individual multiple-transverse mode semiconductor "lasers" having any of the following:
            1. Wavelength of less than 1,400 nm and average or CW output power exceeding 25 W;
            2. Wavelength equal to or greater than 1,400 nm and less than 1,900 nm and average or CW output power exceeding 2.5 W; or
            3. Wavelength equal to or greater than 1,900 nm and average or CW output power exceeding 1 W;
        c. Individual semiconductor "laser" 'bars', having any of the following:
            1. Wavelength of less than 1,400 nm and average or CW output power exceeding 100 W;
            2. Wavelength equal to or greater than 1,400 nm and less than 1,900 nm and average or CW output power exceeding 25 W; or
            3. Wavelength equal to or greater than 1,900 nm and average or CW output power exceeding 10 W;
        d. Semiconductor "laser" 'stacked arrays' (two-dimensional arrays) having any of the following:
            1. Wavelength less than 1,400 nm and having any of the following:
                a. Average or CW total output power less than 3 kW and having average or CW output 'power density' greater than 500 W/cm^2;
                b. Average or CW total output power equal to or exceeding 3 kW but less than or equal to 5 kW, and having average or CW output 'power density' greater than 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 apply to 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 apply to epitaxially-fabricated monolithic devices.

e. Spatially coherent average or CW total output power exceeding 15 W;

3. Wavelength greater than or equal to 1,900 nm and having any of the following:

a. Average or CW output 'power density' greater than 50 W/cm^2;

b. Average or CW output power greater than 10 W; or

c. Spatially coherent average or CW total output power exceeding 1.5 W; or

4. At least one "laser" 'bar' specified by 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 by 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 by 6A005.d.1.e., that are not designed to be further combined or modified are specified by 6A005.d.1.d.

Note 2: 'Stacked arrays', formed by combining semiconductor "laser" 'stacked arrays' specified by 6A005.d.1.e., that are designed to be further combined or modified are specified by 6A005.d.1.e.

Note 3: 6A005.d.1.e. does not apply to modular assemblies of single 'bars' designed to be fabricated into end-to-end stacked linear arrays.

Technical Notes:

For the purposes of 6A00d.1.e:

1. Semiconductor "lasers" are commonly called "laser" diodes.

2. A 'bar' (also called a semiconductor "laser" 'bar', a "laser" diode 'bar' or diode 'bar') consists of multiple semiconductor "lasers" in a one-dimensional array.

3. A 'stacked array' consists of multiple 'bars' forming a two-dimensional array of semiconductor "lasers".

2. Carbon monoxide (CO) "lasers" having any of the following:
   a. Output energy exceeding 2 J per pulse and "peak power" exceeding 5 kW; or
   b. Average or CW output power exceeding 5 kW;
3. Carbon dioxide (CO_2) "lasers" having any of the following:
   a. CW output power exceeding 15 kW;
   b. Pulsed output with a "pulse duration" exceeding 10 µs and any of the following:
      1. "Average output power" exceeding 10 kW; or
      2. "Peak power" exceeding 100 kW; or
   c. Pulsed output with a "pulse duration" equal to or less than 10 µs and any of the following:
      1. Pulse energy exceeding 5 J per pulse; or
      2. "Average output power" exceeding 2.5 kW;
4. Excimer "lasers" having any of the following:
   a. Output wavelength not exceeding 150 nm and any of the following:
      1. Output energy exceeding 50 mJ per pulse; or
      2. "Average output power" exceeding 1 W;
   b. Output wavelength exceeding 150 nm but not exceeding 190 nm and any of the following:
      1. Output energy exceeding 1.5 J per pulse; or
      2. "Average output power" exceeding 120 W;
   c. Output wavelength exceeding 190 nm but not exceeding 360 nm and any of the following:
      1. Output energy exceeding 10 J per pulse; or
      2. "Average output power" exceeding 500 W; or
   d. Output wavelength exceeding 360 nm and any of the following:
      1. Output energy exceeding 1.5 J per pulse; or
      2. "Average output power" exceeding 30 W;

N.B.: For excimer "lasers" specially designed for lithography equipment, see 3B001.

5. "Chemical lasers" as follows:
   a. Hydrogen Fluoride (HF) "lasers";
   b. Deuterium Fluoride (DF) "lasers";
   c. 'Transfer lasers' as follows:
      1. Oxygen Iodine (O_2-I) "lasers";
      2. Deuterium Fluoride-Carbon dioxide (DF-CO_2) "lasers";

      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 nonlasing 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 by 6A005.e.3.
   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 4.6 kW;
         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:

N.B.: For shared aperture optical elements, capable of operating in "Super-High Power Laser" ("SHPL") applications, see the Munitions List.

1. Not used since 2017;

N.B.: For items previously specified by 6A005.f.1., see 6A004.f.

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, 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 better (less) than 10 MHz;

3. "Laser" wavelengths equal to or exceeding 1,000 nm but not exceeding 2,000 nm;

4. Optical system resolution better (less) than 1 nm; and

5. Optical Signal to Noise ratio equal to or exceeding 10^3.

Technical Note:

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:

Note: 6A006 does not apply to 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 lower (better) than 50 fT (rms) per square root Hz at a frequency of 1 Hz; or

b. SQUID systems having an in-motion-magnetometer ‘sensitivity’ lower (better) than 20 pT (rms) per square root Hz at a frequency of 1 Hz and specially designed to reduce in-motion noise;

2. “Magnetometers” using optically pumped or nuclear precession (proton/Overhauser) “technology” having a ‘sensitivity’ lower (better) than 20 pT (rms) per square root Hz at a frequency of 1 Hz;

3. “Magnetometers” using fluxgate “technology” having a ‘sensitivity’ equal to or lower (better) than 10 pT (rms) per square root Hz at a frequency of 1 Hz;

4. Induction coil “magnetometers” having a ‘sensitivity’ lower (better) than any of the following:

a. 0.05 nT (rms) 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’ lower (better) than 1 nT (rms) per square root Hz;

b. Underwater electric field sensors having a ‘sensitivity’ lower (better) than 8 nanovolt per metre per square root Hz when measured at 1 Hz;

c. “Magnetic gradiometers” as follows:

1. “Magnetic gradiometers” using multiple “magnetometers” specified by 6A006.a.;

2. Fibre optic “intrinsic magnetic gradiometers” having a magnetic gradient field ‘sensitivity’ lower (better) than 0.3 nT/m rms per square root Hz;

3. “Intrinsic magnetic gradiometers”, using “technology” other than fibre-optic “technology”, having a magnetic gradient field ‘sensitivity’ lower (better) than 0.015 nT/m rms per square root Hz;

d. “Compensation systems” for magnetic or underwater electric field sensors resulting in a performance equal to or better than the specified parameters of 6A006.a., 6A006.b. or 6A006.c.

e. Underwater electromagnetic receivers incorporating magnetic field sensors specified by 6A006.a. or underwater electric field sensors specified by 6A006.b.

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:

N.B.: 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 apply to ground gravity meters of the quartz element (Worden) type.

b. Gravity meters designed for mobile platforms and having all of the following:

1. A static "accuracy" of less (better) than 0.7 mGal; and
2. An in-service (operational) "accuracy" of less (better) than 0.7 mGal having a "time to steady-state registration" of less than 2 minutes under any combination of attendant corrective compensations and motional influences;

Technical Note:

For the purposes of 6A007.b.2., 'time-to-steady-state registration' (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.

c. Gravity gradiometers.

6A008 Radar systems, equipment and assemblies, having any of the following, and specially designed components therefor:

N.B.: SEE ALSO 6A108.

Note: 6A008 does not apply to:

a. Secondary surveillance radar (SSR);
b. Civil Automotive Radar;
c. Displays or monitors used for air traffic control (ATC);
d. Meteorological (weather) radar;
e. Precision approach radar (PAR) equipment conforming to ICAO standards and employing electronically steerable linear (1-dimensional) arrays or mechanically positioned passive antennae.

a. Operating at frequencies from 40 GHz to 230 GHz and having any of the following:

1. An average output power exceeding 100 mW; or
2. Locating "accuracy" of 1 m or less (better) in range and 0.2 degree or less (better) in azimuth;

b. A tunable bandwidth exceeding ± 6.25% of the 'centre operating frequency';

Technical Note:

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 (SAR), inverse synthetic aperture (ISAR) radar mode, or sidelooking airborne (SLAR) radar mode;

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;

i. Providing ground-based operation with a maximum 'instrumented range' exceeding 185 km;

Note: 6A008.i. does not apply to:

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 Organisation (IHO) Order 1a Standard (5th Edition February 2008) for Hydrographic Surveys or better, and using one or more "lasers" with a wavelength exceeding 400 nm but not exceeding 600 nm;

Note 1: LIDAR equipment specially designed for surveying is only specified by 6A008.j.3.

Note 2: 6A008.j. does not apply to LIDAR equipment specially designed for meteorological observation.

Note 3: Parameters in the IHO Order 1a Standard 5th Edition February 2008 are summarised as follows:

a. Horizontal Accuracy (95% Confidence Level) = 5 m + 5% of depth

b. *Depth Accuracy for Reduced Depths (95% confidence level) = $\pm\sqrt{(a^2+(b^*d)^2)}$, where:*

a = 0.5 m = constant depth error, i.e. the sum of all constant depth errors

b = 0.013 = factor of depth dependent error

b^*d = depth dependent error, i.e. the sum of all depth dependent errors

d = depth

c. *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 apply to 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 apply to conflict alert capability in ATC systems, or 'marine radar'.

Technical Note:

For the purposes of 6A008.al.a., '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 by 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'.

N.B.: See also Munitions List controls.

Note: 6A008.l. does not apply to systems, equipment and assemblies designed for 'vessel traffic services'.

Technical Notes:

1. *For the purposes of 6A008., 'marine radar' is a radar that is designed to navigate safely at sea, inland waterways or near-shore environments.*
2. *For the purposes of 6A008., '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 by 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) or gravity gradiometers, usable in "missiles", and components for gravity meters and gravity gradiometers, as follows:

a. Gravity meters, other than those specified by 6A007.b, designed or modified for airborne or marine use, and having all of the following characteristics:
   1. A static or operational accuracy equal to or less (better) than 0.7 milligal (mgal); and
   2. A "time to steady-state registration" of two minutes or less;

   Technical Note:

   In Item 6A107.a.2., ''time to steady-state registration' (also referred to as the gravity meter's response time) is the time over which the disturbing effects of platform-induced acceleration (high frequency noise) are reduced.

b. Specially designed components for gravity meters specified by 6A007.b. or 6A107.a..

6A108 Radar systems and tracking systems, other than those specified by entry 6A008, as follows:

a. Radar and laser radar systems designed or modified for use in space launch vehicles specified by 9A004 or sounding rockets specified by 9A104;

   Note: 6A108.a. includes the following:
   - *a. Terrain contour mapping equipment;*
   - *b. Imaging sensor equipment;*
   - *c. Scene mapping and correlation (both digital and analogue) equipment;*
   - *d. Doppler navigation radar equipment.*

b. Precision tracking systems, usable for 'missiles', as follows:
   1. Tracking systems which use a code translator in conjunction with either surface or airborne references or navigation satellite systems to provide real-time measurements of in-flight position and velocity;

2. Range instrumentation radars including associated optical/infrared trackers with all of the following capabilities:
    a. Angular resolution better than 1.5 milliradians;
    b. Range of 30 km or greater with a range resolution better than 10 m rms;
    c. Velocity resolution better than 3 m/s.

Technical Note:

In 6A108.b. 'missile' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.

6A202 Photomultiplier tubes having both of the following characteristics:

a. Photocathode area of greater than 20 cm^2; and

b. Anode pulse rise time of less than 1 ns.

6A203 High-speed cameras and imaging devices and components therefor, other than those specified by 6A003, as follows:

N.B.: "Software" specially designed to enhance or release the performance of cameras or imaging devices to meet the characteristics below is controlled in 6D201 and 6D202.

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 by 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 by 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 50ns or less specially designed for cameras specified by 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 by 6A203.b.1. or 6A203.b.2.

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 by 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.

Technical Note:

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.

6A204 Radiation-hardened TV cameras, or lenses thereof, specially designed or rated as radiation hardened to withstand a total radiation dose greater than 5×10^4 'Gy (silicon)' without operational degradation.

Technical Note:

In 6A204, 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 by 0B001.g.5., 0B001.h.6. and 6A005; as follows:

N.B.: 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 apply to single mode oscillators.

d. Pulsed carbon dioxide "lasers" having all of the following characteristics:
   1. Operating at wavelengths between 9,000 nm and 11,000 nm;
   2. A repetition rate greater than 250 Hz;
   3. An average output power greater than 500 W; and
   4. Pulse width of less than 200 ns;

e. Para-hydrogen Raman shifters designed to operate at 16 micrometre output wavelength and at a repetition rate greater than 250 Hz;

f. Neodymium-doped (other than glass) “lasers” with an output wavelength between 1000 and 1100 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 40 W; 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 lasers, other than those specified by 6A005.d.2., having all of the following characteristics:

1. Operating at wavelengths between 5000 and 6000 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.

N.B.: SEE ALSO 6A005.d.2.

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) and PDV (Photonic Doppler Velocimeters) also known as Het-V (Heterodyne 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 by 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 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 apply to 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.

N.B.: SEE ALSO 6B108.

6B108 Systems, other than those specified by 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) of purity levels of 99.9995% or more;

b. Single crystals (including epitaxial wafers) of any of the following:

1. Cadmium zinc telluride (CdZnTe), with zinc content of less than 6% by 'mole fraction';
2. Cadmium telluride (CdTe) of any purity level; or
3. Mercury cadmium telluride (HgCdTe) of any purity level.

Technical Note:

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 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); or
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); or
5. Gallium selenide (GaSe) (CAS 12024-11-2);

c. Non-linear optical materials, other than those specified by 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 3.3×10^{-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:

a. Titanium doped sapphire;

b. Not used;

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 apply to 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 'NA' less than 0.1.

Technical Notes:

1. For the purposes of 6C005., the core 'Numerical Aperture' ('NA') is measured at the emission wavelengths of the fibre.

2. 6C005.b. includes fibres assembled with end caps.

6D Software

6D001 "Software" specially designed for the "development" or "production" of equipment specified by 6A004, 6A005, 6A008 or 6B008.

6D002 "Software" specially designed for the "use" of equipment specified by 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 by 6A001.a.1.e.; and
    b. Automatically detecting, classifying and determining the location of divers or swimmers;

    N.B.: *For diver detection “software” or “source code”, specially designed or modified for military use, see the Munitions List controls.*

b. Not used;

c. “Software” designed or modified for cameras incorporating “focal plane arrays” specified by 6A002.a.3.f. and designed or modified to remove a frame rate restriction and allow the camera to exceed the frame rate specified by 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 by 6A006.e.;
4. “Source code” for “real-time processing” of electromagnetic data using underwater electromagnetic receivers specified by 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” application “programs” 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 phased array antennae specified by 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 by 6A108.

6D103 "Software" which processes post-flight, recorded data, enabling determination of vehicle position throughout its flight path, specially designed or modified for 'missiles'.

Technical Note:

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

6D201 "Software" or encryption keys/codes specially designed to enhance or release the performance characteristics of equipment not controlled in 6A203 so that it meets or exceeds the characteristics specified by 6A203.

6D202 "Software" or encryption keys/codes specially designed to enhance or release the performance characteristics of equipment controlled in 6A203.

6E Technology

6E001 "Technology" according to the General Technology Note for the "development" of equipment, materials or "software" specified by 6A, 6B, 6C or 6D.

6E002 "Technology" according to the General Technology Note for the "production" of equipment, materials or software specified by 6A, 6B, 6C, 6D201 or 6D202.

6E003 Other "technology" as follows:

a. Not used;

b. Not used;

c. Not used;

d. "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 x 10^{-3};

N.B.: See also 2E003.f.

Technical Note:

For the purposes of 6E003.d.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 better than 10 nm rms on non-planar surfaces exceeding 0.5 m^2;

e. "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 by 6A102, 6A107, 6A108, 6B108, 6D102 or 6D103.

Note: 6E101 only specifies "technology" for equipment specified by 6A008 when it is designed for airborne applications and is usable in "missiles".

6E201 "Technology" according to the General Technology Note for the "use" of equipment or "software" specified by 6A202, 6A203, 6A205, 6A225, 6A226, 6D201 or 6D202.

7A Systems, Equipment and Components

N.B.: For automatic pilots for underwater vehicles, see Category 8. For radar, see Category 6.

7A001 Accelerometers as follows and specially designed components therefor:

N.B.: SEE ALSO 7A101.

N.B.: 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 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 apply to accelerometers limited to measurement of only vibration or shock.

b. Angular or rotational accelerometers, specified to function at linear acceleration levels exceeding 100 g.

7A002 Gyros or angular rate sensors, having any of the following and specially designed components therefor:

N.B.: SEE ALSO 7A102.

N.B.: 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 apply to "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 apply to "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:

N.B.: 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 Wassenaar Arrangement Participating States.

Technical Notes:

1. For the purposes of 7A003., '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:

a. Attitude and Heading Reference Systems (AHRSs);

b. Gyrocompasses;

c. Inertial Measurement Units (IMUs);

d. Inertial Navigation Systems (INSs);

e. Inertial Reference Systems (IRSs);

f. 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% distance 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';

Technical Note:

For the purposes of 7A003.b., this entry 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.

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);

d. Providing acceleration measurements or angular rate measurements, in more than one dimension, and having any of the following:

1. Performance specified by 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 apply to 'inertial measurement equipment or systems' that contain "spinning mass gyros" as the only type of gyro.

7A004 'Star trackers' and components therefor, as follows:

N.B.: 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 by 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:

N.B.: SEE ALSO 7A105.

N.B.: 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 apply to "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:

N.B.: 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 apply to systems specially designed for installation on surface vessels or systems requiring acoustic beacons or buoys to provide positioning data.

N.B.: See 6A001.a. for acoustic systems, and 6A001.b. for correlation-velocity and Doppler-velocity sonar log equipment. See 8A002 for other marine systems.

7A101 Linear accelerometers, other than those specified by 7A001, designed for use in inertial navigation systems or in guidance systems of all types, usable in 'missiles', having all the following characteristics, and specially designed components therefor:

a. A "bias" "repeatability" of less (better) than 1250 micro g; and

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

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

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 a 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 by 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 paragraph 2.247).*
3. *In 7A102 'drift rate' is defined as the component of gyro output that is functionally independent of input rotation and is expressed as an angular rate. (IEEE STD 528-2001 paragraph 2.56).*

7A103 Instrumentation, navigation equipment and systems, other than those specified by 7A003, as follows; and specially designed components therefor:

a. 'Inertial measurement equipment or systems', using accelerometers or gyros as follows:
   1. Accelerometers specified by 7A001.a.3., 7A001.b. or 7A101 or gyros specified by 7A002 or 7A102;
   2. Accelerometers specified by 7A001.a.1. or 7A001.a.2. and having all of the following:
      a. Designed for use in inertial navigation systems or in guidance systems of all types and usable in 'missiles';
      b. A "bias" "repeatability" of less (better) than 1250 micro g; and
      c. A "scale factor" "repeatability" of less (better) than 1250 ppm;

Note 1: 7A103.a includes:
- *a. Attitude and Heading Reference Systems (AHRSs);*
- *b. Gyrocompasses;*
- *c. Inertial Measurement Units (IMUs);*
- *d. Inertial Navigation Systems (INSs);*
- *e. Inertial Reference Systems (IRSs);*
- *f. Inertial Reference Units (IRUs).*

Note 2: 7A103.a does not specify equipment containing accelerometers specified by 7A001 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 by 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.

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 "Circular Error Probable" ("CEP") or less;

Technical Note:

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

1. *An inertial measurement device (e.g., an attitude and heading reference system, inertial reference unit, or inertial navigation system);*
2. *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*
3. *Integration hardware and software;*

d. Three axis magnetic heading sensors, designed or modified to be integrated with flight control and navigation systems, having all the following characteristics, and specially designed components therefor;

1. Internal tilt compensation in pitch (± 90 degrees) and roll (± 180 degrees) axes;
2. Capable of providing 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 by 7A004, which derive position or orientation by means of automatically tracking celestial bodies or satellites and specially designed components therefor.

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

a. Designed or modified for use in space launch vehicles specified by 9A004, unmanned aerial vehicles specified by 9A012 or 9A112.a or sounding rockets specified by 9A104; or

b. Designed or modified for airborne applications and having any of the following:

1. Capable of providing navigation information at speeds in excess of 600 m/s;
2. Employing decryption, designed or modified for military or governmental services, to gain access to GNSS secured signal/data; or

3. Being specially designed to employ anti-jam features (e.g. null steering antenna or electronically steerable antenna) to function in an environment of active or passive countermeasures.

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

7A106 Altimeters, other than those specified by 7A006, of radar or laser radar type, designed or modified for use in space launch vehicles specified by 9A004 or sounding rockets specified by 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 by 9A004 or sounding rockets specified by 9A104.

Note: 7A115 includes sensors for the following equipment:

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 by 9A004 or sounding rockets specified by 9A104.

a. Pneumatic, hydraulic, mechanical, electro-optical, or electromechanical 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 by 7A116.a. or 7A116.b., and designed or modified to operate in a vibration environment greater than 10 g rms between 20 Hz and 2 kHz.

7A117 "Guidance sets", usable in "missiles" capable of achieving system accuracy of 3.33% or less of the range (e.g., a 'CEP' of 10 km or less at a range of 300 km).

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 by 7A.

Note: 7B001 does not apply to test, calibration or alignment equipment for 'Maintenance Level I' or 'Maintenance Level II'.

Technical Notes:

For the purposes of 7B001:

1. *'Maintenance Level I'*
   The failure of an inertial navigation unit is detected on the "aircraft" by indications from the Control and Display Unit (CDU) or by the status message from the corresponding sub-system. By following the manufacturer's manual, the cause of the failure may be localised at the level of the malfunctioning Line Replaceable Unit (LRU). The operator then removes the LRU and replaces it with a spare.
2. *'Maintenance Level II'*
   The defective LRU is sent to the maintenance workshop (the manufacturer's or that of the operator responsible for level II maintenance). At the maintenance workshop, the malfunctioning LRU is tested by various appropriate means to verify and localise the defective Shop Replaceable Assembly (SRA) module responsible for the failure. This SRA is removed and replaced by an operative spare. The defective SRA (or possibly the complete LRU) is then shipped to the manufacturer. 'Maintenance Level II' does not include the disassembly or repair of controlled accelerometers or gyro sensors.

7B002 Equipment specially designed to characterise mirrors for ring "laser" gyros, as follows:

N.B.: SEE ALSO 7B102.

a. Scatterometers having a measurement "accuracy" of 10 ppm or less (better);

b. Profilometers having a measurement "accuracy" of 0.5 nm (5 angstrom) or less (better).

7B003 Equipment specially designed for the "production" of equipment specified by 7A.

Note: 7B003 includes:
- *a. Gyro tuning test stations;*
- *b. Gyro dynamic balance stations;*
- *c. Gyro run-in/motor test stations;*
- *d. Gyro evacuation and fill stations;*
- *e. Centrifuge fixtures for gyro bearings;*
- *f. Accelerometer axis align stations;*
- *g. 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 by 7A117;

b. "Production equipment", and other test, calibration and alignment equipment, other than that specified by 7B001 to 7B003, designed or modified to be used with equipment specified by 7A.

Note: 7B103.b includes:
- *a. Inertial Measurement Unit (IMU) Module Testers;*
- *b. IMU Platform Testers;*

c. IMU Stable Element Handling Fixtures;
d. IMU Platform Balance Fixtures;
e. Accelerometer Test Stations.

7C Materials

None.

7D Software

7D001 "Software" specially designed or modified for the "development" or "production" of equipment specified by 7A. or 7B.

7D002 "Source code" for the operation or maintenance of any inertial navigation equipment, including inertial equipment not specified by 7A003 or 7A004, or Attitude and Heading Reference Systems ('AHRS').

Note: 7D002 does not apply to "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 by 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 by 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;

N.B.: For flight control "source code", see 7D004.

e. Computer-Aided-Design (CAD) "software" specially designed for the "development" of "active flight control systems", helicopter multi-axis fly-by-wire or fly-by-light controllers or helicopter "circulation controlled anti-torque or circulation-controlled direction control systems", whose "technology" is specified by 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 by 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 apply to "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 by 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 by 7A103.b.;

b. Integration "software" specially designed for the equipment specified by 7A003 or 7A103.a.

c. Integration "software" designed or modified for the equipment specified by 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 by 7A117 or for their design integration with the space launch vehicles specified by 9A004 or sounding rockets specified by 9A104.

Note: *"Software" specified by 7D103 remains controlled when combined with specially designed hardware specified by 4A102*.

7E Technology

7E001 "Technology" according to the General Technology Note for the "development" of equipment or "software", specified by 7A, 7B or 7D001., 7D002., 7D003. or 7D005.

Note: *7E001. includes key management "technology" exclusively for equipment specified by 7A005.a.*

7E002 "Technology" according to the General Technology Note for the "production" of equipment specified by 7A or 7B.

7E003 "Technology" according to the General Technology Note for the repair, refurbishing or overhaul of equipment specified by 7A001 to 7A004.

Note: *7E003 does not apply to "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'.*

N.B.: *See Technical Notes to 7B001.*

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';

   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 analyze 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 include algorithms for the 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 include 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 apply to:*

   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 VOR, DME, ILS or 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;

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 destabilizing shifts in cargo load.

      3. Performs the functions specified by 7E004.b.5.; or

         Note: *7E004.b.7.b.3. does not apply to 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 $1x10^{-9}$ failures per flight hour;

Note: 7E004.b. does not apply to "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 airfoils', for use in systems using individual blade control.

Technical Note:

For the purposes of 7E004.c.3., 'variable geometry airfoils' 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 or software specified by 7A101 to 7A106, 7A115 to 7A117, 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.

8A Systems, Equipment and Components

8A001 Submersible vehicles and surface vessels, as follows:

N.B.: For the control status of equipment for submersible vehicles, see:
a. Not used;
b. Category 6 for sensors;
c. Categories 7 and 8 for navigation equipment;
d. Category 8A for underwater equipment.

a. Manned, tethered submersible vehicles designed to operate at depths exceeding 1,000 m;

b. Manned, untethered submersible vehicles having any of the following:
1. Designed to 'operate autonomously' and having a lifting capacity of all the following:
a. 10% or more of their weight in air; and
b. 15 kN or more;
2. Designed to operate at depths exceeding 1,000 m; or
3. Having all of the following:
a. Designed to 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, sea-bed or shore, and containing a propulsion system for submerged or surface use.

2. For the purposes of 8A001.b., 'range' means half the maximum distance a submersible vehicle can '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;
b. Acoustic data or command link; or
c. Wireless optical data or command link exceeding 1,000 m;
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; and
c. Having any of the following:
1. Designed for self-propelled manoeuvre using propulsion motors or thrusters specified by 8A002.a.2.; or
2. Fibre optic data link;

d. Not used since 2018;

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:

N.B.: For underwater communications systems, see Category 5, Part 1 — Telecommunications.

a. Systems, equipment and components, specially designed or modified for submersible vehicles and designed to operate at depths exceeding 1,000 m, as follows:

1. Pressure housings or pressure hulls with a maximum inside chamber diameter exceeding 1.5 m;

2. Direct current propulsion motors or thrusters;

3. Umbilical cables, and connectors therefor, using optical fibre and having synthetic strength members;

4. Components manufactured from material specified by 8C001;

Technical Note:

For the purposes of 8A002.a.4., this entry should not be defeated by the export of 'syntactic foam' specified by 8C001 when an intermediate stage of manufacture has been performed and it is not yet in the final component form.

b. Systems specially designed or modified for the automated control of the motion of submersible vehicles specified by 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;

c. Fibre optic pressure hull penetrators;

d. Underwater vision systems having all of the following:

1. Specially designed or modified for remote operation with an underwater vehicle; and

2. Employing any of the following techniques to minimise the effects of back scatter:

a. Range-gated illuminators; or

b. Range-gated laser systems;

e. Not used;

f. Not used;

g. Light systems specially designed or modified for underwater use, as follows:

1. Stroboscopic light systems capable of a light output energy of more than 300 J per flash and a flash rate of more than 5 flashes per second;

2. Argon arc light systems specially designed for use below 1,000 m;

h. "Robots" specially designed for underwater use, controlled by using a dedicated computer and having any of the following:

1. Systems that control the "robot" using information from sensors which measure force or torque applied to an external object, distance to an external object, or tactile sense between the "robot" and an external object; or

2. The ability to exert a force of 250 N or more or a torque of 250 Nm or more and using titanium based alloys or "composite" "fibrous or filamentary materials" in their structural members;

i. Remotely controlled articulated manipulators specially designed or modified for use with submersible vehicles and having any of the following:

1. Systems which control the manipulator using information from sensors which measure any of the following:

a. Torque or force applied to an external object; or

b. Tactile sense between the manipulator and an external object; or

2. Controlled by proportional master-slave techniques and having 5 degrees of 'freedom of movement' or more;

Technical Note:

For the purposes of 8A002.i.2., only functions having proportional related motion control using positional feedback are counted when determining the number of degrees of 'freedom of movement'.

j. Air independent power systems specially designed for underwater use, as follows:

1. Brayton or Rankine cycle engine air independent power systems having any of the following:

a. Chemical scrubber or absorber systems, specially designed to remove carbon dioxide, carbon monoxide and particulates from recirculated engine exhaust;

b. Systems specially designed to use a monoatomic gas;

c. Devices or enclosures, specially designed for underwater noise reduction in frequencies below 10 kHz, or special mounting devices for shock mitigation; or

d. Systems having all of the following:

1. Specially designed to pressurise the products of reaction or for fuel reformation;

2. Specially designed to store the products of the reaction; and

3. Specially designed to discharge the products of the reaction against a pressure of 100 kPa or more;

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

k. Not used;

l. Not used;

m. Not used;

n. Not used;

o. Propellers, power transmission systems, power generation systems and noise reduction systems, 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 engines with a power output exceeding 2.5 MW;
        c. "Superconductive" propulsion engines or permanent magnet electric propulsion engines, with a power output exceeding 0.1 MW;

d. Power transmission shaft systems incorporating "composite" material components and capable of transmitting more than 2 MW;

e. Ventilated or base-ventilated propeller systems, rated at more than 2.5 MW;

3. Noise reduction systems designed for use on vessels of 1,000 tonnes displacement or more, as follows:

a. Systems that attenuate underwater noise at frequencies below 500 Hz and consist of compound acoustic mounts for the acoustic isolation of diesel engines, diesel generator sets, gas turbines, gas turbine generator sets, propulsion motors or propulsion reduction gears, specially designed for sound or vibration isolation and having an intermediate mass exceeding 30% of the equipment to be mounted;

b. 'Active noise reduction or cancellation systems' or magnetic bearings, specially designed for power transmission systems;

Technical Note:

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 apply to individual rebreathers for personal use when accompanying their users.*

N.B.: *For equipment and devices specially designed for military use, see ML17.a. on the Munitions List.*

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 apply to 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:

N.B.: 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 by 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 by 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 by 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;
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 2x (displaced volume at the operational design draft)$^{2/3}$.

9A Systems, Equipment and Components

N.B.: For propulsion systems designed or rated against neutron or transient ionising radiation, see the Munitions List.

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

N.B.: SEE ALSO 9A101.

a. Incorporating any of the "technologies" specified by 9E003.a., 9E003.h. or 9E003.i.;

Note 1: 9A001.a. does not apply to aero gas turbine engines which meet all of the following:

a. Certified by the civil aviation authorities of one or more 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 Wassenaar Arrangement Participating State for the aircraft with this specific engine type:

1. A civil type certificate; or

2. An equivalent document recognised by the International Civil Aviation Organisation (ICAO).

Note 2: 9A001.a. does not apply to aero gas turbine engines designed for Auxiliary Power Units (APUs) approved by the civil aviation authorities of one or more Wassenaar Arrangement Participating States.

b. Not used since 2022

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 by 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 by 9E003.a., 9E003.h. or 9E003i., or 9E003.k., for any of the following gas turbine engine propulsion systems:

a. Specified by 9A001; or

b. Whose design or production origins are either not from a Wassenaar Arrangement Participating State or unknown to the manufacturer.

9A004 Space launch vehicles, "spacecraft", "spacecraft buses", "spacecraft payloads", "spacecraft" on-board systems or equipment, terrestrial equipment, and air-launch platforms and "sub-orbital craft", as follows:

N.B.: SEE ALSO 9A104.

a. Space launch vehicles;

b. "Spacecraft";

c. "Spacecraft buses";

d. "Spacecraft payloads" incorporating items specified by 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: For the purpose of 9A004.e.1., 'command and telemetry data handling' includes bus data management, storage, and processing.

2. 'Payload data handling'; or

Note: For the purpose of 9A004.e.2., 'payload data handling' includes payload data management, storage, and processing.

3. 'Attitude and orbit control';

Note: For the purpose of 9A004.e.3., 'attitude and orbit control' includes sensing and actuation to determine and control the position and orientation of a "spacecraft".

N.B.: For equipment specially designed for military use, see ML 11.c.

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;

h. "Sub-orbital craft".

Note: *Certain items specified in 9A004. may be subject to the MTCR Guidelines for Sensitive Missile-Relevant Transfers.*

9A005 Liquid rocket propulsion systems containing any of the systems or components, specified by 9A006.

N.B.: SEE ALSO 9A105 AND 9A119.

Note: *Certain items specified in 9A005 may be subject to the MTCR Guidelines for Sensitive Missile-Relevant Transfers.*

9A006 Systems and components, specially designed for liquid rocket propulsion systems, as follows:

N.B.: SEE ALSO 9A106, 9A108 AND 9A120.

a. Cryogenic refrigerators, flightweight dewars, cryogenic heat pipes or cryogenic systems, specially designed for use in space vehicles and capable of restricting cryogenic fluid losses to less than 30% per year;

b. Cryogenic containers or closed-cycle refrigeration systems, capable of providing temperatures of 100 K (-173°C) or less for "aircraft" capable of sustained flight at speeds exceeding Mach 3, launch vehicles or "spacecraft";

c. Slush hydrogen storage or transfer systems;

d. High pressure (exceeding 17.5 MPa) turbo pumps, pump components or their associated gas generator or expander cycle turbine drive systems;

e. High-pressure (exceeding 10.6 MPa) thrust chambers and nozzles therefor;

f. Propellant storage systems using the principle of capillary containment or positive expulsion (i.e., with flexible bladders);

g. Liquid propellant injectors with individual orifices of 0.381 mm or smaller in diameter (an area of 1.14×10^{-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:

N.B.: 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 by 9A008; or

e. Insulation and propellant bonding systems, using direct-bonded motor designs to provide a 'strong mechanical bond' or a barrier to chemical migration between the solid propellant and case insulation material.

Technical Note:

For the purposes of 9A007.e., a 'strong mechanical bond' means bond strength equal to or more than propellant strength.

9A008 Components specially designed for solid rocket propulsion systems, as follows:

N.B.: SEE ALSO 9A108.

a. Insulation and propellant bonding systems, using liners to provide a 'strong mechanical bond' or a barrier to chemical migration between the solid propellant and case insulation material;

Technical Note:

'Strong mechanical bond' means bond strength equal to or more than propellant strength.

b. Filament-wound "composite" motor cases exceeding 0.61 m in diameter or having 'structural efficiency ratios (PV/W)' exceeding 25 km;

Technical Note:

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:

a. Total impulse capacity exceeding 1.1 MNs; or

b. Thrust levels exceeding 220 kN in vacuum exit conditions.

9A010 Specially designed components, systems and structures, for launch vehicles, launch vehicle propulsion systems or "spacecraft", as follows:

N.B.: SEE ALSO 1A002 AND 9A110.

a. Components and structures, each exceeding 10 kg and specially designed for launch vehicles manufactured using any of the following:

1. "Composite" materials consisting of "fibrous or filamentary materials" specified by 1C010.e. and resins specified by 1C008. or 1C009.b.;

2. Metal "matrix" "composites" reinforced by any of the following:

a. Materials specified by 1C007.;

b. "Fibrous or filamentary materials" specified by 1C010.; or

c. Aluminides specified by 1C002.a.; or

3. Ceramic “matrix” “composite” materials specified by 1C007.;

Note: The weight cut-off is not relevant for nose cones.

b. Components and structures, specially designed for launch vehicle propulsion systems specified by 9A005 to 9A009 manufactured using any of the following:

1. “Fibrous or filamentary materials” specified by 1C010.e. and resins specified by 1C008. or 1C009.b.;

2. Metal “matrix” “composite” materials reinforced by any of the following:

a. Materials specified by 1C007;

b. “Fibrous or filamentary materials” specified by 1C010; or

c. Aluminides specified by 1C002.a.; or

3. Ceramic “matrix” “composite” materials specified by 1C007;

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.

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).*

N.B.: SEE ALSO 9A111 AND 9A118.

9A012 “Unmanned aerial vehicles” (“UAVs”), unmanned “airships”, related equipment and components, as follows:

N.B.: 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;

Technical Notes:

1. For the purposes of 9A012.a., ‘operator’ is a person who initiates or commands the “UAV” or unmanned “airship” flight.

2. *For the purposes of 9A012.a., 'endurance' is to be calculated for ISA conditions (ISO 2533:1975) at sea level in zero wind.*

3. *For the purposes of 9A012.a., '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" to a "UAV" or unmanned "airship", specified by 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).

Note: *Certain items specified in 9A012 may be subject to the MTCR Guidelines for Sensitive Missile-Relevant Transfers.*

9A101 Turbojet and turbofan engines, as follows:

a. Engines having all of the following characteristics:

1. 'Maximum thrust value' greater than 400 N (achieved un-installed) excluding civil certified engines with a 'maximum thrust value' greater than 8.89 kN (achieved un-installed);

2. Specific fuel consumption of 0.15 kg N^{-1} h^{-1} or less (at maximum continuous power at sea level static conditions using the ICAO standard atmosphere);

3. 'Dry weight' less than 750 kg; and

4. 'First-stage rotor diameter' less than 1 m;

b. Engines designed or modified for use in "missiles", or in other "unmanned aerial vehicles" capable of a range exceeding 300 km, regardless of thrust, specific fuel consumption, 'dry weight' or 'first-stage rotor diameter'.

Technical Notes:

1. *In 9A101, '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.*

2. '*Dry weight*' *is the weight of the engine without fluids (fuel, hydraulic fluid, oil, etc.) and does not include the nacelle (housing).*

3. '*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.*

9A102 'Turboprop engine systems' specially designed for "unmanned aerial vehicles" capable of a range exceeding 300 km, and specially designed components therefor, having a 'maximum power' greater than 10 kW.

Note: *9A102 does not apply to civil certified engines.*

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 uninstalled at sea level static conditions using the ICAO standard atmosphere.

9A104 Sounding rockets, capable of a range of at least 300 km.

N.B.: SEE ALSO 9A004.

Note: Certain items specified in 9A104 may be subject to the MTCR Guidelines for Sensitive Missile-Relevant Transfers.

9A105 Liquid propellant rocket engines or gel propellant rocket motors integrated, or designed or modified to be integrated, into a liquid or gel propellant rocket system, as follows:

N.B.: SEE ALSO 9A119.

a. Engines or motors usable in "missiles", other than those specified by 9A005, having a total impulse capacity equal to or greater than 1.1 MNs;

b. Engines or motors, usable in complete rocket systems or unmanned aerial vehicles, capable of a range of 300 km, other than those specified by 9A005 or 9A105.a., having a total impulse capacity equal to or greater than 0.841 MNs.

Note: Certain items specified in 9A105 may be subject to the MTCR Guidelines for Sensitive Missile-Relevant Transfers.

9A106 Systems or components, other than those specified by 9A006 as follows, specially designed for liquid or gel propellant propulsion systems:

a. Combustion chambers, usable in "missiles", space launch vehicles specified in 9A004 or sounding rockets specified in 9A104;

b. Rocket nozzles, usable in "missiles", space launch vehicles specified in 9A004 or sounding rockets specified in 9A104;

c. Thrust vector control sub-systems, usable in "missiles";

Technical Note:

Examples of methods of achieving thrust vector control specified by 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 by 9A106.d., are the following:

a. Servo valves designed for flow rates equal to or greater than 24 litres per minute, at an absolute pressure equal to or greater than 7 MPa, that have an actuator response time of less than 100 ms;

b. Pumps, for liquid propellants, with shaft speeds equal to or greater than 8,000 r.p.m. at the 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 rpm at the maximum operating mode.

Note: Certain items specified in 9A106 may be subject to the MTCR Guidelines for Sensitive Missile-Relevant Transfers.

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 by 9A007, having total impulse capacity equal to or greater than 0.841 MNs.

N.B.: SEE ALSO 9A119.

9A108 Components, other than those specified by 9A008, as follows, specially designed for solid rocket propulsion systems:

a. Rocket motor cases and "insulation" components therefor, usable in rocket motors specified by 9A107;

b. Rocket nozzles, usable in rocket engines or rocket motors specified by 9A107;

c. Thrust vector control sub-systems, usable in "missiles".

Technical Note:

Examples of methods of achieving thrust vector control specified by 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, other than those specified by 9A009, and specially designed components thereof, as follows:

a. Hybrid rocket motors usable in complete rocket systems or "unmanned aerial vehicles" capable of a range exceeding 300 km, having a total impulse capacity equal to or greater than 0.841 MNs, but less than 1.1 MNs;

b. Specially designed components for hybrid rocket motors specified by 9A109.a.

N.B.: SEE ALSO 9A009 AND 9A119.

9A110 Composite structures, laminates and manufactures thereof, other than those specified by 9A010, specially designed for use in 'missiles' or the subsystems specified by 9A005, 9A007, 9A105, 9A106.c., 9A107, 9A108.c., 9A116 or 9A119.

N.B.: 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 by 9A012, and specially designed components therefor.

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.

N.B.: SEE ALSO 9A011 AND 9A118.

9A112 "Unmanned aerial vehicles" ("UAVs"), other than those specified by 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.

Note: Certain items specified in 9A112 may be subject to the MTCR Guidelines for Sensitive Missile-Relevant Transfers.

9A115 Launch support equipment as follows:

a. Apparatus and devices for handling, control, activation or launching, designed or modified for space launch vehicles specified by 9A004, unmanned aerial vehicles capable of a range exceeding 300 km or sounding rockets specified by 9A104;

Note: Apparatus and devices specified in (A115.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 by 9A004 or sounding rockets specified by 9A104.

9A116 Re-entry vehicles, usable in "missiles", and equipment designed or modified therefor, as follows:

a. Re-entry 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 re-entry vehicles.

9A117 Staging mechanisms, separation mechanisms, and interstages, usable in "missiles".

N.B.: SEE ALSO 9A121.

9A118 Devices to regulate combustion, usable in engines, which are usable in "missiles" or unmanned aerial vehicles specified by 9A012, 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 by 9A005, 9A007, 9A009, 9A105, 9A107 and 9A109.

Note: Certain items specified in 9A119 may be subject to the MTCR Guidelines for Sensitive Missile-Relevant Transfers.

9A120 Liquid or gel propellant tanks, other than those specified by 9A006, specially designed for propellants specified by 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 Munitions List.

9A121 Umbilical and interstage electrical connectors specially designed for "missiles".

Technical Note:

Interstage connectors in 9A121 also include electrical connectors installed between a "missile" and its 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 by 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.

Note: 9A350 does not apply to 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

9B001 Manufacturing equipment, tooling or fixtures, as follows:

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 by 9E003.h. or 9E003.i.

9B003 Equipment specially designed for the "production" or test of gas turbine brush seals designed to operate at tip speeds exceeding 335 m/s and temperatures in excess of 773 K (500°C), and specially designed components or accessories therefor.

9B004 Tools, dies or fixtures, for the solid state joining of "superalloy", titanium or intermetallic airfoil-to-disk combinations described in 9E003.a.3. or 9E003.a.6. for gas turbines.

9B005 On-line (real time) control systems, instrumentation (including sensors) or automated data acquisition and processing equipment, specially designed for use with any of the following:

N.B.: 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 x 10^6.

9B006 Acoustic vibration test equipment capable of producing sound pressure levels of 160 dB or more (referenced to 20 μPa) with a rated output of 4 kW or more at a test cell temperature exceeding 1,273 K (1,000°C), and specially designed quartz heaters therefor.

N.B.: SEE ALSO 9B106.

9B007 Equipment specially designed for inspecting the integrity of rocket motors and using Non-Destructive Test (NDT) techniques other than planar x-ray or basic physical or chemical analysis.

9B008 Transducers specially designed for the direct measurement of the wall skin friction of the test flow with a stagnation temperature exceeding 833 K (560°C).

9B009 Tooling specially designed for producing 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 (UTS) 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 specify tooling for the production of powder.*

9B010 Equipment specially designed for the "production" of items specified by 9A012.

9B105 'Aerodynamic test facilities' for speeds of Mach 0.9 or more, other than those specified by 9B005, usable for 'missiles' and their subsystems.

N.B.: SEE ALSO 9B005.

Note: *9B105 does not apply to wind-tunnels for speeds of Mach 3 or less with dimension of the 'test cross section size' equal to or less than 250 mm.*

Technical Notes:

1. In 9B105 'missile' means complete rocket systems or "unmanned aerial vehicle" capable of a range exceeding 300 km.

2. 'Aerodynamic test facilities' includes wind tunnels and shock tunnels for the study of airflow over objects.

3. *'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.*

9B106 Environmental chambers and anechoic chambers, as follows:

a. Environmental chambers capable of simulating all the following flight conditions:

1. Having any of the following:

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);

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 by 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' or their subsystems, 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.

Technical notes:

1. In 9B107 'missile' means complete rocket systems capable of a range exceeding 300km.

2. *In 9B107 'aerothermodynamic test facilities' include plasma arc jet facilities and plasma wind tunnels for the study of thermal and mechanical effects of airflow on objects.*

9B115 Specially designed "production equipment" for the systems, sub-systems and components specified by 9A005 to 9A009, 9A011, 9A101, 9A102, 9A105 to 9A109, 9A111, 9A116 to 9A120.

9B116 Specially designed "production facilities" for the space launch vehicles specified by 9A004, or systems, sub-systems, and components specified by 9A005 to 9A009, 9A011, 9A101, 9A102, 9A104 to 9A109, 9A111, 9A116 to 9A120, or complete rocket systems or "unmanned aerial vehicles" capable of a range exceeding 300 km.

9B117 Test benches and test stands for solid or liquid propellant rockets or rocket motors, having either of the following characteristics:

a. The capacity to handle more than 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 by 9A008, for rocket motor cases usable in "missiles" or specially designed for 'missiles'.

Technical Note:

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

9C110 Resin impregnated fibre prepregs and metal coated fibre preforms therefor, for composite structures, laminates and manufactures specified by 9A110, made either with organic matrix or metal matrix utilising fibrous or filamentary reinforcements having a "specific tensile strength" greater than 7.62×10^4 m and a "specific modulus" greater than 3.18×10^6 m.

N.B.: SEE ALSO 1C010 AND 1C210.

Note: The only resin impregnated fibre prepregs specified by 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 by 9A001 to 9A121, 9B or 9E003.

9D002 "Software", not specified in 9D003 or 9D004, specially designed or modified for the "production" of equipment specified by 9A001 to 9A121 or 9B.

9D003 "Software" incorporating "technology" specified by 9E003.h. and used in "FADEC systems" for systems specified by 9A or equipment specified by 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;

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 by 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 by 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 specify 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 by 9B001.a. or 9B001.c.;

d. Not used;

e. "Software" specially designed or modified for the operation of items specified by 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 by 9A004.e. or 9A004.f.

N.B.: For "software" for items listed in 9A004.d. that are incorporated into "spacecraft payloads", see the appropriate Categories.

9D101 "Software" specially designed or modified for the "use" of goods specified by 9B105, 9B106, 9B116 or 9B117.

9D103 "Software" specially designed for modelling, simulation or design integration of the space launch vehicles specified by 9A004 or sounding rockets specified by 9A104, or the subsystems specified by 9A005, 9A007, 9A105, 9A106.c., 9A107, 9A108.c., 9A116 or 9A119.

Note 1: "Software" specified by 9D103 remains controlled when combined with specially designed hardware specified by 4A102.

Note 2: Certain items specified in 9D103 may be subject to the MTCR Guidelines for Sensitive Missile-Relevant Transfers.

9D104 "Software" specially designed or modified for the "use" of goods specified by 9A001, 9A005, 9A006.d., 9A006.g., 9A007.a., 9A008.d., 9A009.a., 9A010.d., 9A011, 9A101, 9A102, 9A105, 9A106.c., 9A106.d., 9A107, 9A108.c., 9A109, 9A111, 9A115.a., 9A116.d., 9A117 or 9A118.

Note: Certain items specified in 9D104 may be subject to the MTCR Guidelines for Sensitive Missile-Relevant Transfers.

9D105 "Software" which coordinates the function of more than one subsystem, specially designed or modified for "use" in 'missiles', space launch vehicles specified by 9A004 or sounding rockets specified by 9A104.

Note: For a manned aircraft converted to operate as an unmanned aerial vehicle, 9D105 includes "software", as follows:

a. "Software" specially designed or modified to integrate the conversion equipment with the aircraft system functions;

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 vehicles" capable of a range exceeding 300km.

9E Technology

Note: "Development" or "production" "technology" specified by 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 by 9A004 to 9A012, 9A350, 9B or 9D.

Note: Certain items specified in 9E001 may be subject to the MTCR Guidelines for Sensitive Missile-Relevant Transfers.

9E002 "Technology" according to the General Technology Note for the "production" of equipment specified by 9A004 to 9A011, 9A350 or 9B.

N.B.: For "technology" for the repair of controlled structures, laminates or materials, see 1E002.f.

Note: Certain items specified in 9E002 may be subject to the MTCR Guidelines for Sensitive Missile-Relevant Transfers.

9E003 Other "technology" as follows:

a. "Technology" "required" for the "development" or "production" of any of the following gas turbine engine components or systems:

1. Gas turbine blades, vanes or "tip shrouds", made from directionally solidified (DS) or single crystal (SC) alloys 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 1,883 K (1,610°C);
   b. Non-metallic liners;
   c. Non-metallic shells; or
   d. Liners designed to operate at 'combustor exit temperature' exceeding 1,883 K (1,610°C) and having holes that meet the parameters specified by 9E003.c.;
   e. Utilising 'pressure gain combustion':

      Technical Note:

      For the purposes of 9E003.a.2.e., in 'pressure gain combustion' 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.

   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.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.*

   N.B.: *See 9E003.c. for "technology" "required" for manufacturing cooling holes.*

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 by 1C007;
         b. "Fibrous or filamentary materials" specified by 1C010; or
         c. Aluminides specified by 1C002.a.; or

2. Ceramic “matrix” “composites” specified by 1C007; or

c. Stators, vanes, blades, tip seals (shrouds), rotating blings, rotating blisks, or ‘splitter ducts’, that are all of the following:

1. Not specified by 9E003.a.3.a.;
2. Designed for compressors or fans; and
3. Manufactured from material specified by 1C010.e. with resins specified by 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.

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.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. Airfoil-to-disk blade combinations using solid state joining;
7. Not used since 2019;
8. ‘Damage tolerant’ gas turbine engine rotor components using powder metallurgy materials specified by 1C002.b.; or

Technical Note:

For the purposes of 9#003.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 by 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
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 apply to "technology" for manufacturing constant radius cylindrical holes that are straight through and enter and exit on the external surfaces of the component.

Technical Notes:

1. For the purposes of 9E003.c., the 'cross-sectional area' is the area of the hole in the plane perpendicular to the hole axis.

2. For the purposes of 9E003.c., '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. For the purposes of 9E003.c., '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. For the purposes of 9E003.c., methods for manufacturing holes in 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 widest of any of the following:

a. The outside dimension from valve cover to valve cover;

b. The dimensions of the outside edges of the cylinder heads; or

c. The diameter of the flywheel housing;

Height: *The largest of any of the following:*

a. *The dimension of the crankshaft centre-line to the top plane of the valve cover (or cylinder head) plus twice the stroke; or*

b. *The diameter of the flywheel housing.*

f. "Technology" "required" for the "production" of specially designed components for high output diesel engines, as follows:

1. "Technology" "required" for the "production" of engine systems having all of the following components employing ceramics materials specified by 1C007:

a. Cylinder liners;

b. Pistons;

c. Cylinder heads; and

d. One or more other components (including exhaust ports, turbochargers, valve guides, valve assemblies or insulated fuel injectors);

2. "Technology" "required" for the "production" of turbocharger systems with single-stage compressors 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.

Technical Note:

For the purposes of 9E003.g., 'high output diesel engines' are diesel engines with a specified brake mean effective pressure of 1.8 MPa or more at a speed of 2,300 r.p.m., provided the rated speed is 2,300 r.p.m. or more.

h. "Technology" for gas turbine engine "FADEC systems" as follows:

1. "Development" "technology" for deriving the functional requirements for the components necessary for the "FADEC system" to regulate engine thrust or shaft power (e.g. feedback sensor time constants and accuracies, fuel valve slew rate);

2. “Development” or “production” “technology” for control and diagnostic components unique to the “FADEC system” and used to regulate engine thrust or shaft power;

3. “Development” “technology” for the control law algorithms, including “source code”, unique to the “FADEC system” and used to regulate engine thrust or shaft power.

Note: *9E003.h. does not apply to technical data related to engine-“aircraft” integration required by civil aviation authorities of one or more 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 adjustable flow path systems designed to maintain engine stability for gas generator turbines, fan or power turbines, or propelling nozzles, as follows:

1. “Development” “technology” for deriving the functional requirements for the components that maintain engine stability;

2. “Development” or “production” “technology” for components unique to the adjustable flow path system and that maintain engine stability;

3. “Development” “technology” for the control law algorithms, including “source code”, unique to the adjustable flow path system and that maintain engine stability.

Note: *9E003.i. does not apply to “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.

N.B.: For “technology” “required” for the “development” of wing-folding systems designed for fixed-wing “aircraft” specified by ML10., see ML22.

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 See 9E003.h. for engine control technology.

N.B.: 2 See 9E003.i. for adjustable flow path systems technology

9E101 a. "Technology" according to the General Technology Note for the "development" of goods specified by 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 by 9A012 or goods specified by 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.

Note: Certain items specified in 9E101 may be subject to the MTCR Guidelines for Sensitive Missile-Relevant Transfers.

9E102 "Technology" according to the General Technology Note for the "use" of space launch vehicles specified by 9A004, goods specified by 9A005 to 9A011, 'UAV's specified by 9A012 or goods specified by 9A101, 9A102, 9A104 to 9A111, 9A112.a. 9A115 to 9A121, 9B105, 9B106, 9B115 to 9B117, 9D101 or 9D103.

Technical Note:

In 9E102, 'UAV' means unmanned aerial vehicle systems capable of a range exceeding 300 km.

Note: Certain items specified in 9E102 may be subject to the MTCR Guidelines for Sensitive Missile-Relevant Transfers.

Sensitive List of Dual-Use Goods and Technologies

Note: This list contains a sub-set of the items listed in Categories 1 to 9 of the Part 2 Dual-Use List. The items in this List are considered to be sensitive, requiring additional care in their transfer. General Export Licences are generally not available for the export or supply of the following sensitive goods or technologies.

N.B.: Where abbreviated entries are used, see the Dual-Use List for full details. Text that differs from that in the Dual-Use List is shaded.

Category 1	**SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES**
1A002.a.1.	"Composite" structures or laminates made from an organic "matrix" and "fibrous or filamentary materials" specified by 1C010.c. or 1C010.d.
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: a. Designed to fully contain an explosion equivalent to 2 kg of TNT or greater; and b. Having design elements or features enabling real time or delayed transfer of diagnostic or measurement information.
IB235	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.*
1C001	Materials specially designed for absorbing electromagnetic radiation...
1C007.c.	Ceramic-"matrix" "composite" materials...
1C007.d.	Not used
1C010.c. & 1C010.d.	"Fibrous or filamentary materials"...
1C012	Materials as follows...

Category 1	SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES
1C101	Materials or devices for reduced observables such as radar reflectivity, ultraviolet/infrared signatures and acoustic signatures; other than those specified by 1C001, usable in 'missiles', 'missile' subsystems or unmanned aerial vehicles specified by 9A012. *Note: 1C101 does not apply to materials if such goods are formulated solely for civil applications.* *Technical Note:* *In 1C101 'missile' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.*
1C239	High explosives, other than those specified in the Munitions List, 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.
1D001	"Software" specially designed or modified for the "development", "production" or "use" of equipment specified by 1B234 or 1B235.
1D002	"Software" for the "development" of organic "matrix", metal "matrix" or carbon "matrix" laminates or "composites" specified by this List.
1D103	"Software" specially designed for analysis of reduced observables such as radar reflectivity, ultraviolet/infrared signatures and acoustic signatures.
1E001	"Technology" according to the General Technology Note for the "development" or "production" of equipment or materials specified by 1A002, 1B234, 1B235 or 1C.
1E002.e. & 1E002.f.	Other "technology"...
1E101	"Technology" according to the GTN for the "use" of goods specified by 1C101 or 1D103.
1E102	"Technology" according to the General Technology Note for the "development" of "software" specified by 1D101 or 1D103.
1E201	"Technology" according to the General Technology Note for the "use" of goods specified by 1B234, 1B235 or 1C239.

Category 2	SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES
2B001.a.	Not used since 2002
2B001.b.	Not used since 2002
2B001.d.	Not used since 2002
2B001.f.	Not used since 2002
2B003	Not used since 2002

Category 2	SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES
2D001	"Software", other than that specified by 2D002, specially designed for the "development" or "production" of equipment as follows: a. Specified by 2B001.a., 2B001.b.1., or 2B001.b.2., and having a "unidirectional positioning repeatability" equal to or less (better) than 0.9 µm along one or more linear axis; b. Specified by 2B001.b.3., 2B001.d., 2B001.f. or 2B003.
2E001	"Technology" according to the General Technology Note for the "development" of equipment or "software" as follows: a. Equipment specified by 2B001.a., 2B001.b.1. or 2B001.b.2., and having a "unidirectional positioning repeatability" equal to or less (better) than 0.9 µm along one or more linear axis; b. Equipment specified by 2B001.b.3., 2B001.d., 2B001.f. or 2B003; c. "Software" specified by 2D of this List;
2E002	"Technology" according to the General Technology Note for the "production" of equipment as follows: a. Specified by 2B001.a., 2B001.b.1. or 2B001.b.2., and having a "unidirectional positioning repeatability" equal to or less (better) than 0.9 µm along one or more linear axis; b. Specified by 2B001.b.3., 2B001.d., 2B001.f. or 2B003.

Category 3	SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES
3A001.b.2.	"Monolithic Microwave Integrated Circuit" ("MMIC") 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 300 W (54.8 dBm) at any frequency exceeding 2.7 GHz up to and including 2.9 GHz; 2. A peak saturated power output greater than 300 W (54.8 dBm) at any frequency exceeding 2.9 GHz up to and including 3.2 GHz; 3. A peak saturated power output greater than 300 W (54.8 dBm) at any frequency exceeding 3.2 GHz up to and including 3.7 GHz; or 4. A peak saturated power output greater than 120 W (50.8 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 12 GHz with a "fractional bandwidth" greater than 10%, and having any of the following: 1. A peak saturated power output greater than 25 W (44 dBm) at any frequency exceeding 6.8 GHz up to and including 8.5 GHz; or 2. A peak saturated power output greater than 25 W (44 dBm) at any frequency exceeding 8.5 GHz up to and including 12 GHz.

Category 3	SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES
3A001.b.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 600 W (57.8 dBm) at any frequency exceeding 2.7 GHz up to and including 2.9 GHz; 2. A peak saturated power output greater than 600 W (57.8 dBm) at any frequency exceeding 2.9 GHz up to and including 3.2 GHz; 3. A peak saturated power output greater than 600 W (57.8 dBm) at any frequency exceeding 3.2 GHz up to and including 3.7 GHz; or 4. A peak saturated power output greater than 130 W (51.2 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 12 GHz and having any of the following: 1. A peak saturated power output greater than 130 W (51.2 dBm) at any frequency exceeding 6.8 GHz up to and including 8.5 GHz; or 2. A peak saturated power output greater than 60 W (47.8 dBm) at any frequency exceeding 8.5 GHz up to and including 12 GHz.
3A002.g.1.	Atomic frequency standards… "Space-qualified"
3A229	High-current pulse generators, as follows… *N.B.: See also ML4, ML909*
3A232	Multipoint initiation systems, other than those specified by 1A007, as follows… *N.B.: See also ML4*
3B001.a.2.	Not used
3D001	"Software" specially designed for the "development" or "production" of equipment specified by 3A002.g. of this List.
3E001	"Technology" according to the General Technology Note for the "development" or "production" of equipment specified by 3A of this List.
3E201	"Technology" according to the General Technology Note for the "use" of equipment specified by 3A229 or 3A232.

Category 4	SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES
4A001.a.2.	Electronic computers...radiation hardened…
4A003.b.	Not used since 2002
4A003.c.	Not used since 2001
4D001	Not used since 2022
4E001	Not used since 2022

Category 4	SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES

Category 5	SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES
Part 1	
5A001.b.3.	Being radio equipment…
5A001.b.5.	Being digitally controlled radio receivers…
5A001.h.	Counter Improvised Explosive Device (IED) equipment and related equipment...
5B001.a.	Equipment and specially designed components or accessories therefor, specially designed for the "development" or "production" of equipment, functions or features in 5A001 of this List.
5D001.a.	"Software" specially designed for the "development" or "production" of equipment, functions or features, specified by 5A001 of this List.
5D001.b.	Not used.
5E001.a.	"Technology" according to the General Technology Note for the "development" or "production" of equipment, functions or features specified by 5A001 or "software" specified by 5D001.a. of this List.
Part 2	None

Category 6	SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES
6A001.a.1.b.	Systems or transmitting and receiving arrays, designed for object detection or location, having any of the following: 1. A transmitting frequency below 5 kHz or a sound pressure level exceeding 224 dB (reference 1 µPa at 1 m) for equipment with an operating frequency in the band from 5 kHz to 10 kHz inclusive; 2. Sound pressure level exceeding 224 dB… 3. Sound pressure level exceeding 235 dB… 4. Forming beams of… 5. Designed to operate… 6. Designed to withstand...
6A001.a.1.e.	Active individual sonars…
6A001.a.2.a.1.	Hydrophones…Incorporating…
6A001.a.2.a.2.	Hydrophones…Incorporating flexible assemblies…
6A001.a.2.a.3.	Hydrophones…Having any…
6A001.a.2.a.5.	Hydrophones…Designed to operate…
6A001.a.2.a.6	Hydrophones…Designed for…
6A001.a.2.b.	Towed acoustic hydrophone arrays…

Category 6	SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES
6A001.a.2.c.	Processing equipment, specially designed for real time application with towed acoustic hydrophone arrays, having "user-accessible programmability" and time or frequency domain processing and correlation, including spectral analysis, digital filtering and beamforming using Fast Fourier or other transforms or processes;
6A001.a.2.d.	Heading sensors…
6A001.a.2.e.	Bottom or bay cable hydrophone arrays having any of the following: 1. Incorporating hydrophones… or 2. Incorporating multiplexed hydrophone group signal modules…
6A001.a.2.f.	Processing equipment, specially designed for real time application with bottom or bay cable systems, having "user-accessible programmability" and time or frequency domain processing and correlation, including spectral analysis, digital filtering and beamforming using Fast Fourier or other transforms or processes.
6A002.a.1.a., b. and c.	"Space-qualified" solid-state detectors…
6A002.a.1.d.	"Space-qualified" "focal plane arrays"….
6A002.a.2.a.	Image intensifier tubes … 1. A peak response… 2. Electron image amplification… 3. Photocathodes, as follows: a. Multialkali photocathodes (e.g., S-20 and S-25) having a luminous sensitivity exceeding 700 µA/lm; b. GaAs or GaInAs photocathodes; c. Other "III/V compound" semiconductor photocathodes.
6A002.a.2.b.	Image intensifier tubes…
6A002.a.3.	Non-"space-qualified" "focal plane arrays"…;
	Note 3 *6A002.a.3. does not apply to the following "focal plane arrays" in this List:* *a. Platinum Silicide (PtSi) "focal plane arrays" having less than 10,000 elements;*
	b. Iridium Silicide (IrSi) "focal plane arrays". *Note 4* *6A002.a.3. does not apply to the following "focal plane arrays" in this List:* *a. Indium Antimonide (InSb) or Lead Selenide (PbSe) "focal plane arrays" having less than 256 elements;* *b. Indium Arsenide (InAs) "focal plane arrays";* *c. Lead Sulphide (PbS) "focal plane arrays";* *d. Indium Gallium Arsenide (InGaAs) "focal plane arrays".*

	Note 5 *6A002.a.3. does not apply to Mercury Cadmium Telluride (HgCdTe) "focal plane arrays" as follows in this List:* *a. 'Scanning Arrays' having any of the following:* *1. 30 elements or less; or* *2. Incorporating time delay-and-integration within the element and having 2 elements or less;* *b. 'Staring Arrays' having less than 256 elements.* *Technical Notes:* *1. 'Scanning Arrays' are defined as "focal plane arrays" designed for use with a scanning optical system that images a scene in a sequential manner to produce an image;* *2. 'Staring Arrays' are defined as "focal plane arrays" designed for use with a non-scanning optical system that images a scene.* *Note 6* *6A002.a.3. does not apply to the following "focal plane arrays" in this List:* *a. Gallium Arsenide (GaAs) or Gallium Aluminium Arsenide (GaAlAs) quantum well "focal plane arrays" having less than 256 elements;* *b. Microbolometer "focal plane arrays" having less than 8,000 elements.* *Note 7* *6A002.a.3.g. does not apply to "focal plane arrays", specially designed or modified to achieve 'charge multiplication', as follows:* *a. Linear (1-dimensional) arrays having 4,096 elements or less;* *b. Non-linear (2-dimensional) arrays having all of the following:* *1. A total of 250,000 elements or less; and* *2. A maximum of 4,096 elements in each dimension.* *Note 8* *Not used since 2018.*
6A002.b.	"Monospectral imaging sensors" and "multispectral imaging sensors"…
6A002.c.	'Direct view' imaging equipment incorporating any of the following: 1. Image intensifier tubes having the characteristics listed in 6A002.a.2.a. or 6A002.a.2.b. of this List; 2. "Focal plane arrays" having the characteristics listed in 6A002.a.3. of this List; or 3. Solid-state detectors having the characteristics listed in 6A002.a.1.;
6A002.e.	Not used *N.B.: Entry moved to 6A002.a.1.d. in 2008.*
6A003.b.3.	Imaging cameras incorporating image intensifier tubes having the characteristics listed in 6A002.a.2.a. or 6A002.a.2.b. of this List; *Note: 6A003.b.3. does not apply to imaging cameras specially designed or modified for underwater use.*
6A003.b.4.	Imaging cameras incorporating "focal plane arrays" having any of the following:

Category 6	SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES
	a. Incorporating "focal plane arrays" specified by 6A002.a.3.a. to 6A002.a.3.e. of this List; b. Incorporating "focal plane arrays" specified by 6A002.a.3.f. of this List; or c. Incorporating "focal plane arrays" listed in 6A002.a.3.g. of this List.
6A003.b.4.	*Note 1* ... *Note 2* ... *Note 3* ... *Note 4* ... *Note 5: 6A003.b.4.c. does not apply to imaging cameras specially designed or modified for underwater use.*
6A003.b.5.	Imaging cameras incorporating solid-state detectors specified by 6A002.a.1.;
6A004.c.	"Space-qualified" components for optical systems…
6A004.d.	Optical control equipment…
6A006.a.	Not used
6A006.a.1.	"Magnetometers"… Using "superconductive" (SQUID) "technology"…
6A006.a.2.	"Magnetometers" … Using optically pumped or nuclear precession (proton/Overhauser) "technology" having a 'sensitivity' lower (better) than 2pT rms per square root Hz;
6A006.c.1.	"Magnetic gradiometers" using multiple "magnetometers" specified by 6A006.a.1. or 6A006.a.2. of this List;
6A006.d.	"Compensation systems" for the following: 1. Magnetic sensors specified by 6A006.a.2. and using optically pumped or nuclear precession (proton/Overhauser) "technology" that will permit these sensors to realise a 'sensitivity' lower (better) than 2 pT rms per square root Hz; 2. Underwater electric field sensors specified by 6A006.b.; 3. "Magnetic gradiometers" specified by 6A006.c. that will permit these sensors to realise a 'sensitivity' lower (better) than 3 pT/m rms per square root Hz.
6A006.e.	Underwater electromagnetic receivers incorporating "magnetometers" specified by 6A006.a.1. or 6A006.a.2. of this List.
6A006.g.	Not used
6A006.h.	Not used
6A008.d.	Radar systems…Capable of…
6A008.h.	Radar systems…Employing processing…
6A008.k.	Radar systems…Having "signal processing"…

Category 6	SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES
6A008.l.3.	Not used
6B008	Pulse radar cross-section…
6B108	Systems specially designed for radar cross section measurement usable for "missiles" and their subsystems.
6D001	"Software" specially designed for the "development" or "production" of equipment specified by 6A004, 6A008 or 6B008 of this List.
6D003.a.	"Software", as follows:…
6E001	"Technology" according to…
6E002	"Technology" according to the General Technology Note for the "production" of equipment specified by 6A or 6B of this List.

Category 7	SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES
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), except "guidance sets" designed for missiles with a range under 300 km or manned aircraft.
7B103	Test, calibration or alignment equipment specially designed for equipment specified by 7A117 above. *Note: 7B001 does not apply to test, calibration or alignment equipment for Maintenance Level I or Maintenance Level II.*
7D002	"Source code" for the operation or maintenance…
7D003.a.	"Software" specially designed or modified to…
7D003.b.	"Source code" for…
7D003.c.	Not used
7D003.d.1. to 4. & 7.	Not used
7D004.a. to d. & g.	"Source code" incorporating "development" "technology" specified by…
7D101	"Software" specially designed for the "use" of equipment specified by 7B003 or 7B103 above.
7E001 & 7E002	"Technology" according to the General Technology Note...

Category 7	SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES
7E101	"Technology" according to the General Technology Note for the "use" of equipment specified by 7A117, 7B003, 7B103 and 7D101 above.

Category 8	SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES
8A001.b.	Manned, untethered submersible vehicles…
8A001.c.	Unmanned submersible vehicles...
8A001.d.	Not used since 2018
8A002.b.	Systems specially designed or modified for the automated control of the motion of submersible vehicles specified by 8A001 of this List using navigation data having closed loop servo-controls and having any of the following: 1. Enabling… 2. Maintaining… 3. Maintaining…
8A002.h.	"Robots" specially designed for underwater use...
8A002.j.	Air independent power systems...
8A002.o.3.	Noise reduction systems for use on vessels...
8A002.p.	Pumpjet propulsion systems...
8D001	"Software" specially designed for the "development" or "production" of equipment in 8A of this List.
8D002	Specific "software"…
8E001	"Technology" according to the General Technology Note for the "development" or "production" of equipment specified by 8A of this List.
8E002.a.	Other "technology"...

Category 9	SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES
9A011	Ramjet, scramjet or combined cycle engines...
9A104	Sounding rockets, capable of delivering at least a 500 kg payload to a range of at least 300 km. *N.B.: See also 9A004.*

Category 9	SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES
9A105.a.	Liquid propellant rocket engines integrated, or designed or modified to be integrated, into a liquid propellant propulsion system, as follows: *N.B.: See also 9A119.* a. Liquid propellant rocket engines usable in "missiles", other than those specified by 9A005, having a total impulse capacity equal to or greater than 1.1 MNs; except liquid propellant apogee engines integrated, or designed or modified to be integrated, into a liquid propellant propulsion system, designed or modified for satellite applications and having all of the following: 1. Nozzle throat diameter of 20 mm or less; and 2. Combustion chamber pressure of 15 bar or less.
9A106	Systems or components, other than those specified by 9A006, usable in "missiles", as follows, specially designed for liquid rocket propulsion systems: c. Thrust vector control sub-systems**,** except those designed for rocket systems that are not capable of delivering at least a 500 kg payload to a range of at least 300 km. *Technical Note:* *Examples of methods of achieving thrust vector control specified by 9A106.c. are:* *1. Flexible nozzle;* *2. Fluid or secondary gas injection;* *3. Movable engine or nozzle;* *4. Deflection of exhaust gas stream (jet vanes or probes); or* *5. Thrust tabs.*
9A108.c.	Components, other than those specified by 9A008, usable in "missiles" as follows, specially designed for solid rocket propulsion systems: c. Thrust vector control sub-systems, except those designed for rocket systems that are not capable of delivering at least a 500 kg payload to a range of at least 300 km. *Technical Note:* *Examples of methods of achieving thrust vector control specified by 9A108.c. are:* *1. Flexible nozzle;* *2. Fluid or secondary gas injection;* *3. Movable engine or nozzle;* *4. Deflection of exhaust gas stream (jet vanes or probes); or* *5. Thrust tabs.*
9A116	Re-entry vehicles, usable in "missiles", and equipment designed or modified therefor, as follows, except for re-entry vehicles designed for non-weapon payloads*:* a. Re-entry 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 re-entry vehicles.

Category 9	SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES
9A119	Individual rocket stages, usable in complete rocket systems or "unmanned aerial vehicles", capable of delivering at least a 500 kg payload to a range of 300 km, other than those specified by 9A005 or 9A007.a. above
9B001	Manufacturing equipment, tooling or fixtures, as follows: a. Directional-solidification or single-crystal casting equipment; b. Casting tooling, 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".
9B115	Specially designed "production equipment" for the systems, sub-systems and components specified by 9A005, 9A007.a., 9A008.d., 9A105.a., 9A106.c., 9A108.c., 9A116 or 9A119 above.
9B116	Specially designed "production facilities" for the space launch vehicles specified by 9A004, or systems, sub-systems, and components specified by 9A005, 9A007.a., 9A008.d., 9A104, 9A105.a., 9A106.c., 9A108.c., 9A116 or 9A119 above.
9D001	"Software" specially designed or modified for the "development" of equipment or "technology", specified by 9A, 9B or 9E003 of this List.
9D002	"Software" specially designed or modified for the "production" of equipment specified by 9A or 9B of this List.
9D004.a.	Other "software"… 2D or 3D…
9D004.c.	Other "software"…"Software" specially…
9D101	"Software" specially designed for the "use" of goods specified by 9B116 above.
9E001	"Technology" according to the General Technology Note…
9E002	"Technology" according to the General Technology Note…
9E003.a.1. to 5. and 9E003.a.8.	"Technology" "required" for…
9E003.h.	"Technology" "required" for gas turbine "FADEC systems"…
9E101	"Technology" according to the General Technology Note for the "development" or "production" of goods specified by 9A104, 9A105.a., 9A106.c., 9A108.c., 9A116 or 9A119 above.

Category 9	SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES
9E102	"Technology" according to the General Technology Note for the "use" of space launch vehicles specified by 9A004, 9A005, 9A007.a., 9A008.d., 9A104, 9A105.a., 9A106.c., 9A108.c., 9A116, 9A119, 9B115, 9B116 or 9D101 above.

Very Sensitive List of Dual-Use Goods and Technologies

Note: This List contains Category 0 of the Dual-Use List and a subset of the items contained in the Sensitive List. The items in this List are considered to be very sensitive, requiring extreme care in their transfer. General Export Licences are not available for the export of the following very sensitive goods.

N.B.: Where abbreviated entries are used, see Dual-Use List for full details. Text that differs from that in the Dual-Use List is shaded.

Category 0	**VERY SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES**
	All of Category 0 of Dual-Use List is included in the Very Sensitive List *N.B. For 0C003 and 0C004, only if for use in a "nuclear reactor" (within 0A001.a.).*

Category 1	**VERY SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES**
1A002.a.1.	"Composite" structures or laminates made from an organic "matrix" and "fibrous or filamentary materials" specified by 1C010.c. or 1C010.d.
1B226	Electromagnetic isotope separators designed for, or equipped with, single or multiple ion sources capable of providing a total ion beam current of 50 mA or greater. *Note: 1B226 includes separators:* *a. Capable of enriching stable isotopes;* *b. With the ion sources and collectors both in the magnetic field and those configurations in which they are external to the field.*
1B231	Tritium facilities or plants, and equipment therefor, as follows: a. Facilities or plants for the production, recovery, extraction, concentration, or handling of tritium; b. Equipment for tritium facilities or plants, as follows: 1. Hydrogen or helium refrigeration units capable of cooling to 23 K (-250°C) or less, with heat removal capacity greater than 150 W; 2. Hydrogen isotope storage or purification systems using metal hydrides as the storage or purification medium.

Category 1	VERY SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES
1B233	Lithium isotope separation facilities or plants, and equipment therefor, as follows: a. Facilities or plants for the separation of lithium isotopes; b. Equipment for the separation of lithium isotopes, as follows: 1. Packed liquid-liquid exchange columns specially designed for lithium amalgams; 2. Mercury or lithium amalgam pumps; 3. Lithium amalgam electrolysis cells; 4. Evaporators for concentrated lithium hydroxide solution. c. Ion exchange systems specially designed for lithium isotope separation, and specially designed component parts therefor; d. Chemical exchange systems (employing crown ethers, cryptands, or lariat ethers) specially designed for lithium isotope separation, and specially designed component parts therefor.
IB235	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.
1C001	Materials specially designed for absorbing electromagnetic radiation...
1C012	Materials as follows...
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 apply to thermoluminescent dosimeters.* *Technical Note:* *The natural isotopic abundance of lithium-6 is approximately 6.5 weight per cent (7.5 atom per cent).*
1C235	Tritium, tritium compounds, mixtures containing tritium in which the ratio of tritium to hydrogen atoms exceeds 1 part in 1000, and products or devices containing any of the foregoing. *Note: 1C235 does not apply to a product or device containing less than 1.48 x 10^3 GBq (40 Ci) of tritium.*
1C351.d.4.	Ricin
1C351.d.5.	Saxitoxin

Category 1	VERY SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES
1E001	"Technology" according to the General Technology Note for the "development" or "production" of equipment and materials specified by 1A002 or 1C of this List.
1E201	"Technology" according to the General Technology Note for the "use" of goods specified by 1B226, 1B231, 1B233, 1C233 or 1C235.

Category 2	VERY SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES
	None

Category 3	VERY SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES
3A228	Switching devices, as follows: a. Cold-cathode tubes, whether gas filled or not, operating similarly to a spark gap, having all of the following characteristics: 1. Containing three or more electrodes; 2. Anode peak voltage rating of 2.5 kV or more; 3. Anode peak current rating of 100 A or more; and 4. Anode delay time of 10 µs or less; *Note: 3A228 includes gas krytron tubes and vacuum sprytron tubes.*
	b. Triggered spark-gaps having both of the following characteristics: 1. An anode delay time of 15 µs or less; and 2. Rated for a peak current of 500 A or more.
3A231	Neutron generator systems, including tubes, having both of the following characteristics: a. Designed for operation without an external vacuum system; and b. Utilising electrostatic acceleration to induce a tritium-deuterium nuclear reaction.
3E201	"Technology" according to the General Technology Note for the "use" of equipment specified by 3A228.a., 3A228.b. or 3A231.

Category 4	VERY SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES
	None

Category 5	VERY SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES
Part 1	
5A001.b.5.	Digitally controlled radio receivers...
5A001.h.	Counter Improvised Explosive Device (IED) equipment and related equipment...
5D001.a.	"Software" specially designed for the "development" or "production" of equipment, functions or features specified by Category 5, Part 1 of this List.

Category 5	VERY SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES
5E001.a.	"Technology" according to the General Technology Note for the "development" or "production" of equipment, functions, features or "software" specified by Category 5, Part 1 of this List.
Part 2	None

Category 6	VERY SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES
6A001.a.1.b.1.	Systems or transmitting and receiving arrays, designed for object detection or location, having a sound pressure level exceeding 210 dB (reference 1 µPa at 1 m) and an operating frequency in the band from 30 Hz to 2 kHz.
6A001.a.2.a.1.	Hydrophones...Incorporating…
6A001.a.2.a.2.	Hydrophones...Incorporating flexible assemblies...
6A001.a.2.a.3.	Hydrophones...Having any...
6A001.a.2.a.5.	Hydrophones...Designed to operate…
6A001.a.2.a.6.	Hydrophones...Designed for...
6A001.a.2.b.	Towed acoustic hydrophone arrays...
6A001.a.2.c.	Processing equipment, specially designed for real time application with towed acoustic hydrophone arrays, having "user-accessible programmability" and time or frequency domain processing and correlation, including spectral analysis, digital filtering and beamforming using Fast Fourier or other transforms or processes;
6A001.a.2.e.	Bottom or bay cable hydrophone arrays having any of the following: 1. Incorporating hydrophones... or 2. Incorporating multiplexed hydrophone group signal modules …
6A001.a.2.f.	Processing equipment, specially designed for real time application with bottom or bay cable systems, having "user-accessible programmability" and time or frequency domain processing and correlation, including spectral analysis, digital filtering and beamforming using Fast Fourier or other transforms or processes;
6A002.a.1.c.	"Space-qualified" solid-state detectors...
6A008.l.3.	Not used

Category 6	VERY SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES
6A203	High-speed cameras and imaging devices and components therefor, other than those specified by 6A003, as follows… a. Mechanical rotating mirror cameras, as follows, and specially designed components therefor: 1. Framing cameras with recording rates greater than 225,000 frames per second; 2. Streak cameras with writing speeds greater than 0.5 mm per microsecond; Note: *In 6A203.a. components of such cameras include their synchronizing electronics units and rotor assemblies consisting of turbines, mirrors and bearings.*
6A225	Velocity interferometers for measuring velocities exceeding 1 km/s during time intervals of less than 10 microseconds. Note: *6A225 includes velocity interferometers such as VISARs (Velocity interferometer systems for any reflector) and DLIs (Doppler laser interferometers).*
6A226	Pressure sensors, as follows: a. Manganin gauges for pressures greater than 10 GPa; b. Quartz pressure transducers for pressures greater than 10 GPa.
6B008	Pulse radar cross-section…
6D001	"Software" specially designed for the "development" or "production" of equipment specified by 6B008 of this List.
6D003.a.	"Software", as follows: …
6E001	"Technology" according to the General Technology Note for the "development" of equipment or "software" specified by 6A, 6B, or 6D of this List.
6E002	"Technology" according to the General Technology Note for the "production" of equipment specified by 6A or 6B of this List.

Category 7	VERY SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES
7D003.a.	"Software" specially designed or modified to…
7D003.b.	"Source code" for…

Category 8	VERY SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES
8A001.b.	Manned, untethered submersible vehicles...
8A001.c.1	Unmanned submersible vehicles...
8A001.d.	Not used since 2018

Category 8	VERY SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES
8A002.o.3.b.	Active noise reduction or cancellation systems...
8D001	"Software" specially designed for the "development" or "production" of equipment specified by 8A of this List.
8E001	"Technology" according to the General Technology Note for the "development" or "production" of equipment specified by 8A of this List.

Category 9	VERY SENSITIVE LIST OF DUAL-USE GOODS AND TECHNOLOGIES
9A011	Ramjet, scramjet or combined cycle engines...
9D001	"Software" specially designed or modified for the "development" of equipment or "technology" specified by 9A or 9E003 of this List.
9D002	"Software" specially designed or modified for the "production" of equipment specified by 9A of this List.
9E001	"Technology" according to the General Technology Note for the "development" of equipment or "software" specified by 9A011 or 9D of this List.
9E002	"Technology" according to the General Technology Note for the "production" of equipment specified by 9A011 of this List.
9E003.a.1.	"Technology" "required" for… Gas turbine blades…
9E003.a.3.a.	"Technology" "required" for… Components... Manufactured from organic "composite" materials designed to operate above 588 K (315°C).

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