SCHEDULE 1

PROHIBITED GOODS

Part 2 —

Information Security

*Note:***Information security** equipment, **software,** systems, application specific **electronic assemblies,** modules, integrated circuits, components or functions are specified in this Category even if they are components or **electronic assemblies** of other equipment.

5A2 Equipment, Assemblies and Components

(5A002) Systems, equipment, application specific **electronic assemblies,** modules or integrated circuits for **information security,** as follows, and other specially designed components therefor:

(a) Designed or modified to use **cryptography** employing digital techniques to ensure **information security;**

(b) Designed or modified to perform cryptanalytic functions;

(c) Designed or modified to use **cryptography** employing analogue techniques to ensure **information security;**

except:

1. Equipment using **fixed** band scrambling not exceeding 8 bands and in which the transpositions change not more frequently than once every second;
2. Equipment using **fixed** band scrambling exceeding 8 bands and in which the transpositions change not more frequently than once every ten seconds;
3. Equipment using **fixed** frequency inversion and in which the transpositions change not more frequently than once every second;
4. Facsimile equipment;
5. Restricted audience broadcast equipment;
6. Civil television equipment;

(d) Designed or modified to suppress the compromising emanations of information-bearing signals;

Note: Head d. of this entry does not specify equipment specially designed to suppress emanations for health or safety reasons.

(e) Designed or modified to use cryptographic techniques to generate the spreading code for **spread spectrum** or the hopping code for **frequency agility** systems;

(f) Designed or modified to provide certified or certifiable **multilevel security** or user isolation at a level exceeding Class B2 of the Trusted Computer System Evaluation Criteria (TCSEC);

(g) Communications cable systems which are designed or modified to use mechanical, electrical or electronic means to detect surreptitious intrusion.

Note: This entry does not specify:

a. **Personalized smart cards** using **cryptography** restricted for use only in equipment or systems as follows:

1. Excluded from control under sub-heads c.1. to c.6. of entry 5A002;
2. Excluded from control under heads b. to e. of this Note; or

a. Cellular radio equipment or systems specially designed for cryptographic operation, provided any message traffic encryption capability specified in entry 5A002 contained in such equipment or systems is irreversibly disabled;

b. Access control equipment, such as automatic teller machines, self-service statement printers or point of sale terminals, which protects password or personal identification numbers (PIN) or similar data to prevent unauthorised access to facilities but does not allow for encryption of files or text, except as directly related to the password or PIN protection;

c. Data authentication equipment which calculates a Message Authentication Code (MAC) or similar result to ensure no alteration of text has taken place, or to authenticate users, but does not allow for encryption of data, text or other media other than that needed for the authentication;

d. Cryptographic equipment specially designed, developed or modified for use in machines for banking or money transactions, such as automatic teller machines, self-service statement printers, point of sale terminals, or equipment for the encryption of interbanking transactions, and intended for use only in such applications;

b. Equipment containing **fixed** data compression or coding techniques;

c. Receiving equipment for radio broadcast, pay television or similar restricted audience television of the consumer type, without digital encryption and where digital decryption is limited to the video, audio or management functions;

d. Portable (personal) or mobile radiotelephones for civil use, e.g., for use with commercial civil cellular radiocommunications systems, containing encryption, when accompanying their users;

e. Decryption functions specially designed to allow the execution of copy-protected **software,** provided the decryption functions are not user-accessible.

5B2 Test, Inspection and Production Equipment

(a) (5B002) (a) Equipment specially designed for:

(1) The development of equipment or functions specified in entries 5A002, 5B002, 5D002 or 5E002, including measuring or test equipment;

(2) The production of equipment or functions specified in entries 5A002, 5B002, 5D002 or 5E002, including measuring, test, repair or production equipment;

(b) Measuring equipment specially designed to evaluate and validate the **information security** functions specified in entries 5A002 or 5D002.

5C2 Materials

None

5D2 Software

(a) (5D002) (a) **Software** specially designed or modified for the **development, production** or **use** of equipment or **software** specified in entries 5A002, 5B002 or 5D002;

(b) **Software** specially designed or modified to support **technology** specified in entry 5E002;

(c) Specific **software** as follows:

(1) **Software** having the characteristics, or performing or simulating the functions of the equipment specified in entries 5A002 or 5B002;

(2) **Software** to certify **software** specified in sub-head c.1. of this entry;

(3) Software designed or modified to protect against malicious computer damage, e.g., viruses.

Note: This entry does not specify **software required** for the **use** of equipment described in the Note to 5A002 or providing any of the functions of that equipment 5A002.

5E2 Technology

(5E002) **Technology required** for the **development, production** or **use** of **goods** specified in entries 5A002, 5B002 or 5D002.

Category 6 — Sensors and Lasers

6A Equipment, Assemblies and Components

6A

6A1 Acoustics

(a) (6A001) (a) Marine acoustic systems, equipment or specially designed components therefor, as follows:

(1) Active (transmitting or transmitting-and-receiving) systems, equipment or specially designed components therefor, as follows:

Note: Sub-head a.1. to this entry does not specify:

(a) Depth sounders operating vertically below the apparatus, not including a scanning function exceeding ± 10°, and limited to measuring the depth of water, the distance of submerged or buried objects or fish finding;

(b) Acoustic beacons, as follows:

(1) Acoustic emergency beacons; or

(2) Pingers specially designed for relocating or returning to an underwater position.

(a) Wide-swath bathymetric survey systems for sea bed topographic mapping:

(1) Designed:

(a) To take measurements at an angle exceeding 10° from the vertical; and

(b) To measure depths exceeding 600 m below the water surface; and

(2) Designed:

(a) To incorporate multiple beams any of which is less than 2°; or

(b) To provide data accuracies of better than 0.5% of water depth across the swath averaged over the individual measurements within the swath;

(b) Object detection or location systems having any of the following:

(1) A transmitting frequency below 10 kHz;

(2) Sound pressure level exceeding 224 dB (reference 1 micropascal at 1 m) for equipment with an operating frequency in the band from 10 kHz to 24 kHz inclusive;

(3) Sound pressure level exceeding 235 dB (reference 1 micropascal at 1m) for equipment with an operating frequency in the band between 24 kHz and 30 kHz;

(4) Forming beams of less than 1° on any axis and having an operating frequency of less than 100 kHz;

(5) Designed to withstand pressure during normal operation at depths exceeding 1,000 m and having transducers:

(a) Dynamically compensated for pressure; or

(b) Incorporating other than lead zirconate titanate as the transduction element; or

(6) Designed to operate with an unambiguous display range exceeding 5,120 m;

(c) Acoustic projectors, including transducers, incorporating piezoelectric, magnetostrictive, electrostrictive, electrodynamic or hydraulic elements operating individually or in a designed combination, having any of the following:

Notes:

(1) The control on export of acoustic projectors, including transducers, specially designed for other equipment is determined by the export control requirements applying to that equipment.

(2) Sub-head a.1.c. of this entry does not specify electronic sources which direct the sound vertically only, or mechanical (e.g., air gun or vapour-shock gun) or chemical (e.g., explosive) sources.

(1) An instantaneous radiated acoustic power density exceeding 0.01 mW/mm^2/Hz for devices operating at frequencies below 10 kHz;

(2) A continuously radiated acoustic power density exceeding 0.001 mW/mm^2/Hz for devices operating at frequencies below 10 kHz;

Note: Acoustic power density is obtained by dividing the output acoustic power by the product of the area of the radiating surface and the frequency of operation.

(3) Designed to withstand pressure during normal operation at depths exceeding 1,000 m; or

(4) Side-lobe suppression exceeding 22 dB;

(d) Acoustic systems, equipment or specially designed components for determining the position of surface vessels or underwater vehicles designed:

Note: Sub-head a.1.d. of this entry includes equipment using coherent **signal processing** between two or more beacons and the hydrophone unit carried by the surface vessel or underwater vehicle, or capable of automatically correcting speed-of-sound propagation errors for calculation of a point.

(1) To operate at a range exceeding 1,000 m with a positioning accuracy of less than 10 m rms when measured at a range of 1,000 m; or

(2) To withstand pressure at depths exceeding 1,000 m;

(2) Passive (receiving, whether or not related in normal application to separate active equipment) systems, equipment or specially designed components therefor, as follows:

(a) Hydrophones (transducers) with any of the following characteristics:

(1) Incorporating continuous flexible sensors or assemblies of discrete sensor elements with either a diameter or length less than 20 mm and with a separation between elements of less than 20 mm;

(2) Having any of the following sensing elements:

(a) Optical fibres;

(b) Piezoelectric polymers; or

(c) Flexible piezoelectric ceramic materials;

(3) Hydrophone sensitivity better than -180 dB at any depth with no acceleration compensation;

(4) When designed to operate at depths not exceeding 35 m, hydrophone sensitivity better than -186 dB with acceleration compensation;

(5) When designed for normal operation at depths exceeding 35 m, hydrophone sensitivity better than -192 dB with acceleration compensation;

(6) When designed for normal operation at depths exceeding 100 m, hydrophone sensitivity better than -204 dB; or

(7) Designed for operation at depths exceeding 1,000 m;

Note: Hydrophone sensitivity is defined as twenty times the logarithm to the base 10 of the ratio of rms output voltage to a 1 V rms reference, when the hydrophone sensor, without a pre-amplifier, is placed in a plane wave acoustic field with an rms pressure of 1 micropascal. For example, a hydrophone of -160 dB (reference 1 V per micropascal) would yield an output voltage of 10^{-8} V in such a field, while one of -180 dB sensitivity would yield only 10^{-9} V output. Thus, -160 dB is better than -180 dB.

(b) Towed acoustic hydrophone arrays with any of the following:

(1) Hydrophone group spacing of less than 12.5 m;

(2) Hydrophone group spacing of 12.5 m to less than 25 m and designed or able to be modified to operate at depths exceeding 35 m;

Note: In this sub-head, "Able to be modified" means having provisions to allow a change of the wiring or interconnections to alter hydrophone group spacing or operating depth limits. These provisions are: spare wiring exceeding 10% of the number of wires, hydrophone group spacing adjustment blocks or internal depth limiting devices that are adjustable or that control more than one hydrophone group.

(3) Hydrophone group spacing of 25 m or more and designed to operate at depths exceeding 100 m;

(4) Heading sensors specified in sub-head a.2.d. of this entry;

(5) Non-metallic strength members or longitudinally reinforced array hoses;

(6) An assembled array of less than 40 mm in diameter;

(7) Multiplexed hydrophone group signals; or

(8) Hydrophone characteristics specified in sub-head a.2.a. of this entry;

(c) Processing equipment, specially designed for towed acoustic hydrophone arrays, with either of the following:

(1) A Fast Fourier or other transform of 1,024 or more complex points in less than 20 ms with no **user-accessible programmability**; or

(2) Time or frequency domain processing and correlation, including spectral analysis, digital filtering and beamforming using Fast Fourier or other transforms or processes with **user-accessible programmability**;

(d) Heading sensors having an accuracy of better than ± 0.5°; and

(1) Designed to be incorporated within the array hosing and to operate at depths exceeding 35 m or having an adjustable or removable depth sensing device in order to operate at depths exceeding 35 m; or

(2) Designed to be mounted external to the array hosing and having a sensor unit capable of operating with 360° roll at depths exceeding 35 m;

(b) Terrestrial geophones capable of conversion for use in marine systems, equipment or specially designed components specified in sub-head a.2.a. of this entry;

(c) Correlation-velocity sonar log equipment designed to measure the horizontal speed of the equipment carrier relative to the sea bed at distances between the carrier and the sea bed exceeding 500 m.

(6A002) Optical sensors

a. Optical detectors, as follows(**1**):

Note: Head a. of this entry does not specify germanium or silicon photodevices.

1. **Space-qualified** solid state detectors having any of the following:

a. 1. A peak response in the wavelength range exceeding 10 nm but not exceeding 300 nm; and

2. A response of less than 0.1% relative to the peak response at a wavelength exceeding 400 nm;

b. 1. A peak response in the wavelength range exceeding 900 nm but not exceeding 1,200 nm; and

2. A response **time constant** of 95 ns or less; or

c. A peak response in the wavelength range exceeding 1,200 nm but not exceeding 30,000 nm;

2. Image intensifier tubes and specially designed components therefor, as follows:

a. Image intensifier tubes having all of the following:

1. A peak response in the wavelength range exceeding 400 nm but not exceeding 1,050 nm;

2. A microchannel plate for electron image amplification with a hole pitch (centre-to-centre spacing) of less than 25 micrometres; and

3. a. An S-20, S-25 or multialkali photocathode; or

b. A GaAs or GaInAs photocathode;

b. Specially designed components, as follows:

1. Fibre optic image inverters;

2. Microchannel plates having both of the following characteristics:

a. 15,000 or more hollow tubes per plate; and

b. Hole pitch (centre-to-centre spacing) of less than 25 micro-metres;

(**1**) See also entry 6A102.

3. GaAs or GaInAs photocathodes;

3. Non-**space-qualified focal plane arrays,** having any of the following:

Notes:

1. Linear or two-dimensional multi-element detector arrays are referred to as **focal plane arrays.**
2. Sub-head a.3. of this entry includes photoconductive arrays and photovoltaic arrays.
3. Sub-head a.3. of this entry does not specify silicon focal plane arrays, multi-element (not to exceed 16 elements) encapsulated photoconductive cells or pyroelectric detectors using any of the following:
   a. Lead sulphide;
   b. Triglycine sulphate and variants;
   c. Lead-lanthanum-zirconium titanate and variants;
   d. Lithium tantalate;
   e. Polyvinylidene fluoride and variants;
   f. Strontium barium niobate and variants; or
   g. Lead selenide.

a. 1. Individual elements with a peak response within the wavelength range exceeding 900 nm but not exceeding 1,050 nm; and
   2. A response **time constant** of less than 0.5 ns;

b. 1. Individual elements with a peak response in the wavelength range exceeding 1,050 nm but not exceeding 1,200 nm; and
   2. A response **time constant** of 95 ns or less; or

c. Individual elements with a peak response in the wavelength range exceeding 1,200 nm but not exceeding 30,000 nm;

4. Non-**space-qualified** single-element or non-focal-plane multi-element semi-conductor photodiodes or phototransistors having both of the following:
   a. A peak response in the wavelength range exceeding 1,200 nm but not exceeding 30,000 nm; and
   b. A response **time constant** of 0.5 ns or less;

b. **Multispectral imaging sensors** designed for remote sensing applications, having either of the following characteristics:

1. An Instantaneous-Field-Of-View (IFOV) of less than 200 microradians; or
2. Specified for operation in the wavelength range exceeding 400 nm but not exceeding 30,000 nm; and
   a. Providing output imaging data in digital format; and
   b. 1. **Space-qualified**; or
      2. Designed for airborne operation, using other than silicon detectors, and having an IFOV of less than 2.5 milliradians;

c. Direct view imaging equipment operating in the visible or infrared spectrum, incorporating either of the following:

1. Image intensifier tubes having the characteristics listed in sub-head a.2.a. of this entry; or
2. **Focal plane arrays** having the characteristics listed in sub-head a.3. of this entry;

Notes:

a. In this entry "direct view" means imaging equipment, operating in the visible or infrared spectrum, that presents a visual image to a human observer without converting the image into an electronic signal for television display, and that cannot record or store the image photographically, electronically or by any other means.

b. Head c. of this entry does not specify the following equipment incorporating other than GaAs or GaInAs photocathodes:

a. Industrial or civilian intrusion alarm, traffic or industrial movement control or counting systems;

b. Medical equipment;

c. Industrial equipment used for inspection, sorting or analysis of the properties of materials;

d. Flame detectors for industrial furnaces;

e. Equipment specially designed for laboratory use.

d. Special support components for optical sensors, as follows:

1. **Space-qualified** cryocoolers;

2. Non-**space-qualified** cryocoolers with a cooling source temperature below 218 K (-55°C), as follows:

a. Closed cycle with a specified Mean-Time-To-Failure (MTTF), or Mean-Time-Between-Failures (MTBF), exceeding 2,500 hours;

b. Joule-Thomson (JT) self-regulating minicoolers with bore (outside) diameters of less than 8 mm;

3. Optical sensing fibres:

a. Specially fabricated either compositionally or structurally, or modified by coating, to be acoustically, thermally, inertially, electromagnetically or nuclear radiation sensitive; or

b. Modified structurally to have a **beat length** of less than 50 mm (high birefringence).

(6A003) **Cameras**(**2**)

(a) Instrumentation cameras, as follows:

(1) High-speed cinema recording cameras using any film format from 8 mm to 16 mm inclusive, in which the film is continuously advanced throughout the recording period, and that are capable of recording at framing rates exceeding 13,150 frames per second;

Note: This sub-head does not specify cinema recording cameras for normal civil purposes.

(2) Mechanical high speed cameras, in which the film does not move, capable of recording at rates exceeding 1,000,000 frames per second for the full framing height of 35 mm film, or at proportionately higher rates for lesser frame heights, or at proportionately lower rates for greater frame heights;

(3) Mechanical or electronic streak cameras with writing speeds exceeding 10 mm per microsecond;

(4) Electronic framing cameras having a speed exceeding 1,000,000 frames per second;

(5) Electronic cameras having:

(**2**) See also entry 6A203.

(a) An electronic shutter speed (gating capability) of less than 1 microsecond per full frame; and

(b) A read out time allowing a framing rate of more than 125 full frames per second;

(b) Imaging cameras(**3**), as follows:

Note: Head b. of this entry does not specify television or video cameras specially designed for television broadcasting.

(1) Video cameras incorporating solid state sensors, having any of the following:

(a) More than 4×10^6 **active pixels** per solid state array for monochrome (black and white) cameras;

(b) More than 4×10^6 **active pixels** per solid state array for colour cameras incorporating three solid state arrays; or

(c) More than 12×10^6 **active pixels** for solid state array colour cameras incorporating one solid state array;

(2) Scanning cameras and scanning camera systems:

(a) Incorporating linear detector arrays with more than 8,192 elements per array; and

(b) Having mechanical scanning in one direction;

(3) Incorporating image intensifiers specified in sub-head a.2.a. of entry 6A002;

(4) Incorporating **focal plane arrays** specified in sub-head a.3. of entry 6A002.

Note: For cameras specially designed or modified for underwater use, see heads d. and e. of entry 8A002.

(6A004) **Optics**

(a) Optical mirrors (reflectors), as follows:

(1) **Deformable mirrors** with either continuous or multi-element surfaces, and specially designed components therefor, capable of dynamically repositioning portions of the surface of the mirror at rates exceeding 100 Hz;

(2) Lightweight monolithic mirrors with an average **equivalent density** of less than 30 kg/m^2 and a total weight exceeding 10 kg;

(3) Lightweight **composite** or foam mirror structures with an average **equivalent density** of less than 30 kg/m^2 and a total weight exceeding 2 kg;

(4) Beam steering mirrors more than 100 mm in diameter or length of major axis which maintain a flatness of lambda/2 or better (lambda is equal to 633 nm) with a control bandwidth exceeding 100 Hz;

(b) Optical components made from zinc selenide (ZnSe) or zinc sulphide (ZnS) with transmission in the wavelength range exceeding 3,000 nm but not exceeding 25,000 nm and either of the following:

(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:

(**3**) See heads d. and e. of entry 8A002 for cameras specially modified for underwater use.

(1) Lightweighted to less than 20% **equivalent density** compared with a solid blank of the same aperture and thickness;

(2) Substrates, substrates with surface coatings (single-layer or multi-layer, metallic or dielectric, conducting, semiconducting or insulating) or with protective films;

(3) Segments or assemblies of mirrors designed to be assembled in space into an optical system with a collecting aperture equivalent to or larger than a single optic 1 metre in diameter;

(4) Manufactured from **composite** materials having a coefficient of linear thermal expansion equal to or less than $5 \times 10_{-6}$ in any coordinate direction;

(d) Optical filters, as follows:

(1) For wavelengths longer than 250 nm, comprised of multi-layer optical coatings and having either of the following:

(a) Bandwidths equal to or less than 1 nm Full Width Half Intensity (FWHI) and peak transmission of 90% or more; or

(b) Bandwidths equal to or less than 0.1 nm FWHI and peak transmission of 50% or more;

Note: Sub-head d.1. of this entry does not specify optical filters with fixed air gaps or Lyot-type filters.

(2) For wavelengths longer than 250 nm, having all of the following:

(a) Tunable over a spectral range of 500 nm or more;

(b) Instantaneous optical bandpass of 1.25 nm or less;

(c) Wavelength resettable within 0.1 ms to an accuracy of 1 nm or better within the tunable spectral range; and

(d) A single peak transmission of 91% or more;

(3) Optical opacity switches (filters) with a field of view of 30° or wider and a response time equal to or less than 1 ns;

(e) Optical control equipment, as follows:

(1) Specially designed to maintain the surface figure or orientation of the **space-qualified** components specified in sub-heads c.1. or c.3. of this entry;

(2) Having steering, tracking, stabilization or resonator alignment bandwidths equal to or more than 100 Hz and an accuracy of 10 microradians or less;

(3) Gimbals having a maximum slew exceeding 5°, a bandwidth equal to or more than 100 Hz, and either of the following:

(a) 1. Exceeding 0.15 m but not exceeding 1 m in diameter or major axis length;

2. Capable of angular accelerations exceeding 2 radians/s^2; and

3. Having angular pointing errors equal to or less than 200 microradians; or

(b) 1. Exceeding 1 m in diameter or major axis length;

2. Capable of angular accelerations exceeding 0.5 radians/^{2}; and

3. Having angular pointing errors equal to or less than 200 microradians;

(4) Specially designed to maintain the alignment of phased array or phased segment mirror systems consisting of mirrors with a segment diameter or major axis length of 1 m or more;

(f) **Fluoride fibre** cable, or optical fibres therefor, having an attenuation of less than 4 dB/km in the wavelength range exceeding 1,000 nm but not exceeding 3,000 nm.

(6A005) **Lasers**, components and optical equipment, as follows(**4**):

Notes:

1. Pulsed **lasers** include those that run in a continuous wave (CW) mode with pulses superimposed.
2. Pulse-excited **lasers** include those that run in a continuously excited mode with pulse excitation superimposed.
3. The status of Raman **lasers** is determined by the parameters of the pumping source **lasers**. The pumping source **lasers** can be any of the **lasers** described below.

(a) Gas **lasers**, as follows:

(1) Excimer **lasers** having any of the following:

(a) An output wavelength not exceeding 150 nm and:

(1) An output energy exceeding 50 mJ per pulse; or

(2) An average or CW output power exceeding 1 W;

(b) An output wavelength exceeding 150 nm but not exceeding 190 nm and:

(1) An output energy exceeding 1.5 J per pulse; or

(2) An average or CW output power exceeding 120 W;

(c) An output wavelength exceeding 190 nm but not exceeding 360 nm and:

(1) An output energy exceeding 10 J per pulse; or

(2) An average or CW output power exceeding 500 W; or

(d) An output wavelength exceeding 360 nm and:

(1) An output energy exceeding 1.5 J per pulse; or

(2) An average or CW output power exceeding 30 W;

(2) Metal vapour **lasers**, as follows:

(a) Copper (Cu) **lasers** with an average or CW output power exceeding 20 W;

(b) Gold (Au) **lasers** with an average or CW output power exceeding 5 W;

(c) Sodium (Na) **lasers** with an output power exceeding 5 W;

(d) Barium (Ba) **lasers** with an average or CW output power exceeding 2 W;

(3) Carbon monoxide (CO) **lasers** having either:

(a) An output energy exceeding 2 J per pulse and a pulsed **peak power** exceeding 5 kW; or

(b) An average or CW output power exceeding 5 kW;

(4) Carbon dioxide (CO_2) **lasers** having any of the following:

(a) A CW output power exceeding 10 kW;

(b) A pulsed output with a **pulse duration** exceeding 10 microseconds and:

(1) An average output power exceeding 10 kW; or

(2) A pulsed **peak power** exceeding 100 kW; or

(c) A pulsed output with a **pulse duration** equal to or less than 10 microseconds and:

(**4**) See also entry 6A205.

(1) A pulse energy exceeding 5 J per pulse and **peak power** exceeding 2.5 kW; or

(2) An average output power exceeding 2.5 kW;

(5) **Chemical lasers**, as follows:

(a) Hydrogen Fluoride (HF) **lasers**;

(b) Deuterium Fluoride (DF) **lasers**;

(c) **Transfer lasers**:

(1) Oxygen Iodine (O_2-I) **lasers**;

(2) Deuterium Fluoride-Carbon dioxide (DF-CO_2) **lasers**;

(6) Gas discharge and ion **lasers**, i.e., krypton ion or argon ion **lasers**, as follows:

(a) An output energy exceeding 1.5 J per pulse and a pulsed **peak power** exceeding 50 W; or

(b) An average or CW output power exceeding 50 W; or

(7) Other gas **lasers**, except nitrogen **lasers**, having any of the following:

(a) An output wavelength not exceeding 150 nm and:

(1) An output energy exceeding 50 mJ per pulse and a pulsed **peak power** exceeding 1 W; or

(2) An average or CW output power exceeding 1 W;

(b) An output wavelength exceeding 150 nm but not exceeding 800 nm and:

(1) An output energy exceeding 1.5 J per pulse and a pulsed **peak power** exceeding 30 W; or

(2) An average or CW output power exceeding 30 W;

(c) An output wavelength exceeding 800 nm but not exceeding 1,400 nm and:

(1) An output energy exceeding 0.25 J per pulse and a pulsed **peak power** exceeding 10 W; or

(2) An average or CW output power exceeding 10 W; or

(d) An output wavelength exceeding 1,400 nm and an average or CW output power exceeding 1 W;

(b) Semiconductor **lasers**, as follows:

Notes:

1. Semiconductor **lasers** are commonly called **laser** diodes.
2. The control on export of semiconductor **lasers** specially designed for other equipment is determined by the export control requirements applying to that other equipment.

(1) Individual, single-transverse mode semiconductor **lasers** having:

(a) An average output power exceeding 100 mW; or

(b) A wavelength exceeding 1,050 nm;

(2) Individual, multiple-transverse mode semiconductor **lasers**, or arrays of individual semiconductor **lasers,** having:

(a) An output energy exceeding 500 microjoules per pulse and a pulsed **peak power** exceeding 10 W;

(b) An average or CW output power exceeding 10 W; or

(c) A wavelength exceeding 1,050 nm;

(c) Solid state **lasers**, as follows:

(1) **Tunable lasers** having any of the following:

Note: Sub-head c.1. of this entry includes titanium-sapphire (Ti: Al^2O^3), thulium-YAG (Tm: YAG), thulium-YSGG (Tm: YSGG), alexandrite (Cr: $BeAl^2O^4$) and colour centre **lasers**.

(a) An output wavelength less than 600 nm and:

(1) An output energy exceeding 50 mJ per pulse and a pulsed **peak power** exceeding 1 W; or

(2) An average or CW output power exceeding 1 W;

(b) An output wavelength of 600 nm or more but not exceeding 1,400 nm and:

(1) An output energy exceeding 1 J per pulse and a pulsed **peak power** exceeding 20 W; or

(2) An average or CW output power exceeding 20 W; or

(c) An output wavelength exceeding 1,400 nm and:

(1) An output energy exceeding 50 mJ per pulse and a pulsed **peak power** exceeding 1 W; or

(2) An average or CW output power exceeding 1 W;

(2) Non-**tunable lasers**, as follows:

Note: Sub-head c.2. of this entry includes atomic transition solid state **lasers**.

(a) Ruby **lasers** having an output energy exceeding 20 J per pulse;

(b) Neodymium glass **lasers**, as follows:

(1) **Q-switched lasers** having:

(a) An output energy exceeding 20 J but not exceeding 50 J per pulse and an average output power exceeding 10 W; or

(b) An output energy exceeding 50 J per pulse;

(2) Non-**Q-switched lasers** having:

(a) An output energy exceeding 50 J but not exceeding 100 J per pulse and an average output power exceeding 20 W; or

(b) An output energy exceeding 100 J per pulse;

(c) Neodymium-doped (other than glass) lasers(**5**), as follows, with an output wavelength exceeding 1,000 nm but not exceeding 1,100 nm:

Note: For Neodymium-doped (other than glass) **lasers** having an output wavelength not exceeding 1,000 nm or exceeding 1,100 nm, see sub-head c.2.d. of this entry.

(1) Pulse excited, mode-locked, **Q-switched lasers** with a **pulse duration** of less than 1 ns and:

(a) A **peak power** exceeding 5 GW;

(b) An average output power exceeding 10 W; or

(c) A pulsed energy exceeding 0.1 J;

(**5**) See also sub-head c.2.d. of this entry.

(2) Pulse-excited, **Q-switched lasers**, with a pulse duration equal to or more than 1 ns, and:

(a) A single-transverse mode output with:

(1) A **peak power** exceeding 100 MW;

(2) An average output power exceeding 20 W; or

(3) A pulsed energy exceeding 2 J; or

(b) A multiple-transverse mode output with:

(1) A **peak power** exceeding 200 MW;

(2) An average output power exceeding 50 W; or

(3) A pulsed energy exceeding 2 J;

(3) Pulse-excited, non-**Q-switched lasers**, having:

(a) A single-transverse mode output with:

(1) A **peak power** exceeding 500 kW; or

(2) An average output power exceeding 150 W; or

(b) A multiple-transverse mode output with:

(1) A **peak power** exceeding 1 MW; or

(2) An average power exceeding 500 W;

(4) Continuously excited **lasers** having:

(a) A single-transverse mode output with:

(1) A **peak power** exceeding 500 kW; or

(2) An average or CW output power exceeding 150 W; or

(b) A multiple-transverse mode output with:

(1) A **peak power** exceeding 1 MW; or

(2) An average or CW output power exceeding 500 W;

(d) Other non-**tunable lasers**, having any of the following:

(1) A wavelength less than 150 nm and:

(a) An output energy exceeding 50 mJ per pulse and a pulsed **peak power** exceeding 1 W; or

(b) An average or CW output power exceeding 1 W;

(2) A wavelength of 150 nm or more but not exceeding 800 nm and:

(a) An output energy exceeding 1.5 J per pulse and a pulsed **peak power** exceeding 30 W; or

(b) An average or CW output power exceeding 30 W;

(3) A wavelength exceeding 800 nm but not exceeding 1,400 nm, as follows:

(a) **Q-switched** lasers with:

(1) An output energy exceeding 0.5 J per pulse and a pulsed **peak power** exceeding 50 W; or

(2) An average output power exceeding:

(a) 10 W for single-mode **lasers**;

(b) 30 W for multimode **lasers**;

(b) Non-**Q-switched lasers** with:

(1) An output energy exceeding 2 J per pulse and a pulsed **peak power** exceeding 50 W; or

(2) An average or CW output power exceeding 50 W; or

(4) A wavelength exceeding 1,400 nm and:

(a) An output energy exceeding 100 mJ per pulse and a pulsed **peak power** exceeding 1 W; or

(b) An average or CW output power exceeding 1 W;

(d) Dye and other liquid **lasers**, having any of the following:

(1) A wavelength less than 150 nm and:

(a) An output energy exceeding 50 mJ per pulse and a pulsed **peak power** exceeding 1 W; or

(b) An average or CW output power exceeding 1 W;

(2) A wavelength of 150 nm or more but not exceeding 800 nm and:

(a) An output energy exceeding 1.5 J per pulse and a pulsed **peak power** exceeding 20 W;

(b) An average or CW output power exceeding 20 W; or

(c) A pulsed single longitudinal mode oscillator with an average output power exceeding 1 W and a repetition rate exceeding 1 kHz if the **pulse duration** is less than 100 ns;

(3) A wavelength exceeding 800 nm but not exceeding 1,400 nm and:

(a) An output energy exceeding 0.5 J per pulse and a pulsed **peak power** exceeding 10 W; or

(b) An average or CW output power exceeding 10 W; or

(4) A wavelength exceeding 1,400 nm and:

(a) An output energy exceeding 100 mJ per pulse and a pulsed **peak power** exceeding 1 W; or

(b) An average or CW output power exceeding 1 W;

(e) Free electron **lasers**;

(f) Components, as follows:

(1) Mirrors cooled either by active cooling or by heat pipe cooling, 1 mm or less below the reflective surface;

Note: Active cooling is a cooling technique for optical components using flowing fluids within the subsurface of the optical component to remove heat from the optic.

(2) Optical mirrors or transmissive or partially transmissive optical or electro-optical components specially designed for use with specified **lasers**;

(g) Optical equipment(**6**), as follows:

(1) Dynamic wavefront (phase) measuring equipment capable of mapping at least 50 positions on a beam wavefront with:

(**6**) See head d. of entry ML23 of Group 1 of Part III of this Schedule for shared aperture optical elements capable of operating in Super-High Power Laser applications.

(a) Frame rates equal to or more than 100 Hz and phase discrimination of at least 5% of the beam's wavelength; or

(b) Frame rates equal to or more than 1,000 Hz and phase discrimination of at least 20% of the beam's wavelength;

(2) **Laser** diagnostic equipment capable of measuring **Super-High Power Laser** (SHPL) system angular beam steering errors of equal to or less than 10 microradians;

(3) Optical equipment, assemblies or components specially designed for a phased-array SHPL system for coherent beam combination to an accuracy of Lambda/10 at the designed wavelength, or 0.1 micrometre, whichever is the smaller;

(4) Projection telescopes specially designed for use with SHPL systems.

(6A006) **Magnetometers, magnetic gradiometers, intrinsic magnetic gradiometers** and compensation systems, and specially designed components therefor, as follows:

Note: This entry does not specify instruments specially designed for biomagnetic measurements for medical diagnostics, unless they incorporate unembedded sensors specified in head h. of this entry.

(a) **Magnetometers** using **superconductive**, optically pumped or nuclear precession (proton/ Overhauser) technology having a **noise level** (sensitivity) lower (better) than 0.05 nT rms per square root Hz;

(b) Induction coil **magnetometers** having a **noise level** (sensitivity) lower (better) than:

(1) 0.05 nT rms per square root Hz at frequencies of less than 1 Hz;

(2) 1×10^{-3} nT rms per square root Hz at frequencies of 1 Hz or more but not exceeding 10 Hz; or

(3) 1×10^{-4} nT rms per square root Hz at frequencies exceeding 10 Hz;

(c) Fibre optic **magnetometers** having a **noise level** (sensitivity) lower (better) than 1 nT rms per square root Hz;

(d) **Magnetic gradiometers** using multiple **magnetometers** specified in heads a., b. or c. of this entry;

(e) Fibre optic **intrinsic magnetic gradiometers** having a magnetic gradient field **noise level** (sensitivity) lower (better) than 0.3 nT/m rms per square root Hz;

(f) **Intrinsic magnetic gradiometers**, using technology other than fibre-optic technology, having a magnetic gradient field **noise level** (sensitivity) lower (better) than 0.015 nT/m rms per square root Hz;

(g) Magnetic compensation systems for magnetic sensors designed for operation on mobile platforms;

(h) **Superconductive** electromagnetic sensors, containing components manufactured from **superconductive** materials, as follows:

(1) Designed for operation at temperatures below the **critical temperature** of at least one of their **superconductive** constituents (including Josephson effect devices or **superconductive** quantum interference devices (SQUIDS));

(2) Designed for sensing electromagnetic field variations at frequencies of 1 kHz or less; and

(3) Having any of the following characteristics:

(a) Incorporating thin-film SQUIDS with a minimum feature size of less than 2 micrometres and with associated input and output coupling circuits;

(b) Designed to operate with a magnetic field slew rate exceeding 1×10^6 magnetic flux quanta per second;

(c) Designed to function without magnetic shielding in the earth's ambient magnetic field; or

(d) Having a temperature coefficient less (smaller) than 0.1 magnetic flux quantum/K.

(6A007) Gravity meters (gravimeters) and gravity gradiometers, as follows(**7**):

(a) Gravity meters for ground use having a static accuracy of less (better) than 10 microgal;

Note: Head a. of this entry does not specify ground gravity meters of the quartz element (Worden) type.

(b) Gravity meters for mobile platforms for ground, marine, submersible, space or airborne use having:

(1) A static accuracy of less (better) than 0.7 milligal; and

(2) An in-service (operational) accuracy of less (better) than 0.7 milligal with a time-to-steady-state registration of less than 2 minutes under any combination of attendant corrective compensations and motional influences;

(c) Gravity gradiometers.

(6A008) Radar systems, equipment and assemblies having any of the following characteristics, and specially designed components therefor(**8**):

Note: This entry does not specify:

a. Secondary surveillance radar (SSR);

b. Car radar designed for collision prevention;

c. Displays or monitors used for air traffic control (ATC) having no more than 12 resolvable elements per mm;

d. Meteorological (weather) radar.

(a) Operating at frequencies from 40 GHz to 230 GHz and having an average output power exceeding 100 mW;

(b) Having a tunable bandwidth exceeding ± 6.25% of the centre operating frequency;

Note: The centre operating frequency equals one half of the sum of the highest plus the lowest specified operating frequencies.

(c) Capable of operating simultaneously on more than two carrier frequencies;

(d) Capable of operating in synthetic aperture (SAR), inverse synthetic aperture (ISAR) or sidelooking airborne (SLAR) radar mode;

(e) Incorporating **electronically steerable phased array antennae**;

(f) Capable of heightfinding non-cooperative targets;

Note: Head f. of this entry does not specify precision approach radar equipment (PAR) conforming with International Civil Aviation Organisation (ICAO) standards published by ICAO in Annex 10 of Volume 1.

(g) Designed specially for airborne (balloon or airframe mounted) operation and having Doppler signal processing for the detection of moving targets;

(h) Employing processing of radar signals using:

(**7**) See also entry 6A107.
(**8**) See also entry 6A108.

(1) **Radar spread spectrum** techniques; or

(2) **Radar frequency agility** techniques;

(i) Providing ground-based operation with a maximum **instrumented range** exceeding 185 km;

Note: Head i. of this entry does not specify;

a. Fishing ground surveillance radar;

b. Ground radar equipment specially designed for enroute air traffic control and **software** specially designed for the **use** thereof, provided:

1. It has a maximum **instrumented** range of 500 km or less;

2. It is configured so that radar target data can be transmitted only one way from the radar site to one or more civil ATC centres;

3. It contains no provisions for remote control of the radar scan rate from the enroute ATC centre; and

4. It is to be permanently installed.

N.B.: The **use software** must be limited to **object code** and the minimum amount of **source code** necessary for installation, operation or maintenance.

(j) **Laser** radar or Light Detection and Ranging (LIDAR) equipment, having either of the following:

(1) **Space-qualified**; or

(2) Employing coherent heterodyne or homodyne detection techniques and having an angular resolution of less (better) than 20 microradians;

Note: Head j. of this entry does not specify LIDAR equipment specially designed for surveying or for meteorological observation.

(k) Having signal processing sub-systems using **pulse compression** with:

(1) A **pulse compression** ratio exceeding 150; or

(2) A pulse width of less than 200 ns; or

(l) Having data processing sub-systems with:

(1) **Automatic target tracking** providing, at any antenna rotation, the predicted target position beyond the time of the next antenna beam passage;

Note: Sub-head l.1. of this entry does not specify conflict alert capability in ATC systems, or marine or harbour radar.

(2) Calculation of target velocity from primary radar having non-periodic (variable) scanning rates;

(3) Processing for automatic pattern recognition (feature extraction) and comparison with target characteristic data bases (waveforms or imagery) to identify or classify targets; or

(4) Superposition and correlation, or fusion, of target data from two or more **geographically dispersed** and **interconnected radar sensors** to enhance and discriminate targets.

Note: Sub-head l.4 of this entry does not specify systems, equipment and assemblies used for marine traffic control.

(6A102) Radiation hardened detectors, other than those specified in entry 6A002, for use in protecting against nuclear effects (e.g. electromagnetic pulse (EMP), X-rays, combined blast and

thermal effects), and usable for **missiles**, designed or rated to withstand radiation levels which meet or exceed a total irradiation dose of 5×10^5 rads (Si).

In this entry, "a detector" means a mechanical, electrical, optical or chemical device that automatically identifies and records, or registers a stimulus such as an environmental change in pressure or temperature, an electrical or electromagnetic signal or radiation from a radioactive material.

(6A107) Specially designed components for gravity meters and gravity gradiometers specified in heads b. and c. of entry 6A007.

(6A108) Radar systems and tracking systems, other than those specified in entry 6A008, as follows:

(a) Radar and laser radar systems designed or modified for use in systems specified in entries 9A004 or 9A104;

(b) Precision tracking systems, usable for **missiles**, as follows:

(1) Tracking systems which use a code translator in conjunction with either surface or airborne references or navigation satellite systems to provide real-time measurements of in-flight position and velocity;

(2) Range instrumentation radars including associated optical/infrared trackers with all of the following capabilities:

(a) angular resolution better than 3 milliradians (0.5 mils);

(b) range of 30 km or greater with a range resolution better than 10 m rms;

(c) velocity resolution better than 3 m/s.

(6A202) Photomultiplier tubes with a photocathode area of greater than 20 cm^2 having an anode pulse rise time of less than 1 ns.

(6A203) Cameras and components, other than those specified in entry 6A003, as follows:

(a) Mechanical rotating mirror cameras and specially designed components therefor, as follows:

(1) Mechanical framing cameras with recording rates greater than 225,000 frames per second;

(2) Streak cameras with writing speeds greater than 0.5 mm per microsecond;

Note: Components of such cameras include specially designed synchronizing electronics and specially designed rotor assemblies (consisting of turbines, mirrors and bearings).

(b) Electronic streak and framing cameras and tubes, as follows:

(1) Electronic streak cameras capable of 50 ns or less time resolution and streak tubes therefor;

(2) Electronic (or electronically shuttered) framing cameras capable of 50 ns or less frame exposure time;

(3) Framing tubes and solid-state imaging devices for use with cameras specified in sub-head b.2. of this entry, as follows:

(a) Proximity focused image intensifier tubes having the photocathode deposited on a transparent conductive coating to decrease photocathode sheet resistance;

(b) Gate silicon intensifier target (SIT) videcon tubes, where a fast system allows gating the photoelectrons from the photocathode before they impinge on the SIT plate;

(c) Kerr or pockel cell electro-optical shuttering; or

(d) Other framing tubes and solid-state imaging devices having a fast-image gating time of less than 50 ns specially designed for cameras specified in sub-head b.2. of this entry;

(c) Radiation-hardened TV cameras specially designed or rated as radiation hardened to withstand greater than 5×10^4 grays (Si)(5×10^6 rad (Si)) without operational degradation and specially designed lenses used therein.

(6A205) **Lasers**, other than those specified in entry 6A005, as follows:

(a) Argon ion **lasers** with greater than 40 W average output power operating at wavelengths between 400 nm and 515 nm;

(b) Tunable pulsed single-mode dye oscillators capable of an average power output of greater than 1 W, a repetition rate greater than 1 kHz, a pulse less than 100 ns, and a wavelength between 300 nm and 800 nm;

(c) Tunable pulsed dye **laser** amplifiers and oscillators, with an average power output of greater than 30W, a repetition rate greater than 1 kHz, a pulse width less than 100 ns, and a wavelength between 300 nm and 800 nm;

except:

Single mode oscillators;

(d) Pulsed carbon dioxide **lasers** with a repetition rate greater than 250 Hz, an average power output of greater than 500 W, and a pulse of less than 200 ns operating at wavelengths between 9,000 nm and 11,000 nm;

(e) Para-hydrogen Raman shifters designed to operate at 16 micrometres output wavelength and at a repetition rate greater than 250 Hz.

(6A225) Velocity interferometers for measuring velocities in excess of 1 km/s during time intervals of less than 10 microsecond (VISARs, Doppler laser interferometers (DLIs), etc.).

(6A226) Pressure sensors, as follows:

(a) Manganin gauges for pressures greater than 100 kilobars; or

(b) Quartz pressure transducers for pressures greater than 100 kilobars.

6B Test, Inspection and Production Equipment

(a) (6B004) (a) Equipment for measuring absolute reflectance to an accuracy of ± 0.1% of the reflectance value;

(b) Equipment other than optical surface scattering measurement equipment, having an unobscured aperture of more than 10 cm, specially designed for the non-contact optical measurement of a non-planar optical surface figure (profile) to an **accuracy** of 2 nm or less (better) against the required profile.

Note: This entry does not specify microscopes.

(6B005) Specially designed or modified equipment, including tools, dies, fixtures or gauges, as follows, and other specially designed components and accessories therefor:

(a) For the manufacture or inspection of:

(1) Free electron **laser** magnet wigglers;

(2) Free electron **laser** photo injectors;

(b) For the adjustment, to required tolerances, of the longitudinal magnetic field of free electron **lasers**.

(6B007) Equipment to produce, align and calibrate land-based gravity meters with a static accuracy of better than 0.1 milligal.

(6B008) Pulse radar cross-section measurement systems having transmit pulse widths of 100 ns or less and specially designed components therefor.

(6B108) Systems specially designed for radar cross section measurement usable for **missiles** and their subsystems.

6C Materials

(6C002) Optical Sensors:

(a) Elemental tellurium (Te) of purity levels equal to or more than 99.9995%;

(b) Single crystals of cadmium telluride (CdTe), cadmium zinc telluride (CdZnTe) or mercury cadmium telluride (HgCdTe) of any purity level, including epitaxial wafers thereof;

(c) **Optical fibre preforms** specially designed for the manufacture of high birefringence fibres specified in sub-head d.3. of entry 6A002.

(6C004) Optics:

(a) Zinc selenide (ZnSe) and zinc sulphide (ZnS) **substrate blanks** produced by the chemical vapour deposition process:

(1) Larger than 100 cm^3 in volume; or

(2) Larger than 80 mm in diameter with a thickness equal to or more than 20 mm;

(b) Boules of the following electro-optic materials:

(1) Potassium titanyl arsenate (KTA);

(2) Silver gallium selenide ($AgGaSe_2$); or

(3) Thallium arsenic selenide (Tl_3AsSe_3, also known as TAS);

(c) Non-linear optical materials having:

(1) Third order susceptibility (chi 3) equal to or less than 1 W/m^2; and

(2) A response time of less than 1 ms;

(d) **Substrate blanks** of silicon carbide or beryllium beryllium (Be/Be) deposited materials exceeding 300 mm in diameter or major axis length;

(e) Low optical absorption materials, as follows:

(1) Bulk fluoride compounds containing ingredients with a purity of 99.999% or better;

Note: Sub-head e.1. of this entry specifies fluorides of zirconium or aluminium and variants.

(2) Bulk fluoride glass made from compounds specified in sub-head e.1. of this entry;

(f) Glass, including fused silica, phosphate glass, fluorophosphate glass, zirconium fluoride (ZrF_4) and hafnium fluoride (HfF_4) with:

(1) A hydroxyl ion (OH—) concentration of less than 5 ppm;

(2) Integrated metallic purity levels of less than 1 ppm; and

(3) High homogeneity (index of refraction variance) less than 5×10^{-6};

(g) Synthetically produced diamond material with an absorption of less than 10^{-5} cm^{-1} for wavelengths exceeding 200 nm but not exceeding 14,000 nm;

(h) **Optical fibre preforms** made from bulk fluoride compounds containing ingredients with a purity of 99.999% or better, specially designed for the manufacture of **fluoride fibres** specified in head f. of entry 6A004.

(6C005) Synthetic crystalline laser host material in unfinished form, as follows:

(a) Titanium doped sapphire;

(b) Alexandrite.

6D Software

(6D001) **Software** specially designed for the **development** or **production** of **goods** specified in entries 6A004, 6A005, 6A008 or 6B008.

(6D002) **Software** specially designed for the **use** of **goods** specified in head b. of entry 6A002, or entries 6A008 or 6B008.

(6D003) Other **software**, as follows:

(a) (1) **Software** specially designed for acoustic beam forming for the **real time processing** of acoustic data for passive reception using towed hydrophone arrays;

(2) **Source code** for the **real time processing** of acoustic data for passive reception using towed hydrophone arrays;

(b) (1) **Software** specially designed for magnetic compensation systems for magnetic sensors designed to operate on mobile platforms;

(2) **Software** specially designed for magnetic anomaly detection on mobile platforms;

(c) **Software** specially designed to correct motional influences of gravity meters or gravity gradiometers;

(d) (1) Air Traffic Control **software** application **programmes** hosted on general purpose computers located at Air Traffic Control centres and capable of any of the following:

(a) Processing and displaying more than 150 simultaneous **system tracks**;

(b) Accepting radar target data from more than four primary radars; or

(c) Automatically handing over primary radar target data (if not correlated with secondary surveillance radar (SSR) data) from the host ATC centre to another ATC centre;

(2) **Software** for the design or **production** of radomes which:

(a) Are specially designed to protect the **electronically steerable phased** array antennae specified in head e. of entry 6A008; and

(b) Limit the average side-lobe level increase by less than 13 dB for frequencies equal to or higher than 2 GHz.

(6D102) Software specially designed for the **use** of **goods** specified in entry 6A108.

(6D103) **Software** which processes post-flight, recorded data, obtained from the systems specified in head b. of entry 6A108, enabling determination of vehicle position throughout its flight path.

6E Technology

(6E001) **Technology required** for the **development** of **goods** specified in sub-categories 6A, 6B, 6C or 6D.

(6E002) **Technology required** for the **production** of **goods** specified in sub-categories 6A, 6B or 6C.

(6E003) Other **technology**, as follows:

(a) (1) Optical surface coating and treatment **technology** required to achieve uniformity of 99.5% or better for optical coatings 500 mm or more in diameter or major axis length and with a total loss (absorption and scatter) of less than 5×10^{-3}

(2) Optical fabrication technologies, as follows:

(a) For serially producing optical components at a rate exceeding 10 m^2 of surface area per year on any single spindle and with:

(1) An area exceeding 1 m^2; and

(2) A surface figure exceeding lambda/10 rms at the designed wave-length;

(b) Single point diamond turning techniques producing surface finish accuracies of better than 10 nm rms on non-planar surfaces exceeding 0.5m^2(**9**);

(b) (1) **Technology** for optical filters with a bandwidth equal to or less than 10 nm, a field of view (FOV) exceeding 40° and a resolution exceeding 0.75 line pairs per milliradian;

(2) **Technology required** for the **development**, **production** or **use** of specially designed diagnostic instruments or targets in test facilities for **Super High Power Lasers** (SHPL) testing or testing or evaluation of materials irradiated by SHPL beams;

(c) **Technology required** for the **development** or production of fluxgate **magnetometers** or fluxgate **magnetometer** systems having a noise level:

(1) Less than 0.05 nT rms per square root Hz at frequencies of less than 1 Hz; or

(2) 1×10^{-3} nT rms per square root Hz at frequencies of 1 Hz or more.

(6El01) **Technology required** for the **use** of **goods** specified in entry 6A002, heads b. and c. of entry 6A007, entries 6A008, 6A102, 6A107, 6A108, 6B108, 6D102 or 6D103.

Note: This entry only specifies technology for goods specified in entry 6A008 when designed for airborne applications and usable in **missiles**.

(6E201) **Technology required** for the **use** of **goods** specified in entry 6A003, sub-head a.1.c. of entry 6A005, sub-head a.2.a. of entry 6A005, sub-head c.1.b. of entry 6A005, sub-head c.2.c.2. of entry 6A005, sub-head c.2.d.2.b. of entry 6A005, entries 6A202, 6A203, 6A205, 6A225, or 6A226.

Category 7 — Navigation and Avionics

Equipment, Assemblies and Components

7A.—(7A001) Accelerometers designed for use in inertial navigation or guidance systems and having any of the following characteristics, and specially designed components therefor(**10**):

(a) A **bias stability** of less (better) than 130 micro g with respect to a fixed calibration value over a period of one year;

(b) A **scale factor stability** of less (better) than 130 ppm with respect to a fixed calibration value over a period of one year;

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

(7A002) Gyros having any of the following characteristics, and specially designed components therefor(**11**):

(a) A **drift rate stability**, when measured in a 1 g environment over a period of three months and with respect to a fixed calibration value, of:

(1) Less (better) than 0.1° per hour when specified to function at linear acceleration levels below 10 g; or

(**9**) See also head d. of entry 2E003.
(**10**) See also entry 7A101
(**11**) See also entry 7A102.

(2) Less (better) than 0.5° per hour when specified to function at linear acceleration levels from 10 g to 100 g inclusive;

(b) Specified to function at linear acceleration levels above 100 g.

(7A003) Inertial navigation systems (gimballed and strapdown) and inertial equipment for attitude, guidance or control having any of the following characteristics, and specially designed components therefor(**12**):

(a) For **aircraft**:

(1) Navigation error (free inertial) of 0.8 nautical mile per hour (50% Circular Error Probable (CEP)) or less (better) subsequent to normal alignment;

(2) Not certified for use on civil **aircraft** by civil aviation authorities; or

(3) Specified to function at linear acceleration levels exceeding 10 g;

(b) For land or **spacecraft**:

(1) Navigation error (free inertial) of 0.8 nautical mile per hour (50% CEP) or less (better) subsequent to normal alignment; or

(2) Specified to function at linear acceleration levels exceeding 10 g.

(7A004) Gyro-astro compasses, and other devices which derive position or orientation by means of automatically tracking celestial bodies or satellites, with an azimuth accuracy of equal to or less (better) than 5 seconds of arc(**13**).

(7A005) Global Positioning Satellite (GPS) receiving equipment having either of the following characteristics, and specially designed components therefor(**14**):

(a) Employing encryption/decryption; or

(b) A null-steerable antenna.

(7A006) Airborne altimeters(**15**) operating at frequencies other than 4.2 to 4.4 GHz inclusive, having either of the following characteristics(**16**):

(a) **Power management**; or

(b) Using phase shift key modulation.

Note: For automatic pilots for underwater vehicles, see Category 8, for radar, see Category 6.

(7A101) Accelerometers, other than those specified in entry 7A001, with a threshold of 0.05 g or less, or a linearity error within 0.25% of full scale output, or both, which are designed for use in inertial navigation systems or in guidance systems of all types and specially designed components therefor.

Note: This entry does not specify accelerometers which are specially designed and developed as Measurement While Drilling (MWD) sensors for use in downhole well service operations.

(7A102) All types of gyros, other than those specified in entry 7A002, usable in **missiles**, with a rated **drift rate stability** of less than 0.5° (1 sigma or rms) per hour in a 1 g environment and specially designed components therefor.

(7A103) Instrumentation, navigation and direction finding equipment and systems, other than those specified in entry 7A003, as follows; and specially designed components therefor:

(**12**) See also entry 7A102.
(**13**) See also entry 7A104.
(**14**) See also entry 7A105.
(**15**) See Category 6 for radar and Category 8 for automatic pilots for underwater vehicles.
(**16**) See also entry 7A106.

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

(b) Integrated flight instrument systems, which include gyrostabilisers or automatic pilots, designed or modified for use in systems specified in entries 9A004 or 9A104.

(7A104) Gyro-astro compasses and other devices, other than those specified in entry 7A004, which derive position or orientation by means of automatically tracking celestial bodies or satellites and specially designed components therefor.

(7A105) Global Positioning Systems (GPS) or similar satellite receivers, other than those specified in entry 7A005, capable of providing navigation information under the following operational conditions and designed or modified for use in systems specified in entry 9A004 or 9A104;

(a) At speeds in excess of 515 m/s; and

(b) At altitudes in excess of 18 km.

(7A106) Altimeters, other than those specified in entry 7A006, of radar or laser radar type, designed or modified for use in systems specified in entry 9A004 or 9A104.

(7A115) Passive sensors for determining bearing to specific electromagnetic source (direction finding equipment) or terrain characteristics, designed or modified for use in systems specified in entry 9A004 or 9A104.

Note: This entry includes sensors for the following equipment:

a. Terrain contour mapping equipment;

b. Imaging sensor equipment;

c. Interferometer equipment.

(7A116) Flight Control systems, as follows; designed or modified for systems specified in entry 9A004 or 9A104:

(a) Hydraulic, mechanical, electro-optical, electro-mechanical or fly by wire types;

(b) Attitude control equipment.

(7A117) **Guidance sets**, usable in **missiles**, capable of achieving system accuracy of 3.33% or less of the range (e.g., a CEP of 10 km or less at a range of 300 km).

7B Test, Inspection and Production Equipment

(7B001) Test, calibration or alignment equipment specially designed for equipment specified in sub-category 7A except: equipment for Maintenance Level I or Maintenance Level II.

Notes:

1. Maintenance Level I

   The failure of an inertial navigation unit is detected on the aircraft by indications from the control and display unit (CDU) or by the status message from the corresponding sub-system. By following the manufacturer's manual, the cause of the failure may be localised at the level of the malfunctioning line replaceable unit (LRU). The operator then removes the LRU and replaces it with a spare.

2. Maintenance Level II

   The defective LRU is sent to the maintenance workshop (the manufacturer's or that of the operator responsible for level II maintenance). At the maintenance workshop, the malfunctioning LRU is tested by various appropriate means to verify and localise the defective shop replaceable assembly (SRA) module responsible for the failure. This SRA is removed and replaced by an operative spare. The defective SRA (or possibly the complete LRU) is then shipped to the manufacturer.

3. *N.B.:* Maintenance Level II does not include the removal of specified accelerometers or gyro sensors from the SRA.

(7B002) Equipment, as follows(**17**), specially designed to characterize mirrors for ring laser gyros:

(a) Scatterometers having a measurement accuracy of 10 ppm or less (better);

(b) Profilometers having a measurement accuracy of 0.5 nm (5 angstrom) or less (better).

(7B003) Equipment specially designed for the production of equipment specified in sub-category 7A, including:

(a) Gyro tuning test stations;

(b) Gyro dynamic balance stations;

(c) Gyro run-in/motor test stations;

(d) Gyro evacuation and fill stations;

(e) Centrifuge Fixture for Gyro bearing;

(f) Accelerometer axis align stations.

(7B102) Reflectometers specially designed to characterise mirrors, for **laser** gyros, having a measurement accuracy of 50 ppm or less (better).

(7B103) Specially designed **production facilities** for equipment specified in entry 7A117.

7C Materials

None

7D Software

(7D001) **Software** specially designed or modified for the **development** or **production** of **goods** specified in sub-categories 7A or 7B.

(7D002) **Source code** for the **use** of any inertial navigation equipment or Attitude Heading Reference Systems (AHRS) (except: gimballed AHRS) including inertial equipment not specified in entries 7A003 or 7A004.

Note: AHRS generally differ from inertial navigation systems (INS) in that an AHRS provides attitude heading information and normally does not provide the acceleration, velocity and position information associated with an INS.

(7D003) Other software, as follows:

(a) **Software** specially designed or modified to improve the operational performance or reduce the navigational error of systems to the levels specified in entries 7A003 or 7A004;

(b) **Source code** for hybrid integrated systems which improves the operational performance or reduces the navigational error of systems to the level specified in entry 7A003 by continuously combining inertial data with any of the following navigation data:

(1) Doppler radar velocity;

(2) Global Positioning Satellite (GPS) references; or

(3) Terrain data base;

(c) **Source code** for integrated avionics or mission systems which combine sensor data and employ knowledge-based expert systems;

(d) **Source code** for the **development** of:

(1) Digital flight management systems for flight path optimization;

(**17**) See also entry 7B102.

(2) Integrated propulsion and flight control systems;

(3) Fly-by-wire or fly-by-light control systems;

(4) Fault-tolerant or self-reconfiguring **active flight control systems**;

(5) Airborne automatic direction finding equipment;

(6) Air data systems based on surface static data;

(7) Raster-type head-up displays or three dimensional displays.

(7D101) **Software** specially designed for the **use** of **goods** specified in entries 7A001 to 7A006, 7A101 to 7A106, 7A115, 7B002, 7B003, 7B102 or 7B103.

(7D102) Integration **software** for the **goods** specified in entries 7A003 or 7A103.

(7D103) **Software** specially designed for modelling or simulation of the **guidance sets** specified in entry 7A117 or for their design integration with the systems specified in entries 9A004 or 9A104.

*Note:***Software** specified in this entry remains controlled by this entry when combined with specially designed hardware specified in entry 4A102.

7E Technology

(7E001) **Technology required** for the **development** of **goods** or **software** specified in sub-categories 7A, 7B or 7D.

(7E002) **Technology required** for the **production** of **goods** specified in sub-categories 7A or 7B.

(7E003) **Technology required** for the repair, refurbishing or overhaul of **goods** specified in entries 7A001 to 7A004;

except:

for maintenance **technology** directly associated with calibration, removal or replacement of damaged or unserviceable LRUs and SRAs of a civil **aircraft** as described in Maintenance Level I or Maintenance Level II(**18**).

(7E004) Other technology, as follows:

(a) Technology for the development or production of:

(1) Airborne automatic direction finding equipment operating at frequencies exceeding 5 MHz;

(2) Air data systems based on surface static data only, i.e., which dispense with conventional air data probes;

(3) Raster-type head-up displays or three dimensional displays for **aircraft**;

(4) Inertial navigation systems or gyro-astro compasses containing accelerometers or gyros specified in entries 7A001 or 7A002;

(b) **Development technology**, as follows, for **active flight control systems** (including fly-by-wire or fly-by-light):

(1) Configuration design for interconnecting multiple microelectronic processing elements (on-board computers) to achieve **real time processing** for control law implementation;

(2) Control law compensation for sensor location or dynamic airframe loads, i.e., compensation for sensor vibration environment or for variation of sensor location from the centre of gravity;

(3) Electronic management of data redundancy or systems redundancy for fault detection, fault tolerance, fault isolation or reconfiguration;

(**18**) See Note to entry 7B001.

Note: Sub-head b.3. of this entry does not specify **technology** for the design of physical redundancy.

(4) Flight controls which permit inflight reconfiguration of force and moment controls for real time autonomous air vehicle control;

(5) Integration of digital flight control, navigation and propulsion control data into a digital flight management system for flight path optimization;

except:

development technology for aircraft flight instrument systems integrated solely for VOR, DME, ILS or MLS navigation or approaches;

(6) Full authority digital flight control or multi sensor mission management systems incorporating knowledge-based expert systems (**19**);

(c) **Technology** for the **development** of helicopter systems, as follows:

(1) Multi-axis fly-by-wire or fly-by-light controllers which combine the functions of at least two of the following into one controlling element:

(a) Collective controls;

(b) Cyclic controls;

(c) Yaw controls;

(2) *Circulation-controlled anti-torque or circulation-controlled directional control systems;*

(3) Rotor blades incorporating variable geometry airfoils for use in systems using individual blade control.

(7E101) **Technology required** for the **use** of **goods** specified in entries 7A001 to 7A006, 7A101 to 7A106, 7A115 to 7A117, 7B002, 7B003, 7B102, 7B103 or 7D101 to 7D103.

(7E102) **Technology** for protection of avionics and electrical subsystems against electromagnetic pulse (EMP) and electromagnetic interference (EMI) hazards, from external sources, as follows:

(a) Design **technology** for shielding systems;

(b) Design **technology** for the configuration of hardened electrical circuits and sub-systems;

(c) Design **technology** for the determination of hardening criteria for heads a. or b. of this entry.

(7E104) *Technology* for the integration of the flight control, guidance, and propulsion data into a flight management system for optimization of rocket system trajectory.

Category 8 — Marine

Equipment, Assemblies and Components

8A.—(8A001) Submersible vehicles(**20**) or surface vessels, as follows:

(a) Manned, tethered submersible vehicles designed to operate at depths exceeding 1,000 m;

(b) Manned, untethered submersible vehicles:

(1) Designed to **operate autonomously** and having a lifting capacity of:

(a) 10% or more of their weight in air; and

(**19**) For technology for Full Authority Digital Engine Control (FADEC) see sub-head a.10. of entry 9E003.

(**20**) See also Category 5 for encrypted communication equipment; Category 6 for sensors; Categories 7 and 8 for navigation equipment; entry 8A002 for underwater systems or equipment.

(b) 15 kN or more;

(2) Designed to operate at depths exceeding 1,000 m; or

(3) (a) Designed to carry a crew of 4 or more;

(b) Designed to **operate autonomously** for 10 hours or more;

(c) Having a **range** of 25 nautical miles or more; and

(d) Having a length of 21 m or less;

(c) Unmanned, tethered submersible vehicles designed to operate at depths exceeding 1,000 m:

(1) Designed for self-propelled manoeuvre using propulsion motors or thrusters specified in sub-head a.2. of entry 8A002; or

(2) Having a fibre optic data link;

(d) Unmanned, untethered submersible vehicles:

(1) Designed for deciding a course relative to any geographical reference without real-time human assistance;

(2) Having an acoustic data or command link; or

(3) Having a fibre optic data or command link exceeding 1,000 m;

(e) Ocean salvage systems with a lifting capacity exceeding 5 MN for salvaging objects from depths exceeding 250 m and having either of the following:

(1) Dynamic positioning systems capable of position keeping within 20 m of a given point provided by the navigation system; or

(2) Seafloor navigation and navigation integration systems for depths exceeding 1,000 m with positioning accuracies to within 10 m of a predetermined point;

(f) Surface-effect vehicles (fully skirted variety) with a maximum design speed, fully loaded, exceeding 30 knots in a significant wave height of 1.25 m (Sea State 3) or more, a cushion pressure exceeding 3,830 Pa, and a light-ship-to-full-load displacement ratio of less than 0.7;

(g) Surface-effect vehicles (rigid sidewalls) with a maximum design speed, fully loaded, exceeding 40 knots in a significant wave height of 3.25 m (Sea State 5) or more;

(h) Hydrofoil vessels with active systems for automatically controlling foil systems, with a maximum design speed, fully loaded, of 40 knots or more in a significant wave height of 3.25 m (Sea State 5) or more;

(i) Small waterplane area vessels with:

(1) A full load displacement exceeding 500 tonnes with a maximum design speed, fully loaded, exceeding 35 knots in a significant wave height of 3.25 m (Sea State 5) or more; or

(2) A full load displacement exceeding 1,500 tonnes with a maximum design speed, fully loaded, exceeding 25 knots in a significant wave height of 4 m (Sea State 6) or more.

Note: A small waterplane area vessel is defined by the following formula: waterplane area at an operational design draft less than 2 × (displaced volume at the operational design draught)^2/3;.

(8A002) Systems or equipment(**21**), as follows:

(**21**) See Category 5 Telecommunications for underwater communications systems and underwater optical fibre cable.

Note: For underwater communications systems and underwater optical fibre cables, see Category 5 Telecommunications.

a. Systems or equipment, specially designed or modified for submersible vehicles, designed to operate at depths exceeding 1,000 m, as follows:

    1. Pressure housings or pressure hulls with a maximum inside chamber diameter exceeding 1.5 m;

    2. Direct current propulsion motors or thrusters;

    3. Umbilical cables, and connectors therefor, using optical fibre and having synthetic strength members;

b. Systems specially designed or modified for the automated control of the motion of equipment for submersible vehicles specified in entry 8A001 using navigation data and having closed loop servo-controls to:

    1. Enable a vehicle to move within 10 m of a predetermined point in the water column;

    2. Maintain the position of the vehicle within 10 m of a predetermined point in the water column; or

    3. Maintain the position of the vehicle within 10 m while following a cable on or under the seabed;

c. Fibre optic hull penetrators or connectors;

d. Underwater vision systems, as follows:

    1. a. Television systems (comprising camera, lights, monitoring and signal transmission equipment) having a limiting resolution when measured in air of more than 500 lines and specially designed or modified for remote operation with a submersible vehicle; or

        b. Underwater television cameras having a limiting resolution when measured in air of more than 700 lines;

        Note: Limiting resolution in television is a measure of horizontal resolution usually expressed in terms of the maximum number of lines per picture height discriminated on a test chart, using Institution of Electrical and Electronic Engineers (IEEE) Standard 208/1960.

    2. Systems, specially designed or modified for remote operation with an underwater vehicle, employing techniques to minimise the effects of back scatter, including range-gated illuminators or **laser** systems;

    3. Low light level television cameras specially designed or modified for underwater use containing:

        a. Image intensifier tubes specified in sub-head a.2.a. of entry 6A002; and

        b. More than 150,000 **active pixels** per solid state area array;

e. Photographic still cameras specially designed or modified for underwater use, having a film format of 35 mm or larger, and:

    1. Annotating the film with data provided by a source external to the camera;

    2. Having autofocussing or remote focussing specially designed for underwater use;

    3. Having automatic back focal distance correction; or

    4. Having automatic compensation control specially designed to permit an underwater camera housing to be usable at depths exceeding 1,000 m;

f. Electronic imaging systems, specially designed or modified for underwater use, capable of storing digitally more than 50 exposed images;

g. Light systems, as follows, specially designed or modified for underwater use:

1. Stroboscopic light systems capable of a light output energy of more than 300 J per flash;

2. Argon arc light systems specially designed for use below 1,000 m;

h. **Robots** specially designed for underwater use, controlled by using a dedicated stored programme computer:

1. Having systems that control the **robot** using information from sensors which measure force or torque applied to an external object, distance to an external object, or tactile sense between the **robot** and an external object; or

2. Capable of exerting a force of 250 N or more or a torque of 250 Nm or more and using titanium based alloys or **fibrous or filamentary composite** materials in their structural members;

i. Remotely controlled articulated manipulators specially designed or modified for use with submersible vehicles:

1. Having systems which control the manipulator using the information from sensors which measure the torque or force applied to an external object, or tactile sense between the manipulator and an external object; or

2. Controlled by proportional master-slave techniques or by using a dedicated stored programme computer, and having 5 degrees of freedom of movement or more;

Note: Only functions having proportional control using positional feedback or by using a dedicated stored programme computer are counted when determining the number of degrees of freedom of movement.

j. Air independent power systems, as follows, specially designed for underwater use:

1. Brayton, Stirling or Rankine cycle engine air independent power systems having any of the following:

a. Chemical scrubber or absorber systems specially designed to remove carbon dioxide, carbon monoxide and particulates from recirculated engine exhaust;

b. Systems specially designed to use a monoatomic gas;

c. Devices or enclosures specially designed for underwater noise reduction in frequencies below 10 kHz, or special mounting devices for shock mitigation; or

d. Systems specially designed:

1. To pressurise the products of reaction or for fuel reformation;

2. To store the products of the reaction; and

3. To discharge the products of the reaction against a pressure of 100 kPa or more;

2. Diesel cycle engine air independent systems, having all of the following:

a. Chemical scrubber or absorber systems specially designed to remove carbon dioxide, carbon monoxide and particulates from recirculated engine exhaust;

b. Systems specially designed to use a monoatomic gas;

c. Devices or enclosures specially designed for underwater noise reduction in frequencies below 10 kHz or special mounting devices for shock mitigation; and

d. Specially designed exhaust systems that do not exhaust continuously the products of combustion;

3. Fuel cell air independent power systems with an output exceeding 2 kW having either of the following:
    a. Devices or enclosures specially designed for underwater noise reduction in frequencies below 10 kHz or special mounting devices for shock mitigation; or
    b. Systems specially designed:
        1. To pressurise the products of reaction or for fuel reformation;
        2. To store the products of the reaction; and
        3. To discharge the products of the reaction against a pressure of 100 kPa or more;

k. Skirts, seals and fingers, as follows:
    1. Designed for cushion pressures of 3,830 Pa or more, operating in a significant wave height of 1.25 m (Sea State 3) or more and specially designed for **surface effect vehicles** (fully skirted variety) specified in head f. of entry 8A001;
    2. Designed for cushion pressures of 6,224 Pa or more, operating in a significant wave height of 3.25 m (Sea State 5) or more and specially designed for **surface effect vehicles** (rigid sidewalls) specified in head g. of entry 8A001;

l. Lift fans rated at more than 400 kW specially designed for **surface effect vehicles** specified in heads f. or g. of entry 8A001;

m. Fully submerged subcavitating or supercavitating hydrofoils specially designed for vessels specified in head h. of entry 8A001;

n. Active systems specially designed or modified to control automatically the sea-induced motion of vehicles or vessels specified in heads f., g., h. or i. of entry 8A001;

o. 1. Water-screw propeller or power transmission systems, as follows, specially designed for **surface effect vehicles** (fully skirted or rigid sidewall variety), hydrofoils or small waterplane area vessels specified in heads f., g., h. or i. of entry 8A001:
    a. Supercavitating, super-ventilated, partially-submerged or surface piercing propellers rated at more than 7.5 MW;
    b. Contrarotating propeller systems rated at more than 15 MW;
    c. Systems employing pre-swirl or post-swirl techniques for smoothing the flow into a propeller;
    d. Light-weight, high capacity (K factor exceeding 300) reduction gearing;
    e. Power transmission shaft systems, incorporating **composite** material components, capable of transmitting more than 1 MW;
    2. Water-screw propeller, power generation or transmission systems for use on vessels, as follows:
    a. Controllable-pitch propellers and hub assemblies rated at more than 30 MW;
    b. Internally liquid-cooled electric propulsion engines with a power output exceeding 2.5 MW;
    c. **Superconductive** propulsion engines, or permanent magnet electric propulsion engines, with a power output exceeding 0.1 MW;
    d. Power transmission shaft systems, incorporating **composite** material components, capable of transmitting more than 2 MW;
    e. Ventilated or base-ventilated propeller systems rated at more than 2.5 MW;

3. Noise reduction systems for use on vessels of 1,000 tonnes displacement or more, as follows:

    a. Noise reduction systems that attenuate at frequencies below 500 Hz and consist of compound acoustic mounts for the acoustic isolation of diesel engines, diesel generator sets, gas turbines, gas turbine generator sets, propulsion motors or propulsion reduction gears, specially designed for sound or vibration isolation, having an intermediate mass exceeding 30% of the equipment to be mounted;

    b. Active noise reduction or cancellation systems, or magnetic bearings, specially designed for power transmission systems, and incorporating electronic control systems capable of actively reducing equipment vibration by the generation of anti-noise or anti-vibration signals directly to the source;

p. Pumpjet propulsion systems with a power output exceeding 2.5 MW using divergent nozzle and flow conditioning vane techniques to improve propulsive efficiency or reduce propulsion-generated underwater-radiated noise.

(8A990) **The export of goods specified in this entry is prohibited to any destination in Iran or Iraq.**

Vessels, other than those specified in entry 8A001, as follows: and specially designed components therefor;

a. Vessels having special structural features for landing personnel and/or vehicles on a beach;

b. Vessels capable of supporting helicopter operations and maintenance;

c. Vessels capable of submerging;

d. Vessels not elsewhere specified in this Part of this Schedule of below 100 tonnes GRT including inflatable craft in an inflated or uninflated state;

except:

Light vessels, fire floats and dredgers.

(8A991) **The export of goods specified in this entry is prohibited to any destination in Libya.**

Vessels with decks and platforms specially strengthened to receive weapons, other than those specified in entry 8A001, and specially designed components therefor.

8B Test, Inspection and Production Equipment

(8B001) Water tunnels, having a background noise of less than 100 dB (reference 1 micro-pascal, 1 Hz) in the frequency range from 0 to 500 Hz, designed for measuring acoustic fields generated by a hydro-flow around propulsion system models.

8C Materials

(8C001) Syntactic foam for underwater use:

(a) Designed for marine depths exceeding 1,000 m; and

(b) With a density less than 561 kg/m^3.

Note: Syntactic foam consists of hollow spheres of plastic or glass embedded in a resin matrix.

8D Software

(8D001) **Software** specially designed or modified for the **development, production** or **use** of **goods** specified in sub-categories 8A, 8B or 8C.

(8D002) Specific **software** specially designed or modified for the **development, production**, repair, overhaul or refurbishing (re-machining) of propellers specially designed for underwater noise reduction.

8E Technology

(8E001) **Technology required** for the **development** or **production** of **goods** specified in entries 8A001 and 8A002, or sub-categories 8B or 8C.

(8E002) Other **technology,** as follows:

(a) **Technology** for the **development, production,** repair, overhaul or refurbishing (re-machining) of propellers specially designed for underwater noise reduction;

Note: For the purpose of head a. of this entry, a licence granted in relation to propellers which are specially designed for underwater noise reduction, does not authorize the export of any related repair technology.

(b) **Technology** for the overhaul or refurbishing of equipment specified in entry 8A001 or heads b., j., o. or p. of entry 8A002.

(8E990) **The export of goods specified in this entry is prohibited to any destination in Iran or Iraq.**

Technology required for the **development, production** or **use of goods** specified in entry 8A990.

(8E991) **The export of goods specified in this entry is prohibited to any destination in Libya.**

Technology required for the **development, production** or **use** of **goods** specified in entry 8A991.

Category 9 — Aircraft, Space Vehicles, Propulsion Systems and Related Equipment

Equipment, Assemblies and Components

9A.—(9A001) Aero gas turbine engines incorporating any of the technologies specified in head a. of entry 9E003., as follows(**22**):

(a) Not certified for the specific civil **aircraft** for which they are intended;

(b) Not certified for civil use by the aviation authorities in a relevant country;

In this head, "relevant country" means an authority in Australia, Belgium, Canada, Denmark, Eire, France, Germany, Greece, Italy, Japan, Luxembourg, Netherlands, Norway, Portugal, Spain, Turkey, United Kingdom or United States of America.

(c) Designed to cruise at speeds exceeding Mach 1.2 for more than thirty minutes.

(9A002) Marine gas turbine engines with an ISO standard continuous power rating of 24,245 kW or more and a specific fuel consumption of less than 0.219 kg/kWh at any point in the power range from 35 to 100%, and specially designed assemblies and components therefor.

Note: Marine gas turbine engines includes those industrial, or aero-derivative, gas turbine engines adapted for marine propulsion or shipboard power generation.

(9A003) Specially designed assemblies and components, incorporating any of the technologies specified in head a. of entry 9E003, for the following gas turbine engine propulsion systems:

(a) Specified in entry 9A001; or

(b) Whose design or production origins are unknown to the manufacturer.

(**22**) See also entry 9A101.

Note: This entry does not specify multiple domed combustors operating at average burner outlet temperatures equal to or less than 1,813 K (1,540°C).

(9A004) Space launch vehicles or **spacecraft** (not including their payloads)(**23**).

(9A005) Liquid rocket propulsion systems containing any of the systems or components specified in entry 9A006(**24**).

(9A006) Systems or components, as follows(**25**), specially designed for liquid rocket propulsion systems:

(a) Cryogenic refrigerators, flightweight dewars, cryogenic heat pipes or cryogenic systems specially designed for use in space vehicles and capable of restricting cryogenic fluid losses to less than 30% per year;

(b) Cryogenic containers or closed-cycle refrigeration systems capable of providing temperatures of 100 K (-173°C) or less for **aircraft** capable of sustained flight at speeds exceeding Mach 3, launch vehicles or **spacecraft;**

(c) Slush hydrogen storage or transfer systems;

(d) High pressure (exceeding 17.5 MPa) turbo pumps, pump components or their associated gas generator or expander cycle turbine drive systems;

(e) High-pressure (exceeding 10.6 MPa) thrust chambers and nozzles therefor;

(f) Propellant storage systems using the principle of capillary containment or positive expulsion (i.e., with flexible bladders).

(9A007) Solid rocket propulsion systems with any of the following,(**26**):

(a) (1) Total impulse capacity exceeding 1.1 MNs; or

(2) Specific impulse of 2.4 kNs/kg or more when the nozzle flow is expanded to ambient sea level conditions for an adjusted chamber pressure of 7 MPa;

(b) (1) Stage mass fractions exceeding 88%; and

(2) Propellant solid loadings exceeding 86%;

(c) Any of the components specified in entry 9A008; or

(d) Insulation and propellant bonding systems using direct-bonded motor designs to provide a strong mechanical bond or a barrier to chemical migration between the solid propellant and case insulation material.

Note: For the purposes of head d. of this entry, a strong mechanical bond means bond strength equal to or more than propellant strength.

(9A008) Components, as follows(**27**), specially designed for solid rocket propulsion systems:

(a) Insulation and propellant bonding systems using liners to provide a strong mechanical bond or a barrier to chemical migration between the solid propellant and case insulation material;

Note: For the purposes of head a. of this entry, a strong mechanical bond means bond strength equal to or more than propellant strength.

(b) Filament-wound **composite** motor cases exceeding 0.61 m in diameter or having structural efficiency ratios (PV/W) exceeding 25 km;

(**23**) See also entry 9A104. See the appropriate categories for products contained in spacecraft payloads.
(**24**) See also entries 9A105 and 9A119.
(**25**) See also entry 9A106.
(**26**) See also entry 9A119.
(**27**) See also entry 9A108.

Note: The structural efficiency ratio (PV/W) is the burst pressure (P) multiplied by the vessel volume (V) divided by the total pressure vessel weight (W).

(c) Nozzles with thrust levels exceeding 45 kN or nozzle throat erosion rates of less than 0.075 mm/s;

(d) Movable nozzle or secondary fluid injection thrust vector control systems capable of:

(1) Omni-axial movement exceeding ±5°;

(2) Angular vector rotations of 20°/s or more; or

(3) Angular vector accelerations of 40°/s^2 or more.

(9A009) Hybrid rocket propulsion systems(**28**) with:

(a) Total impulse capacity exceeding 1.1 MNs; or

(b) Thrust levels exceeding 220 kN in vacuum exit conditions.

(9A010) Specially designed components or structures, for launch vehicles or launch vehicle propulsion systems, manufactured using metal **matrix composite,** organic **composite,** ceramic **matrix** or intermetallic reinforced materials specified in entries 1C007 or 1C010(**29**).

(9A011) Ramjet, scramjet or combined cycle engines and specially designed components therefor(**30**).

(9A101) Lightweight turbojet and turbofan engines (including turbocompound engines) usable in **missiles,** other than those specified in entry 9A001, as follows;

(a) Engines having both of the following characteristics:

(1) Maximum thrust value greater than 1 kN (achieved un-installed) excluding civil certified engines with a maximum thrust value greater than 8.89 kN (achieved un-installed); and

(2) Specific fuel consumption of 0.13 kg/N/hr or less (at sea level static and standard conditions); or

(b) Engines designed or modified for use in **missiles.**

(9A104) Sounding rockets, capable of a range of at least 300 km.

(9A105) Liquid propellant rocket engines usable in **missiles,** other than those specified in entry 9A005, having a total impulse capacity of 0.841 MNs or greater(**31**).

(9A106) Systems or components, other than those specified in entry 9A006, usable in **missiles,** as follows, specially designed for liquid rocket propulsion systems:

(a) Rocket nozzles;

(b) Thrust vector control sub-systems;

Note: Examples of methods of achieving thrust vector control specified in head b. of this entry are:

a. Flexible Nozzle;

b. Fluid or secondary gas injection;

c. Movable engine or nozzle;

d. Deflection of exhaust gas stream (jet vanes or probes); or

e. Thrust tabs.

(**28**) See also entries 9A109 and 9A119.
(**29**) See also entries IA002 and 9A110.
(**30**) See also entries 9A111 and 9A118.
(**31**) See also entry 9A119.

(c) Liquid and slurry propellant (including oxidiser) control systems, and specially designed components therefor, designed or modified to operate in vibration environments of more than 10 g rms between 20 Hz and 2000 Hz.

Note: The only servo valves and pumps specified in head c. of this entry are as follows:

a. Servo valves designed for flow rates of 24 litres per minute or greater, at an absolute pressure of 7 MPa or greater, that have an actuator response time of less than 100 ms;

b. Pumps, for liquid propellants, with shaft speeds equal to or greater than 8,000 rpm or with discharge pressures equal to or greater than 7 MPa.

(9A107) Solid propellant rocket engines, usable in **missiles,** other than those specified in entry 9A007 having a total impulse capacity of 0.841 MNs or greater(**32**).

(9A108) Components, other than those specified in entry 9A008, usable in **missiles,** as follows, specially designed for solid rocket propulsion systems:

(a) Rocket motor cases, interior lining and **insulation** therefor;

(b) Rocket nozzles;

(c) Thrust vector control sub-systems.

Note: Examples of methods of achieving thrust vector control specified in head c. of this entry are:

a. Flexible Nozzle;

b. Fluid or secondary gas injection;

c. Movable engine or nozzle;

d. Deflection of exhaust gas stream (jet vanes or probes); or

e. Thrust tabs.

Note: In this entry, "interior lining" means suited for the bond interface between the solid propellant and the case or insulating liner; usually a liquid polymer based dispersion of refractory or insulating materials, e.g. carbon filled hydroxy-terminated polybutadiene (HTPB) or other polymer with added curing agents sprayed or screeded over a case interior.

(9A109) Hybrid rocket motors, usable in **missiles,** other than those specified in entry 9A009, and specially designed components therefor(**33**).

(9A110) Composite structures, laminates and manufactures thereof, other than those specified in entry 9A010, specially designed for use in the systems specified in entries 9A004 or 9A104 or the subsystems specified in entries 9A005, 9A007, 9A105 to 9A108, 9A116 or 9A119, and resin impregnated fibre prepregs and metal coated fibre preforms therefor, made either with organic matrix or metal matrix utilising fibrous or filamentary reinforcements having a specific tensile strength greater than 7.62×10^4 m and a specific modulus greater than 3.18×10^6 m(**34**).

Note: The only resin impregnated fibre prepregs specified in this entry are those using resins with a glass transition temperature (T_g), after cure, exceeding 418 K (145°C) as determined by ASTM D4065 or equivalent.

(9A111) Pulse jet engines, usable in **missiles,** and specially designed components therefor(**35**).

(**32**) See also entry 9A119.
(**33**) See also entry 9A119.
(**34**) See also entry 1A002.
(**35**) See also entries 9A011 and 9A118.

(9A115) Launch support equipment, designed or modified for systems specified in entries 9A004 or 9A104, as follows:

(a) Apparatus and devices for handling, control, activation or launching;

(b) Vehicles for transport, handling, control, activation or launching.

(9A116) Reentry vehicles, usable in **missiles,** and equipment designed or modified therefor, as follows:

(a) Heat shields and components therefor fabricated of ceramic or ablative materials;

(b) Heat sinks and components therefor fabricated of light-weight, high heat capacity materials;

(c) Electronic equipment specially designed for reentry vehicles.

(9A117) Staging mechanisms, separation mechanisms, and interstages, usable in **missiles.**

(9A118) Devices to regulate combustion usable in engines, which are usable in **missiles,** specified in entries 9A011 or 9A111.

(9A119) Individual rocket stages, usable in **missiles,** other than those specified in entries 9A005, 9A007, 9A009, 9A105, 9A107 or 9A109.

(9A990) **The export of goods specified in this entry is prohibited to any destination in Libya, Iran, Iraq, Syria or South Africa.**

Aircraft having a maximum all up weight of 390 kg or more, and aeroengines, and equipment or components designed therefor, other than those specified eleswhere in this Schedule.

(9A991) **Aircraft** or steerable parachutes other than those specified in entry ML10 of Group 1 of Part III of this Schedule, having a maximum all up weight of not more than 390 kg.

(9A993) **The export of goods specified in this entry is prohibited to any destination in Libya.**

Equipment for simulating or modelling any function of any **aircraft** or any part of any **aircraft,** specially designed components and specially designed accessories therefor.

9B Test, Inspection and Production Equipment

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

(a) Automated equipment using non-mechanical methods for measuring airfoil wall thickness;

(b) Tooling, fixtures or measuring equipment for the **laser,** water jet or ECM/EDM hole drilling processes specified in head c. of entry 9E003;

(c) Directional solidification or single crystal casting equipment;

(d) Ceramic cores or shells;

(e) Ceramic core manufacturing equipment or tools;

(f) Ceramic core leaching equipment;

(g) Ceramic shell wax pattern preparation equipment;

(h) Ceramic shell burn out or firing equipment.

(9B002) On-line (real time) control systems, instrumentation (including sensors) or automated data acquisition and processing equipment, specially designed for the development of gas turbine engines, assemblies or components incorporating technologies specified in head a. of entry 9E003.

(9B003) Equipment specially designed for the production or test of gas turbine brush seals designed to operate at tip speeds exceeding 335 m/s, and specially designed parts or accessories therefor.

(9B004) Tools, dies or fixtures for the solid state joining of gas turbine **superalloy** or titanium components.

(9B005) On-line (real time) control systems, instrumentation (including sensors) or automated data acquisition and processing equipment, specially designed for use with the following wind tunnels or devices(**36**):

(a) Wind tunnels designed for speeds of Mach 1.2 or more;

except:

those specially designed for educational purposes and having a test section size (measured laterally) of less than 250 mm;

In this head, "Test section size" means the diameter of the circle, or the side of a square, or the longest side of a rectangle, at the largest test section location.

(b) Devices for simulating flow-environments at speeds exceeding Mach 5, including hot-shot tunnels, plasma arc tunnels, shock tubes, shock tunnels, gas tunnels and light gas guns;

(c) Wind tunnels or devices, other than two-dimensional sections, capable of simulating Reynolds number flows exceeding 25×10^6.

(9B006) Specially designed acoustic vibration test equipment capable of producing sound pressure levels of 160 dB or more (referenced to 20 micropascals) with a rated output of 4 kW or more at a test cell temperature exceeding 1,273 K (1,000°C), and specially designed transducers, strain gauges, accelerometers, thermocouples or quartz heaters therefor.

(9B007) Equipment specially designed for inspecting the integrity of rocket motors using non-destructive test (NDT) techniques other than planar X-ray or basic physical or chemical analysis(**37**).

(9B008) Transducers specially designed for the direct measurement of the wall skin friction of the test flow with a stagnation temperature exceeding 833 K (560°C).

(9B009) Tooling specially designed for producing turbine engine powder metallurgy rotor components capable of operating at stress levels of 60% of ultimate tensile strength (UTS) or more and metal temperatures of 873 K (600°C) or more.

(9B105) Wind tunnels for speeds of Mach 0.9 or more, usable for **missiles** and their subsystems.

(9B106) Environmental chambers and anechoic chambers, as follows:

(a) Environmental chambers capable of simulating the following flight conditions:

(1) Vibration environments of 10 g rms or greater between 20 Hz and 2,000 Hz and imparting forces of 5 kN or greater; and

(2) Altitudes of 15,000 m or greater; or

(3) Temperature of at least 223 K (-50°C) to 398 K (+ 125°C);

(b) Anechoic chambers capable of simulating the following flight conditions:

(1) Acoustic environments at an overall sound pressure level of 140 dB or greater (referenced to 20 micropascals) or with a rated power output of 4 kW or greater; and

(2) Altitudes of 15,000 m or greater; or

(3) Temperature of at least 223 K (-50°C) to 398 K (+ 125°C).

(9B115) Specially designed **production equipment** for the systems, sub-systems and components specified in entries 9A005 to 9A009, 9A011, 9A101, 9A105 to 9A109, 9A111, 9A116 to 9A119.

(**36**) See also 9B105

(**37**) For Radiographic equipment, see sub-head e.5. of entry 3A001.

(9B116) Specially designed **production facilities** for the systems, sub-systems, and components specified in entries 9A004 to 9A009, 9A011, 9A101, 9A104 to 9A109, 9A111, 9A116 to 9A119.

(9B117) Test benches and test stands for solid or liquid propellant rockets or rocket motors, having either of the following characteristics:

(a) The capacity to handle more than 90 kN of thrust; or

(b) Capable of simultaneously measuring the three axial thrust components.

9C Materials

None

9D Software

(9D001) **Software** required for the **development** of **goods** or **technology** specified in sub-categories 9A, 9B or entry 9E003.

(9D002) **Software** required for the **production** of **goods** specified in sub-categories 9A or 9B.

(9D003) **Software** required for the **use** of full authority digital electronic engine controls (FADEC) for propulsion systems specified in sub-category 9A or equipment specified in sub-category 9B, as follows:

(a) **Software** in digital electronic controls for propulsion systems, aerospace test facilities or air breathing aero-engine test facilities;

(b) Fault-tolerant **software** used in FADEC systems for propulsion systems and associated test facilities.

(9D004) Other **software,** as follows:

(a) **Software** specially designed for vibration test equipment, other than that specified in entry 2D101, using real time digital controls with individual exciters (thrusters) with a maximum thrust exceeding 100 kN;

(b) 2D or 3D viscous **software** validated with wind tunnel or flight test data required for detailed engine flow modelling;

(c) **Software** required for the **development** or **production** of real time full authority electronic test facilities for engines or components specified in sub-category 9A;

(d) **Software** for testing aero gas turbine engines, assemblies or components, specially designed to collect, reduce and analyse data in real time, and capable of feedback control, including the dynamic adjustment of test articles or test conditions, as the test is in progress;

(e) **Software** specially designed to control directional solidification or single crystal casting;

(f) **Software** in **source code, object code** or machine code required for the use of active compensating systems for rotor blade tip clearance control.

Note: Head f. of this entry does not specify **software** embedded in non-specified equipment or required for maintenance activities associated with the calibration or repair or updates to the active compensating clearance control system.

(9D101) **Software** specially designed for the use of **goods** specified in entries 9B105, 9B106, 9B116 or 9B117.

(9D103) **Software** specially designed for modelling, simulation or design integration of the systems specified in entries 9A004 or 9A104 or the sub-systems specified in entries 9A005, 9A007, 9A105 to 9A108, 9A116 or 9A119.

*Note:***Software** specified in this entry remains controlled when combined with specially designed hardware specified in entry 4A102.

(9D993) **The export of goods specified in this entry is prohibited to any destination in Libya.**

Software specially designed or modified for the use of **goods** specified in entry 9A993.

9E Technology

(9E001) **Technology required** for the **development** of **goods** specified in head c. of entry 9A001, or entries 9A004 to 9A011, or sub-Categories 9B or 9D.

(9E002) **Technology required** for the **production** of **goods**(**38**) specified in head c. of entry 9A001, or entries 9A004 to 9A011 or sub-Category 9B.

Notes:

1. **Development** or **production technology** specified in sub-category 9E for gas turbine engines remains specified when used as **use technology** for repair, rebuild and overhaul.
2. This entry does not include technical data, drawings or documentation for maintenance activities directly associated with calibration, removal or replacement of damaged or unserviceable line replaceable units, including replacement of whole engines or engine modules.
3. For **technology** for the repair of specified structures, laminates or materials, see head f. of entry 1E002.

(9E003) Other **technology,** as follows:

(a) **Technology required** for the **development** or **production** of the following gas turbine engine components or systems:

(1) Directionally solidified gas turbine blades, vanes or tip shrouds rated to operate at gas path temperatures exceeding 1,593 K (1,320°C);

(2) Single crystal blades, vanes or tip shrouds;

(3) Multiple domed combustors operating at average burner outlet temperatures exceeding 1,643 K (1,370°C), or combustors incorporating thermally de-coupled combustion liners, non-metallic liners or non-metallic shells;

(4) Components manufactured from organic **composite** materials designed to operate above 588 K (315°C), or from metal **matrix composite,** ceramic **matrix,** intermetallic or intermetallic reinforced materials specified in entries 1A002 or 1C007;

(5) Uncooled turbine blades, vanes, tip-shrouds or other components designed to operate at gas path temperatures of 1,323 K (1,050°C) or more;

(6) Cooled turbine blades, vanes or tip-shrouds, other than those described in sub-heads a.1. and a.2. of this entry, exposed to gas path temperatures of 1,643 K (1,370°C) or more;

(7) Airfoil-to-disk blade combinations using solid state joining;

(8) Gas turbine engine components using **diffusion bonding technology** specified in head b. of entry 2E003;

(9) Damage tolerant gas turbine engine rotating components using powder metallurgy materials specified in head b. of entry 1C002;

(10) FADEC for gas turbine and combined cycle engines and their related diagnostic components, sensors and specially designed components;

(11) Adjustable flow path geometry and associated control systems for:

(a) Gas generator turbines;

(b) Fan or power turbines;

(**38**) See head f. of entry 1E002 for technology for the repair of specified structures, laminates or materials.

(c) Propelling nozzles;

Notes:

(1) Adjustable flow path geometry and associated control systems do not include inlet guide vanes, variable pitch fans, variable stators or bleed valves for compressors.

(2) Sub-head a.11. of this entry does not specify **development** or **production technology** for adjustable flow path geometry for reverse thrust.

(12) Rotor blade tip clearance control systems employing active compensating casing **technology** limited to a design and development data base;

(13) Gas bearings for gas turbine engine rotor assemblies;

(14) Wide chord hollow fan blades without part-span support;

(b) **Technology required** for the **development** or **production** of:

(1) Wind tunnel aero-models equipped with non-intrusive sensors capable of transmitting data from the sensors to the data acquisition system;

(2) **Composite** propeller blades or propfans capable of absorbing more than 2,000 kW at flight speeds exceeding Mach 0.55;

(c) **Technology required** for the **development** or **production** of gas turbine engine components using **laser,** water jet or ECM/EDM hole drilling processes to produce holes with:

(1) (a) Depths more than four times their diameter;

(b) Diameters less than 0.76 mm; and

(c) Incidence angles equal to or less than 25°; or

(2) (a) Depths more than five times their diameter;

(b) Diameters less than 0.4 mm; and

(c) Incidence angles of more than 25°;

Note: For the purposes of head c. of this entry, incidence angle is measured from a plane tangential to the airfoil surface at the point where the hole axis enters the airfoil surface.

(d) **Technology required** for the **development** or **production** of helicopter power transfer systems or tilt rotor or tilt wing aircraft power transfer systems:

(1) Capable of loss-of-lubrication operation for 30 minutes or more; or

(2) Having an input power-to-weight ratio equal to or more than 8.87 kW/kg;

(e) (1) **Technology** for the **development** or **production** of reciprocating diesel engine ground vehicle propulsion systems having all of the following:

(a) A box volume of 1.2 m^3 or less;

(b) An overall power output of more than 750 kW based on Council Directive 80/1269/EEC(**39**) or ISO 2534; and

(c) A power density of more than 700 kW/m^3 of box volume;

Note: Box volume is the product of three perpendicular dimensions measured in the following way:

(**39**) O.J. No. L.375, Vol 23 31.12.80, p.46 as amended by Commission Directive 88/195/EEC, O.J. No. L.92, 9.4.88, p.50 and Commission Directive 89/491/EEC, O.J. No. L.238, 15.8.89 p.43.

Length: The length of the crankshaft from front flange to flywheel face;

Width: The widest of the following:

(a) The outside dimension from valve cover to valve cover;

(b) The dimensions of the outside edges of the cylinder heads; or

(c) The diameter of the flywheel housing;

Height: The largest of the following:

(a) The dimension of the crankshaft centre-line to the top plane of the valve cover (or cylinder head) plus twice the stroke; or

(b) The diameter of the flywheel housing.

(2) **Technology required** for the **production** of specially designed components, as follows, for high output diesel engines:

(a) **Technology required** for the **production** of engine systems having all of the following components employing ceramics materials specified in entry 1C007:

(1) Cylinder liners;

(2) Pistons;

(3) Cylinder heads; and

(4) One or more other components (including exhaust ports, turbo-chargers, valve guides, valve assemblies or insulated fuel injectors);

(b) **Technology required** for the **production** of turbocharger systems, with single-stage compressors having all of the following:

(1) Operating at pressure ratios of 4:1 or higher;

(2) A mass flow in the range from 30 to 130 kg per minute; and

(3) Variable flow area capability within the compressor or turbine sections;

(c) **Technology required** for the **production** of fuel injection systems with a specially designed multifuel (e.g., diesel or jet fuel) capability covering a viscosity range from diesel fuel (2.5 cSt at 310.8 K (37.8°C)) down to gasoline fuel (0.5 cSt at 310.8 K (37.8°C)), having both of the following:

(1) Injection amount in excess of 230 mm^3 per injection per cylinder; and

(2) Specially designed electronic control features for switching governor characteristics automatically depending on fuel property to provide the same torque characteristics by using the appropriate sensors;

(3) **Technology required** for the **development** or **production** of high output diesel engines for solid, gas phase or liquid film (or combinations thereof) cylinder wall lubrication, permitting operation to temperatures exceeding 723 K (450°C), measured on the cylinder wall at the top limit of travel of the top ring of the piston.

Note: High output diesel engines are diesel engines with a specified brake mean effective pressure of 1.8 MPa or more at a speed of 2,300 rpm, provided the rated speed is 2,300 rpm or more.

(9El01) **Technology required** for the **development** or **production** of **goods** specified in entries 9A101, 9A104 to 9A111 or 9A115 to 9A119.

(9E102) **Technology required** for the **use** of **goods** specified in entries 9A004 to 9A011, 9A101, 9A104 to 9A111, 9A115 to 9A119, 9B105, 9B106, 9B115 to 9B117, 9D101 or 9D103.

(9E990) **The export of goods specified in this entry is prohibited to any destination in Libya, Iran, Iraq, Syria or South Africa.**

Technology required for the **development, production** or **use** of **goods** specified in entry 9A990.

(9E991) **Technology required** for the **development, production** or **use** of **goods** specified in entry 9A991.

(9E993) **The export of goods specified in this entry is prohibited to any destination in Libya.**

Technology required for the **development, production** or **use** of **goods** specified in entry 9A993.