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Letter dated 2 October 2017 from the Chair of the Security Council Committee established pursuant to resolution 1718 (2006) addressed to the President of the Security Council

On behalf of the Security Council Committee established pursuant to resolution 1718 (2006), I have the honour to transmit herewith the report of the Committee dated 2 October 2017, submitted in accordance with paragraph 5 of Security Council resolution 2375 (2017) (see annex).

I would appreciate it if the present letter and its annex were brought to the attention of the members of the Security Council and issued as a document of the Council.

(*Signed*) Sebastiano **Cardi**
Chair
Security Council Committee established
pursuant to resolution 1718 (2006)

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Annex

Report of the Security Council Committee established pursuant to resolution 1718 (2006) prepared in accordance with paragraph 5 of resolution 2375 (2017)

On 11 September 2017, the Security Council, by its resolution 2375 (2017), decided to adjust the measures imposed by paragraph 8 (a), (b) and (c) of resolution 1718 (2006), through the designation of additional conventional arms-related items, materials, equipment, goods and technology, and directed the Committee to undertake its tasks to this effect and to report to the Council within 15 days of the adoption of resolution 2375 (2017).

In order to fulfil those tasks, the Committee considered a list of conventional arms-related items, materials, equipment, goods and technology.[1]

On 2 October 2017, the Committee acted in line with the directive of the Security Council and approved the following list:

Special materials and related items

Systems, equipment and components

1. Seals, gaskets, sealants or fuel bladders, specially designed for “aircraft” or aerospace use, made from more than 50 per cent by weight of any of the fluorinated polyimides or fluorinated phosphazene elastomers.

2. Manufactures of non-”fusible” aromatic polyimides in film, sheet, tape or ribbon:

(a) A thickness exceeding 0.254 mm; or

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

Note: The category above does not apply to manufactures when coated or laminated with copper and designed for the production of electronic printed circuit boards.

3. Protective and detection equipment and components, not specially designed for military use, as follows:

(a) Full face masks, filter canisters, protective suits, gloves and shoes, detection systems and decontamination equipment specially designed or modified for defence against any of the following:

1. “Biological agents”;

2. “Radioactive materials”; or

3. Chemical warfare (CW) agents.

4. Equipment and devices, specially designed to initiate charges and devices containing “energetic materials”, by electrical means, as follows:

(a) Explosive detonator firing sets designed to drive explosive detonators specified in item (b);

[1] The agreement of the Committee on the list shall not be considered as a precedent for the future work of Security Council committees, including the Committee established pursuant to resolution 1718 (2006), or for other subsidiary bodies of the Security Council or multilateral mechanisms.

(b) Electrically driven explosive detonators, as follows:

1. Exploding bridge (EB);

2. Exploding bridge wire (EBW);

3. Slapper; or

4. Exploding foil initiators (EFI).

Technical notes:

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

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

5. Charges, devices and components, as follows:

(a) “Shaped charges”;

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

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

(b) Linear shaped cutting charges;

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

2. A width of 10 mm or more;

(c) Detonating cord with explosive core load greater than 64 g/m; or

(d) Cutters and severing tools, having a NEQ greater than 3.5 kg, and other severing tools.

Test, inspection and production equipment

1. Equipment for the production or inspection of “composite” structures or laminates or “fibrous or filamentary materials” as follows, and specially designed components and accessories therefor:

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

2. Equipment for producing metal alloys, metal alloy powder or alloyed material specially designed to avoid contamination and specially designed for use in one of the following processes:

(a) Vacuum atomization;

(b) Gas atomization;

(c) Rotary atomization;

(d) Splat quenching;

(e) Melt spinning and comminution;

(f) Melt extraction and comminution;

(g) Mechanical alloying; or

(h) Plasma atomization.

3. Tools, dies, moulds or fixtures, for "superplastic forming" or "diffusion bonding" titanium, aluminium or their alloys:

(a) Airframe or aerospace structures;

(b) "Aircraft" or aerospace engines; or

(c) Specially designed components for structures specified in item (a) or for engines specified in item (b).

Materials

Technical note:

Metals and alloys

Unless provision to the contrary is made, the words "metals" and "alloys" cover crude and semi-fabricated forms, as follows:

Crude forms

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

1. Materials specially designed for use as absorbers of electromagnetic waves, or intrinsically conductive polymers, as follows:

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

1. Polyaniline;

2. Polypyrrole;

3. Polythiophene;

4. Poly phenylene-vinylene; or

5. Poly thienylene-vinylene.

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

2. "Superconductive" "composite" conductors consisting of one or more "superconductive" "filaments", which remain "superconductive" above 115 K (-158.16oC).

Technical note: For the purposes of the item above, "filaments" may be in wire, cylinder, film, tape or ribbon form.

3. "Fibrous or filamentary materials", as follows:

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

1. "Specific modulus" exceeding 12.7×10^6 m; and

2. "Specific tensile strength" exceeding 23.5×10^4 m;

Note: This item does not apply to polyethylene.

(b) Carbon "fibrous or filamentary materials", having all of the following:

1. "Specific modulus" exceeding 14.65 x 10^6 m; and

2. "Specific tensile strength" exceeding 26.82 x 10^4 m;

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

1. "Specific modulus" exceeding 2.54 x 10^6 m; and

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

Software

1. "Software" specially designed or modified for the "development", "production" or "use" of equipment specified above.

2. "Software" for the "development" of material specified above.

3. "Software" specially designed or modified to enable non-listed equipment to perform the functions of any equipment specified above.

Technology

"Technology" for the "development", "production" or "use" of equipment materials or software specified above.

Materials processing equipment

Systems, equipment and components

1. Anti-friction bearings and bearing systems, as follows, and components therefore:

Note: This category does not apply to balls with tolerances specified by the manufacturer in accordance with ISO 3290 as grade 5 or worse.

(a) Ball bearings and solid roller bearings, having all tolerances specified by the manufacturer in accordance with ISO 492 Tolerance Class 4 (or national equivalents) or better, and having both "rings" and "rolling elements", made from monel or beryllium;

Technical notes:

1. "Ring" — annular part of a radial rolling bearing incorporating one or more raceways (ISO 5593:1997).

2. "Rolling element" — ball or roller which rolls between raceways (ISO 5593:1997).

(b) Active magnetic bearing systems using any of the following:

1. Materials with flux densities of 2.0 T or greater and yield strengths greater than 414 MPa;

2. All-electromagnetic three-dimensional homopolar bias designs for actuators; or

3. High-temperature (450 K (177°C) and above) position sensors.

Test, inspection and production equipment

1. Machine tools and any combination thereof, for removing (or cutting) metals, ceramics or “composites”, which, according to the manufacturer’s technical specification, can be equipped with electronic devices for “numerical control”:

(a) Machine tools for grinding having any of the following:

1. Three or more axes which can be coordinated simultaneously for “contouring control” and a “unidirectional positioning repeatability” equal to or less (better) than 1.1 µm along one or more linear axis; or

2. Five or more axes which can be coordinated simultaneously for “contouring control”;

(b) Machine tools for removing metals, ceramics or “composites”, having all of the following:

1. Removing material by means of any of the following:

a. Water or other liquid jets, including those employing abrasive additives;

b. Electron beam; or

c. “Laser” beam; and

2. At least two rotary axes that can be coordinated simultaneously for “contouring control”.

2. Numerically controlled optical finishing machine tools equipped for selective material removal to produce non-spherical optical surfaces having all of the following characteristics:

(a) Finishing the form to less (better) than 1.0 µm;

(b) Finishing to a roughness less (better) than 100 nm rms;

(c) Four or more axes which can be coordinated simultaneously for “contouring control”; and

(d) Using any of the following processes:

1. “Magnetorheological finishing (MRF)”;

2. “Electrorheological finishing (ERF)”;

3. “Energetic particle beam finishing”;

4. “Inflatable membrane tool finishing”; or

5. “Fluid jet finishing”.

Technical notes: For the purposes of the items above:

1. “MRF” is a material removal process using an abrasive magnetic fluid whose viscosity is controlled by a magnetic field.

2. “ERF” is a removal process using an abrasive fluid whose viscosity is controlled by an electric field.

3. “Energetic particle beam finishing” uses Reactive Atom Plasmas (RAP) or ion beams to selectively remove material.

4. “Inflatable membrane tool finishing” is a process that uses a pressurized membrane that deforms to contact the workpiece over a small area.

5. "Fluid jet finishing" makes use of a fluid stream for material removal.

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

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

(b) Having any of the following:

1. A maximum working pressure exceeding 207 MPa;

2. A controlled thermal environment exceeding 1,773 K (1,500°C); or

3. A facility for hydrocarbon impregnation and removal of resultant gaseous degradation products.

4. Equipment specially designed for the deposition, processing and in-process control of inorganic overlays, coatings and surface modifications, as follows:

(a) Chemical vapour deposition (CVD) production equipment having all of the following:

1. A process modified for one of the following:

a. Pulsating CVD;

b. Controlled nucleation thermal deposition (CNTD); or

c. Plasma enhanced or plasma assisted CVD; and

2. Having any of the following:

a. Incorporating high vacuum (equal to or less than 0.01 Pa) rotating seals; or

b. Incorporating in situ coating thickness control;

(b) Ion implantation production equipment having beam currents of 5 mA or more;

(c) Electron beam physical vapour deposition (EB-PVD) production equipment incorporating power systems rated for over 80 kW and having any of the following:

1. A liquid pool level "laser" control system which regulates precisely the ingots feed rate; or

2. A computer controlled rate monitor operating on the principle of photo-luminescence of the ionized atoms in the evaporant stream to control the deposition rate of a coating containing two or more elements;

(d) Plasma spraying production equipment having any of the following:

1. Operating at reduced pressure controlled atmosphere (equal to or less than 10 kPa measured above and within 300 mm of the gun nozzle exit) in a vacuum chamber capable of evacuation down to 0.01 Pa prior to the spraying process; or

2. Incorporating in situ coating thickness control;

(e) Sputter deposition production equipment capable of current densities of 0.1 mA/mm^2 or higher at a deposition rate of 15 µm/h or more;

(f) Cathodic arc deposition production equipment incorporating a grid of electromagnets for steering control of the arc spot on the cathode; or

(g) Ion plating production equipment capable of in situ measurement of any of the following:

1. Coating thickness on the substrate and rate control; or

2. Optical characteristics.

5. Dimensional inspection or measuring systems, equipment and “electronic assemblies”, as follows:

(a) Computer-controlled or “numerically controlled” Coordinate Measuring Machines (CMM), having a three-dimensional (volumetric) maximum permissible error of length measurement (E0,MPE) at any point within the operating range of the machine (i.e., within the length of axes) equal to or less (better) than 1.7 + L/1,000 µm (L is the measured length in mm), according to ISO 10360-2 (2009);

(b) Linear and angular displacement measuring instruments, as follows:

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

a. Non-contact-type measuring systems with a “resolution” equal to or less (better) than 0.2 µm within a measuring range up to 0.2 mm;

b. Linear Variable Differential Transformer (LVDT) systems:

1. Having any of the following:

a. “Linearity” equal to or less (better) than 0.1 per cent measured from 0 to the “full operating range”, for LVDTs with a “full operating range” up to and including ± 5 mm; or

b. “Linearity” equal to or less (better) than 0.1 per cent measured from 0 to 5 mm for LVDTs with a “full operating range” greater than ± 5 mm; and

2. Drift equal to or less (better) than 0.1 per cent per day at a standard ambient test room temperature ±1 K;

Technical note:

For the purposes of item b. above, “full operating range” is half of the total possible linear displacement of the LVDT. For example, LVDTs with a “full operating range” up to and including ± 5 mm can measure a total possible linear displacement of 10 mm.

c. Measuring systems having all of the following:

1. Containing a “laser”;

2. A “resolution” over their full scale of 0.200 nm or less (better); and

3. Capable of achieving a “measurement uncertainty” equal to or less (better) than (1.6 + L/2,000) nm (L is the measured length in mm) at any point within a measuring range, when compensated for the refractive index of air and measured over a period of 30 seconds at a temperature of 20±0.01oC; or

d. “Electronic assemblies” specially designed to provide feedback capability in systems specified above;

2. Angular displacement measuring instruments;

Note: The category above does not apply to optical instruments, such as autocollimators, using collimated light (e.g., "laser" light) to detect angular displacement of a mirror.

(c) Equipment for measuring surface roughness (including surface defects), by measuring optical scatter with a sensitivity of 0.5 nm or less (better).

6. "Robots" having any of the following characteristics and specially designed controllers and "end-effectors" therefor:

(a) Capable in real time of full three-dimensional image processing or full three-dimensional "scene analysis" to generate or modify "programs" or to generate or modify numerical program data;

Technical note:

The "scene analysis" limitation does not include approximation of the third dimension by viewing at a given angle, or limited greyscale interpretation for the perception of depth or texture for the approved tasks (2 1/2 D).

(b) Specially designed to comply with national safety standards applicable to potentially explosive munitions environments;

(c) Specially designed or rated as radiation-hardened to withstand greater than 5 x 103 Gy (Si) without operational degradation; or

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

7. Assemblies or units, specially designed for machine tools, or dimensional inspection or measuring systems and equipment, as follows:

(a) Linear position feedback units having an overall "accuracy" less (better) than (800 + (600 x L/1,000)) nm (L equals the effective length in mm);

(b) Rotary position feedback units having an "accuracy" less (better) than 0.00025°; or

(c) "Compound rotary tables" and "tilting spindles", for use with machine tools to or above the levels specified by this category.

8. Spin-forming machines and flow-forming machines, which, according to the manufacturer's technical specification, can be equipped with "numerical control" units or a computer control and having all of the following:

(a) Three or more axes which can be coordinated simultaneously for "contouring control"; and

(b) A roller force more than 60 kN.

Technical note:

Machines combining the functions of spin-forming and flow-forming are regarded as flow-forming machines.

Software

1. "Software" specially designed or modified for the "development", "production" or "use" of equipment specified above; or

2. "Software" specially designed or modified to allow non-listed equipment to function as equipment specified above.

Technology

"Technology" for the "development", "production" or "use" of equipment or "software" specified above.

Electronics

Systems, equipment and components

1. Electronic items, as follows:

(a) General-purpose integrated circuits, as follows:

Note 1: The status of wafers (finished or unfinished), in which the function has been determined, is to be evaluated against the parameters of 3.A.1.a.

Note 2: Integrated circuits include the following types:

– *"Monolithic integrated circuits";*

– *"Hybrid integrated circuits";*

– *"Multichip integrated circuits";*

– *"Film-type integrated circuits", including silicon-on-sapphire integrated circuits;*

– *"Optical integrated circuits";*

– *"Three-dimensional integrated circuits";*

– *"Monolithic Microwave Integrated Circuits" ("MMICs").*

1. Integrated circuits designed or rated as radiation hardened to withstand any of the following:

a. A total dose of 5×10^3 Gy (Si) or higher;

b. A dose rate upset of 5 x 106 Gy (Si)/s or higher; or

c. A fluence (integrated flux) of neutrons (1 MeV equivalent) of 5 x 1013 n/cm^2 or higher on silicon, or its equivalent for other materials;

Note: The category above does not apply to Metal Insulator Semiconductors (MIS).

2. "Microprocessor microcircuits", "microcomputer microcircuits", microcontroller microcircuits, storage integrated circuits manufactured from a compound semiconductor, analogue-to-digital converters, integrated circuits that contain analogue-to-digital converters and store or process the digitized data, digital-to-analogue converters, electro-optical or "optical integrated circuits" designed for "signal processing", field programmable logic devices, custom integrated circuits for which either the function is unknown or the status of the equipment in which the integrated circuit will be used is unknown, Fast Fourier Transform (FFT) processors, Electrical Erasable Programmable Read-Only Memories (EEPROMs), flash memories, Static Random-Access Memories (SRAMs) or Magnetic Random-Access Memories (MRAMs), having any of the following:

a. Rated for operation at an ambient temperature above 398 K (+125°C);

b. Rated for operation at an ambient temperature below 218 K (-55°C); or

c. Rated for operation over the entire ambient temperature range from 218 K (-55°C) to 398 K (+125°C);

Note: This category does not apply to integrated circuits for civil automobile or railway train applications.

3. Electro-optical and "optical integrated circuits", designed for "signal processing" and having all of the following:

a. One or more than one internal "laser" diode;

b. One or more than one internal light detecting element; and

c. Optical waveguides;

4. Field programmable logic devices having any of the following:

a. A maximum number of single-ended digital input/outputs of greater than 700; or

b. An "aggregate one-way peak serial transceiver data rate" of 500 Gb/s or greater;

Note: This category includes:

– *Simple Programmable Logic Devices (SPLDs);*

– *Complex Programmable Logic Devices (CPLDs);*

– *Field Programmable Gate Arrays (FPGAs);*

– *Field Programmable Logic Arrays (FPLAs);*

– *Field Programmable Interconnects (FPICs).*

5. Neural network integrated circuits;

6. Custom integrated circuits for which the function is unknown, or the status of the equipment in which the integrated circuits will be used is unknown to the manufacturer, having any of the following:

a. More than 1,500 terminals;

b. A typical "basic gate propagation delay time" of less than 0.02 ns; or

c. An operating frequency exceeding 3 GHz;

7. Direct Digital Synthesizer (DDS) integrated circuits having any of the following:

a. A Digital-to-Analogue Converter (DAC) clock frequency of 3.5 GHz or more and a DAC resolution of 10 bit or more, but less than 12 bit; or

b. A DAC clock frequency of 1.25 GHz or more and a DAC resolution of 12 bit or more;

Technical note:

The DAC clock frequency may be specified as the master clock frequency or the input clock frequency.

(b) Microwave or millimetre wave items, as follows:

1. a. Travelling-wave "vacuum electronic devices", pulsed or continuous wave;

1. Devices operating at frequencies exceeding 31.8 GHz;

2. Devices having a cathode heater with a turn-on time to rated RF power of less than 3 seconds;

3. Coupled cavity devices, or derivatives thereof, with a “fractional bandwidth” of more than 7 per cent or a peak power exceeding 2.5 kW;

4. Devices based on helix, folded waveguide, or serpentine waveguide circuits, or derivatives thereof, having any of the following:

a. An “instantaneous bandwidth” of more than one octave, and average power (expressed in kW) times frequency (expressed in GHz) of more than 0.5;

b. An “instantaneous bandwidth” of one octave or less, and average power (expressed in kW) times frequency (expressed in GHz) of more than 1;

c. Being “space-qualified”; or

d. Having a gridded electron gun;

5. Devices with a “fractional bandwidth” of greater than or equal to 10 per cent, with any of the following:

a. An annular electron beam;

b. A non-axisymmetric electron beam; or

c. Multiple electron beams;

b. Crossed-field amplifier “vacuum electronic devices” with a gain of more than 17 dB;

c. Thermionic cathodes designed for “vacuum electronic devices” producing an emission current density at rated operating conditions exceeding 5 A/cm² or a pulsed (non-continuous) current density at rated operating conditions exceeding 10 A/cm^2;

d. “Vacuum electronic devices” with the capability to operate in a “dual mode”;

Technical note:

“Dual mode” means that the “vacuum electronic device” beam current can be intentionally changed between continuous-wave and pulsed mode operation by use of a grid and produces a peak pulse output power greater than the continuous-wave output power.

2. “Monolithic Microwave Integrated Circuit” (“MMIC”) amplifiers that are any of the following:

a. Rated for operation at frequencies exceeding 2.7 GHz up to and including 6.8 GHz with a “fractional bandwidth” of greater than 15 per cent, and having any of the following:

1. A peak saturated power output greater than 75 W (48.75 dBm) at any frequency exceeding 2.7 GHz up to and including
2.9 GHz;

2. A peak saturated power output greater than 55 W (47.4 dBm) at any frequency exceeding 2.9 GHz up to and including
3.2 GHz;

3. A peak saturated power output greater than 40 W (46 dBm) at any frequency exceeding 3.2 GHz up to and including 3.7 GHz; or

4. A peak saturated power output greater than 20 W (43 dBm) at any frequency exceeding 3.7 GHz up to and including 6.8 GHz;

b. Rated for operation at frequencies exceeding 6.8 GHz up to and including 16 GHz with a "fractional bandwidth" of greater than 10 per cent, and having any of the following:

1. A peak saturated power output greater than 10W (40 dBm) at any frequency exceeding 6.8 GHz up to and including 8.5 GHz; or

2. A peak saturated power output greater than 5W (37 dBm) at any frequency exceeding 8.5 GHz up to and including 16 GHz;

c. Rated for operation with a peak saturated power output greater than 3 W (34.77 dBm) at any frequency exceeding 16 GHz up to and including 31.8 GHz, and with a "fractional bandwidth" of greater than 10 per cent;

d. Rated for operation with a peak saturated power output greater than 0.1n W (-70 dBm) at any frequency exceeding 31.8 GHz up to and including 37 GHz;

e. Rated for operation with a peak saturated power output greater than 1 W (30 dBm) at any frequency exceeding 37 GHz up to and including 43.5 GHz, and with a "fractional bandwidth" of greater than 10 per cent;

f. Rated for operation with a peak saturated power output greater than 31.62 mW (15 dBm) at any frequency exceeding 43.5 GHz up to and including 75 GHz, and with a "fractional bandwidth" of greater than 10 per cent;

g. Rated for operation with a peak saturated power output greater than 10 mW (10 dBm) at any frequency exceeding 75 GHz up to and including 90 GHz, and with a "fractional bandwidth" of greater than 5 per cent; or

h. Rated for operation with a peak saturated power output greater than 0.1 nW (-70 dBm) at any frequency exceeding 90 GHz;

Note 1: The status of the MMIC whose rated operating frequency includes frequencies listed in more than one frequency range is determined by the lowest peak saturated power output threshold.

Note 2: This category does not apply to MMICs if they are specially designed for other applications, e.g., telecommunications, radar, automobiles.

3. Discrete microwave transistors that are any of the following:

a. Rated for operation at frequencies exceeding 2.7 GHz up to and including 6.8 GHz and having any of the following:

1. A peak saturated power output greater than 400 W (56 dBm) at any frequency exceeding 2.7 GHz up to and including 2.9 GHz;

2. A peak saturated power output greater than 205 W (53.12 dBm) at any frequency exceeding 2.9 GHz up to and including 3.2 GHz;

3. A peak saturated power output greater than 115 W (50.61 dBm) at any frequency exceeding 3.2 GHz up to and including 3.7 GHz; or

4. A peak saturated power output greater than 60 W (47.78 dBm) at any frequency exceeding 3.7 GHz up to and including 6.8 GHz;

b. Rated for operation at frequencies exceeding 6.8 GHz up to and including 31.8 GHz and having any of the following:

1. A peak saturated power output greater than 50 W (47 dBm) at any frequency exceeding 6.8 GHz up to and including 8.5 GHz;

2. A peak saturated power output greater than 15 W (41.76 dBm) at any frequency exceeding 8.5 GHz up to and including 12 GHz;

3. A peak saturated power output greater than 40 W (46 dBm) at any frequency exceeding 12 GHz up to and including 16 GHz; or

4. A peak saturated power output greater than 7 W (38.45 dBm) at any frequency exceeding 16 GHz up to and including 31.8 GHz;

c. Rated for operation with a peak saturated power output greater than 0.5 W (27 dBm) at any frequency exceeding 31.8 GHz up to and including 37 GHz;

d. Rated for operation with a peak saturated power output greater than 1 W (30 dBm) at any frequency exceeding 37 GHz up to and including 43.5 GHz; or

e. Rated for operation with a peak saturated power output greater than 0.1 nW (-70 dBm) at any frequency exceeding 43.5 GHz;

Note 1: The status of a transistor whose rated operating frequency includes frequencies listed in more than one frequency range is determined by the lowest peak saturated power output threshold.

Note 2: This category includes bare dice, dice mounted on carriers or dice mounted in packages. Some discrete transistors may also be referred to as power amplifiers.

4. Microwave solid-state amplifiers and microwave assemblies/modules containing microwave solid-state amplifiers that are any of the following:

a. Rated for operation at frequencies exceeding 2.7 GHz up to and including 6.8 GHz with a “fractional bandwidth” of greater than 15 per cent and having any of the following:

1. A peak saturated power output greater than 500 W (57 dBm) at any frequency exceeding 2.7 GHz up to and including 2.9 GHz;

2. A peak saturated power output greater than 270 W (54.3 dBm) at any frequency exceeding 2.9 GHz up to and including 3.2 GHz;

3. A peak saturated power output greater than 200 W (53 dBm) at any frequency exceeding 3.2 GHz up to and including 3.7 GHz; or

4. A peak saturated power output greater than 90 W (49.54 dBm) at any frequency exceeding 3.7 GHz up to and including 6.8 GHz;

b. Rated for operation at frequencies greater than 6.8 GHz up to and including 31.8 GHz with a "fractional bandwidth" of greater than 10 per cent and having any of the following:

1. A peak saturated power output greater than 70 W (48.54 dBm) at any frequency exceeding 6.8 GHz up to and including 8.5 GHz;

2. A peak saturated power output greater than 50 W (47 dBm) at any frequency exceeding 8.5 GHz up to and including 12 GHz;

3. A peak saturated power output greater than 30 W (44.77 dBm) at any frequency exceeding 12 GHz up to and including 16 GHz; or

4. A peak saturated power output greater than 20 W (43 dBm) at any frequency exceeding 16 GHz up to and including 31.8 GHz;

c. Rated for operation with a peak saturated power output greater than 0.5 W (27 dBm) at any frequency exceeding 31.8 GHz up to and including 37 GHz;

d. Rated for operation with a peak saturated power output greater than 2 W (33 dBm) at any frequency exceeding 37 GHz up to and including 43.5 GHz, and with a "fractional bandwidth" of greater than 10 per cent;

e. Rated for operation at frequencies exceeding 43.5 GHz and having any of the following:

1. A peak saturated power output greater than 0.2 W (23 dBm) at any frequency exceeding 43.5 GHz up to and including 75 GHz, and with a "fractional bandwidth" of greater than 10 per cent;

2. A peak saturated power output greater than 20 mW (13 dBm) at any frequency exceeding 75 GHz up to and including 90 GHz, and with a "fractional bandwidth" of greater than 5 per cent; or

3. A peak saturated power output greater than 0.1 nW (-70 dBm) at any frequency exceeding 90 GHz;

Note: The status of an item whose rated operating frequency includes frequencies listed in more than one frequency range is determined by the lowest peak saturated power output threshold.

5. Electronically or magnetically tunable band-pass or band-stop filters, having more than 5 tunable resonators capable of tuning across a 1.5:1 frequency band (fmax/fmin) in less than 10 µs and having any of the following:

a. A band-pass bandwidth of more than 0.5 per cent of centre frequency; or

b. A band-stop bandwidth of less than 0.5 per cent of centre frequency;

6. Converters and harmonic mixers that are any of the following:

a. Designed to extend the frequency range of "signal analysers" beyond 90 GHz;

b. Designed to extend the operating range of signal generators as follows:

1. Beyond 90 GHz;

2. To an output power greater than 100 mW (20 dBm) anywhere within the frequency range exceeding 43.5 GHz but not exceeding 90 GHz;

c. Designed to extend the operating range of network analysers as follows:

1. Beyond 110 GHz;

2. To an output power greater than 31.62 mW (15 dBm) anywhere within the frequency range exceeding 43.5 GHz but not exceeding 90 GHz;

3. To an output power greater than 1 mW (0 dBm) anywhere within the frequency range exceeding 90 GHz but not exceeding 110 GHz; or

d. Designed to extend the frequency range of microwave test receivers beyond 110 GHz;

a. Designed to extend the frequency range of "signal analysers" beyond 90 GHz;

b. Designed to extend the operating range of signal generators as follows:

1. Beyond 90 GHz;

2. To an output power greater than 100 mW (20 dBm) anywhere within the frequency range exceeding 43.5 GHz but not exceeding 90 GHz;

c. Designed to extend the operating range of network analysers as follows:

1. Beyond 110 GHz;

2. To an output power greater than 31.62 mW (15 dBm) anywhere within the frequency range exceeding 43.5 GHz but not exceeding 90 GHz;

3. To an output power greater than 1 mW (0 dBm) anywhere within the frequency range exceeding 90 GHz but not exceeding 110 GHz; or

d. Designed to extend the frequency range of microwave test receivers beyond 110 GHz;

7. Microwave power amplifiers containing "vacuum electronic devices" specified above and having all of the following:

a. Operating frequencies above 3 GHz;

b. An average output power to mass ratio exceeding 80 W/kg; and

c. A volume of less than 400 cm^3;

Note: This category does not apply to equipment designed or rated for operation in any frequency band which is "allocated by the International Telecommunication Union (ITU)" for radio communications services, but not for radio determination.

8. Microwave Power Modules (MPMs) consisting of, at least, a travelling-wave "vacuum electronic device", a "Monolithic Microwave Integrated Circuit" ("MMIC") and an integrated electronic power conditioner and having all of the following:

a. A "turn-on time" from off to fully operational in less than 10 seconds;

b. A volume less than the maximum rated power in watts multiplied by 10 cm^3/W; and

c. An "instantaneous bandwidth" of greater than 1 octave (fmax > 2fmin) and having any of the following:

1. For frequencies equal to or less than 18 GHz, an RF output power greater than 100 W; or

2. A frequency greater than 18 GHz;

Technical notes:

1. *To calculate the volume in item b. above, the following example is provided: for a maximum rated power of 20 W, the volume would be: 20 W x 10 cm^3/W = 200 cm^3.*

2. *The "turn-on time" in item a. above refers to the time from fully off to fully operational, i.e., it includes the warm-up time of the MPM.*

9. Oscillators or oscillator assemblies, specified to operate with a single sideband (SSB) phase noise, in dBc/Hz, less (better) than -(126 + 20log10F - 20log10f) anywhere within the range of 10 Hz ≤ F ≤ 10 kHz;

Technical note:

In the category above, F is the offset from the operating frequency in Hz and f is the operating frequency in MHz.

10. "Frequency synthesizer" "electronic assemblies" having a "frequency switching time" as specified by any of the following:

a. Less than 143 ps;

b. Less than 100 µs for any frequency change exceeding 2.2 GHz within the synthesized frequency range exceeding 4.8 GHz but not exceeding 31.8 GHz;

c. Less than 500 µs for any frequency change exceeding 550 MHz within the synthesized frequency range exceeding 31.8 GHz but not exceeding 37 GHz;

d. Less than 100 µs for any frequency change exceeding 2.2 GHz within the synthesized frequency range exceeding 37 GHz but not exceeding 90 GHz; or

e. Less than 1 ms within the synthesized frequency range exceeding 90 GHz;

11. "Transmit/receive modules", "transmit/receive MMICs", "transmit modules" and "transmit MMICs", rated for operation at frequencies above 2.7 GHz and having all of the following:

a. A peak saturated power output (in watts), Psat, greater than 505.62 divided by the maximum operating frequency (in GHz) squared [Psat>505.62 W*GHz2/fGHz2] for any channel;

b. A "fractional bandwidth" of 5 per cent or greater for any channel;

c. Any planar side with length d (in cm) equal to or less than 15 divided by the lowest operating frequency in GHz [d ≤ 15 cm*GHz*N/fGHz] where N is the number of transmit or transmit/receive channels; and

d. An electronically variable phase shifter per channel;

Technical notes:

1. A "transmit/receive module" is a multifunction "electronic assembly" that provides bidirectional amplitude and phase control for transmission and reception of signals.

2. A "transmit module" is an "electronic assembly" that provides amplitude and phase control for transmission of signals.

3. A "transmit/receive MMIC" is a multifunction "MMIC" that provides bidirectional amplitude and phase control for transmission and reception of signals.

4. A "transmit MMIC" is a "MMIC" that provides amplitude and phase control for transmission of signals.

*5. 2.7 GHz should be used as the lowest operating frequency (fGHz) in the formula in item 11.c. for transmit/receive or transmit modules that have a rated operation range extending downward to 2.7 GHz and below [d≤15 cm*GHz*N/2.7 GHz].*

6. Item 11 applies to "transmit/receive modules" or "transmit modules" with or without a heat sink. The value of d in item 11.c. does not include any portion of the "transmit/receive module" or "transmit module" that functions as a heat sink.

7. "Transmit/receive modules", "transmit modules", "transmit/receive MMICs" or "transmit MMICs" may or may not have N integrated radiating antenna elements where N is the number of transmit or transmit/receive channels.

(c) Acoustic wave devices as follows and specially designed components therefor:

1. Surface acoustic wave and surface skimming (shallow bulk) acoustic devices with any of the following:

a. A carrier frequency exceeding 6 GHz;

b. A carrier frequency exceeding 1 GHz, but not exceeding 6 GHz and having any of the following:

1. A "frequency side-lobe rejection" exceeding 65 dB;

2. A product of the maximum delay time and the bandwidth (time in µs and bandwidth in MHz) of more than 100;

3. A bandwidth of greater than 250 MHz; or

4. A dispersive delay of more than 10 µs; or

c. A carrier frequency of 1 GHz or less and having any of the following:

1. A product of the maximum delay time and the bandwidth (time in µs and bandwidth in MHz) of more than 100;

2. A dispersive delay of more than 10 µs; or

3. A "frequency side-lobe rejection" exceeding 65 dB and a bandwidth greater than 100 MHz;

2. Bulk (volume) acoustic wave which permit the direct processing of signals at frequencies exceeding 6 GHz;

3. Acoustic-optic "signal processing" devices employing interaction between acoustic waves (bulk wave or surface wave) and light waves which

permit the direct processing of signals or images, including spectral analysis, correlation or convolution;

(d) Electronic devices and circuits containing components, manufactured from “superconductive” materials, specially designed for operation at temperatures below the “critical temperature” of at least one of the “superconductive” constituents and having any of the following:

1. Current switching for digital circuits using “superconductive” gates with a product of delay time per gate (in seconds) and power dissipation per gate (in watts) of less than 10-14 J; or

2. Frequency selection at all frequencies using resonant circuits with Q-values exceeding 10,000;

(e) High-energy devices, as follows:

1. “Cells”, as follows:

a. “Primary cells” having an “energy density” exceeding 550 Wh/kg at 20°C;

b. “Secondary cells” having an “energy density” exceeding 350 Wh/kg at 20°C;

Technical notes:

1. For the purposes of high-energy devices, “energy density” (Wh/kg) is calculated from the nominal voltage multiplied by the nominal capacity in ampere-hours (Ah) divided by the mass in kilograms. If the nominal capacity is not stated, energy density is calculated from the nominal voltage squared, then multiplied by the discharge duration in hours divided by the discharge load in Ohms and the mass in kilograms.

2. For the purposes of high-energy devices, a “cell” is defined as an electrochemical device, which has positive and negative electrodes and an electrolyte, and is a source of electrical energy. It is the basic building block of a battery.

3. For the purposes of high-energy devices, a “primary cell” is a “cell” that is not designed to be charged by any other source.

4. For the purposes of high-energy devices, a “secondary cell” is a “cell” that is designed to be charged by an external electrical source.

Note: High-energy devices do not apply to batteries, including single-cell batteries.

2. High-energy storage capacitors, as follows:

a. Capacitors with a repetition rate of less than 10 Hz (single shot capacitors) and having all of the following:

1. A voltage rating equal to or more than 5 kV;

2. An energy density equal to or more than 250 J/kg; and

3. A total energy equal to or more than 25 kJ;

b. Capacitors with a repetition rate of 10 Hz or more (repetition rated capacitors) and having all of the following:

1. A voltage rating equal to or more than 5 kV;

2. An energy density equal to or more than 50 J/kg;

3. A total energy equal to or more than 100 J; and

4. A charge/discharge cycle life equal to or more than 10,000;

3. "Superconductive" electromagnets and solenoids, specially designed to be fully charged or discharged in less than one second and having all of the following:

Note: The item above does not apply to "superconductive" electromagnets or solenoids specially designed for Magnetic Resonance Imaging (MRI) medical equipment.

a. Energy delivered during the discharge exceeding 10 kJ in the first second;

b. Inner diameter of the current carrying windings of more than 250 mm; and

c. Rated for a magnetic induction of more than 8 T or "overall current density" in the winding of more than 300 A/mm^2;

4. Solar cells, cell-interconnect-coverglass (CIC) assemblies, solar panels, and solar arrays, which are "space-qualified", having a minimum average efficiency exceeding 20 per cent at an operating temperature of 301 K (28°C) under simulated "AM0" illumination with an irradiance of 1,367 watts per square metre (W/m^2);

Technical note:

"AM0", or "Air Mass Zero", refers to the spectral irradiance of sunlight in the Earth's outer atmosphere when the distance between the Earth and the sun is one astronomical unit (AU).

(f) Rotary input type absolute position encoders having an "accuracy" equal to or less (better) than 1.0 second of arc and specially designed encoder rings, discs or scales therefor;

(g) Solid-state pulsed power switching thyristor devices and "thyristor modules", using either electrically, optically or electron radiation controlled switch methods and having any of the following:

1. A maximum turn-on current rate of rise (di/dt) greater than 30,000 A/μs and off-state voltage greater than 1,100 V; or

2. A maximum turn-on current rate of rise (di/dt) greater than 2,000 A/μs and having all of the following:

a. An off-state peak voltage equal to or greater than 3,000 V; and

b. A peak (surge) current equal to or greater than 3,000 A;

Note 1: Item (g) above includes:

– *Silicon Controlled Rectifiers (SCRs);*

– *Electrical Triggering Thyristors (ETTs);*

– *Light Triggering Thyristors (LTTs);*

– *Integrated Gate Commutated Thyristors (IGCTs);*

– *Gate Turn-off Thyristors (GTOs);*

– *MOS Controlled Thyristors (MCTs);*

– *Solidtrons.*

Note 2: Item (g) above does not apply to thyristor devices and "thyristor modules" incorporated into equipment designed for civil railway or "civil aircraft" applications.

Technical note:

For the purposes of item (g) above, a "thyristor module" contains one or more thyristor devices.

(h) Solid-state power semiconductor switches, diodes or "modules", having all of the following:

1. Rated for a maximum operating junction temperature greater than 488 K (215°C);

2. Repetitive peak off-state voltage (blocking voltage) exceeding 300 V; and

3. Continuous current greater than 1 A.

Note: Repetitive peak off-state voltage in the item above includes drain to source voltage, collector to emitter voltage, repetitive peak reverse voltage and peak repetitive off-state blocking voltage.

2. General-purpose "electronic assemblies", modules and equipment, as follows:

(a) Recording equipment and oscilloscopes, as follows:

1. Digital data recorders having all of the following:

a. A sustained "continuous throughput" of more than 6.4 Gbit/s to disk or solid-state drive memory; and

b. A processor that performs analysis of radio frequency signal data while it is being recorded;

Technical notes:

1. For recorders with a parallel bus architecture, the "continuous throughput" rate is the highest word rate multiplied by the number of bits in a word.

2. "Continuous throughput" is the fastest data rate the instrument can record to disk or solid-state drive memory without the loss of any information while sustaining the input digital data rate or digitizer conversion rate.

2. Real-time oscilloscopes having a vertical root-mean-square (rms) noise voltage of less than 2 per cent of full-scale at the vertical scale setting that provides the lowest noise value for any input 3 dB bandwidth of 60 GHz or greater per channel;

(b) "Signal analysers", as follows:

1. "Signal analysers" having a 3 dB resolution bandwidth (RBW) exceeding 10 MHz anywhere within the frequency range exceeding 31.8 GHz but not exceeding 37 GHz;

2. "Signal analysers" having Displayed Average Noise Level (DANL) less (better) than -150 dBm/Hz anywhere within the frequency range exceeding 43.5 GHz but not exceeding 90 GHz;

3. "Signal analysers" having a frequency exceeding 90 GHz;

4. "Signal analysers" having all of the following:

a. "Real-time bandwidth" exceeding 170 MHz; and

b. Having any of the following:

1. 100 per cent probability of discovery, with less than a 3 dB reduction from full amplitude due to gaps or windowing effects, of signals having a duration of 15 µs or less; or

2. A “frequency mask trigger” function with 100 per cent probability of trigger (capture) for signals having a duration of 15 µs or less;

Technical notes:

1. Probability of discovery in item 1. above is also referred to as probability of intercept or probability of capture.

2. For the purposes of item 1. above, the duration for 100 per cent probability of discovery is equivalent to the minimum signal duration necessary for the specified level measurement uncertainty.

Note: The category above does not apply to those “signal analysers” using only constant percentage bandwidth filters (also known as octave or fractional octave filters).

(c) Signal generators having any of the following:

1. Specified to generate pulse-modulated signals having all of the following, anywhere within the frequency range exceeding 31.8 GHz but not exceeding 37 GHz:

a. “Pulse duration” of less than 25 ns; and

b. On/off ratio equal to or exceeding 65 dB;

2. An output power exceeding 100 mW (20 dBm) anywhere within the frequency range exceeding 43.5 GHz but not exceeding 90 GHz;

3. A “frequency switching time” as specified by any of the following:

a. Less than 100 µs for any frequency change exceeding 2.2 GHz within the frequency range exceeding 4.8 GHz but not exceeding 31.8 GHz;

b. Less than 500 µs for any frequency change exceeding 550 MHz within the frequency range exceeding 31.8 GHz but not exceeding 37 GHz; or

c. Less than 100 µs for any frequency change exceeding 2.2 GHz within the frequency range exceeding 37 GHz but not exceeding 90 GHz;

(d) Network analysers having any of the following:

1. An output power exceeding 31.62 mW (15 dBm) anywhere within the operating frequency range exceeding 43.5 GHz but not exceeding 90 GHz;

2. An output power exceeding 1 mW (0 dBm) anywhere within the operating frequency range exceeding 90 GHz but not exceeding 110 GHz;

3. “Non-linear vector measurement functionality” at frequencies exceeding 50 GHz but not exceeding 110 GHz; or

Technical note:

“Non-linear vector measurement functionality” is an instrument’s ability to analyse the test results of devices driven into the large-signal domain or the non-linear distortion range.

4. A maximum operating frequency exceeding 110 GHz;

(e) Microwave test receivers having all of the following;

1. A maximum operating frequency exceeding 110 GHz; and

2. Being capable of measuring amplitude and phase simultaneously;

(f) Atomic frequency standards being any of the following:

1. “Space-qualified”;

2. Non-rubidium and having a long-term stability less (better) than 1 x 10-11/month; or

3. Non-”space-qualified” and having all of the following:

a. Being a rubidium standard;

b. Long-term stability less (better) than 1 x 10-11/month; and

c. Total power consumption of less than 1 Watt.

Test, inspection and production equipment

1. Equipment for the manufacturing of semiconductor devices or materials, as follows and specially designed components and accessories therefor:

(a) Equipment designed for ion implantation and having any of the following:

1. Being designed and optimized to operate at a beam energy of 20 keV or more and a beam current of 10 mA or more for hydrogen, deuterium or helium implant;

2. Direct write capability;

3. A beam energy of 65 keV or more and a beam current of 45 mA or more for high-energy oxygen implant into a heated semiconductor material “substrate”; or

4. Being designed and optimized to operate at a beam energy of 20 keV or more and a beam current of 10 mA or more for silicon implant into a semiconductor material “substrate” heated to 600°C or greater;

(b) Lithography equipment as follows and imprint lithography equipment capable of producing features of 45 nm or less:

1. Align and expose step and repeat (direct step on wafer) or step and scan (scanner) equipment for wafer processing using photo-optical or X-ray methods and having any of the following:

a. A light source wavelength shorter than 193 nm; or

b. Capable of producing a pattern with a “Minimum Resolvable Feature size” (MRF) of 45 nm or less;

Technical note:

The "Minimum Resolvable Feature size" (MRF) is calculated by using the following formula:

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

where the K factor = 0.35

(c) 1. Equipment specially designed for mask using deflected focused electron beam, ion beam or "laser" beam;

2. Equipment designed for device processing using direct writing methods;

(d) Masks and reticles, designed for integrated circuits.

2. Test equipment specially designed for testing finished or unfinished semiconductor and microwave devices as follows and specially designed components and accessories therefor:

(a) For testing S-parameters of transistor devices at frequencies exceeding 31.8 GHz;

(b) For testing microwave integrated circuits specified above.

Materials

1. Hetero-epitaxial materials consisting of a "substrate" having stacked epitaxially grown multiple layers with any of the following:

(a) Silicon (Si);

(b) Germanium (Ge);

(c) Silicon Carbide (SiC); or

(d) "III/V compounds" of gallium or indium.

Note: This item does not apply to a "substrate" having one or more P-type epitaxial layers of GaN, InGaN, AlGaN, InAlN, InAlGaN, GaP, GaAs, AlGaAs, InP, InGaP, AlInP or InGaAlP, independent of the sequence of the elements, except if the P-type epitaxial layer is between N-type layers.

2. Resist materials as follows and "substrates" coated with the following resists:

(a) Resists designed for semiconductor lithography as follows:

1. Positive resists adjusted (optimized) for use at wavelengths less than 245 nm but equal to or greater than 15 nm;

2. Resists adjusted (optimized) for use at wavelengths less than 15 nm but greater than 1 nm;

(b) All resists designed for use with electron beams or ion beams, with a sensitivity of 0.01 µcoulomb/mm^2 or better;

(c) All resists optimized for surface imaging technologies;

(d) All resists designed or optimized for use with imprint lithography equipment capable of producing features of 45 nm or less that use either a thermal or photo-curable process.

3. Organo-inorganic compounds:

(a) Organo-metallic compounds of aluminium, gallium or indium, having a purity (metal basis) better than 99.999 per cent;

(b) Organo-arsenic, organo-antimony and organo-phosphorus compounds, having a purity (inorganic element basis) better than 99.999 per cent.

4. Hydrides of phosphorus, arsenic or antimony, having a purity better than 99.999 per cent, even diluted in inert gases or hydrogen.

Note: The item above does not apply to hydrides containing 20 per cent molar or more of inert gases or hydrogen.

5. Silicon carbide (SiC), gallium nitride (GaN), aluminium nitride (AlN) or aluminium gallium nitride (AlGaN) semiconductor “substrates”, or ingots, boules or other preforms of those materials, having resistivities greater than 10,000 ohm-cm at 20°C.

6. “Substrates” specified in item 5 above with at least one epitaxial layer of silicon carbide, gallium nitride, aluminium nitride or aluminium gallium nitride.

Software

1. “Software” specially designed for the “development”, “production” or “use” of equipment specified above.

2. “Software” specially designed or modified to allow non-listed equipment to function as equipment specified above.

Technology

“Technology” for the “development”, “production” or “use” of equipment or materials specified above.

Sensors and “lasers”

Optical sensors

1. Optical sensors or equipment and components therefor, as follows:

(a) Special support components for optical sensors, as follows:

1. “Space-qualified” cryocoolers;

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

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

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

3. Optical sensing fibres specially fabricated either compositionally or structurally, or modified by coating, to be acoustically, thermally, inertially, electromagnetically or nuclear radiation sensitive.

Cameras

1. Cameras, systems or equipment, and components therefor, as follows:

(a) Instrumentation cameras and specially designed components therefor, as follows:

Note: Instrumentation cameras, specified above, with modular structures should be evaluated by their maximum capability, using plug-ins available according to the camera manufacturer's specifications.

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

Note: The item above does not apply to cinema recording cameras designed for civil purposes.

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

3. Mechanical or electronic streak cameras as follows:

a. Mechanical streak cameras having writing speeds exceeding 10 mm/µs;

b. Electronic streak cameras having temporal resolution better than 50 ns;

4. Electronic framing cameras having a speed exceeding 1,000,000 frames/s;

5. Electronic cameras having all of the following:

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

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

6. Plug-ins having all of the following characteristics:

a. Specially designed for instrumentation cameras which have modular structures and which are specified in this item; and

b. Enabling these cameras to meet the characteristics specified above, according to the manufacturer's specifications;

(b) Imaging cameras, as follows:

Note: The item above does not apply to television or video cameras, specially designed for television broadcasting.

1. Video cameras incorporating solid-state sensors, having a peak response in the wavelength range exceeding 10 nm, but not exceeding 30,000 nm and having all of the following:

a. Having any of the following:

1. More than 4 x 106 "active pixels" per solid-state array for monochrome (black and white) cameras;

2. More than 4 x 106 "active pixels" per solid-state array for colour cameras incorporating three solid-state arrays; or

3. More than 12 x 106 "active pixels" for solid-state array colour cameras incorporating one solid-state array; and

b. Having any of the following:

1. Optical mirrors specified below;

2. Optical control equipment specified below; or

3. The capability for annotating internally generated “camera tracking data”;

Technical notes:

1. For the purposes of this entry, digital video cameras should be evaluated by the maximum number of “active pixels” used for capturing moving images.

2. For the purposes of this entry, “camera tracking data” is the information necessary to define camera line of sight orientation with respect to the Earth. This includes: (a) the horizontal angle the camera line of sight makes with respect to the Earth’s magnetic field direction; and (b) the vertical angle between the camera line of sight and the Earth’s horizon.

2. Scanning cameras and scanning camera systems;

a. A peak response in the wavelength range exceeding 10 nm, but not exceeding 30,000 nm;

b. Linear detector arrays with more than 8,192 elements per array; and

c. Mechanical scanning in one direction;

Note: The item above does not apply to scanning cameras and scanning camera systems, specially designed for any of the following:

(a) Industrial or civilian photocopiers;

(b) Image scanners specially designed for civil, stationary, close proximity scanning applications (e.g., reproduction of images or print contained in documents, artwork or photographs); or

(c) Medical equipment.

3. Imaging cameras incorporating image intensifier tubes having any of the following:

a. Having all of the following:

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

2. Electron image amplification using any of the following:

a. A microchannel plate with a hole pitch (centre-to-centre spacing) of 12 µm or less; or

b. An electron sensing device with a non-binned pixel pitch of 500 µm or less, specially designed or modified to achieve “charge multiplication” other than by a microchannel plate; and

3. Any of the following photocathodes:

a. Multialkali photocathodes (e.g., S-20 and S-25) having a luminous sensitivity exceeding 350 µA/lm;

b. GaAs or GaInAs photocathodes; or

c. Other “III/V compound” semiconductor photocathodes having a maximum “radiant sensitivity” exceeding 10 mA/W; or

b. Having all of the following:

1. A peak response in the wavelength range exceeding 1,050 nm but not exceeding 1,800 nm;

2. Electron image amplification using any of the following:

a. A microchannel plate with a hole pitch (centre-to-centre spacing) of 12 µm or less; or

b. An electron sensing device with a non-binned pixel pitch of 500 µm or less, specially designed or modified to achieve “charge multiplication” other than by a microchannel plate; and

3. “III/V compound” semiconductor (e.g., GaAs or GaInAs) photocathodes and transferred electron photocathodes, having a maximum “radiant sensitivity” exceeding 15 mA/W;

4. Imaging cameras incorporating “focal plane arrays” having any of the following:

a. Incorporating non-“space-qualified” “focal plane arrays” having any of the following:

1. Having all of the following:

a. Individual elements with a peak response within the wavelength range exceeding 900 nm but not exceeding 1,050 nm; and

b. Any of the following:

1. A response “time constant” of less than 0.5 ns; or

2. Specially designed or modified to achieve “charge multiplication” and having a maximum “radiant sensitivity” exceeding 10 mA/W;

2. Having all of the following:

a. Individual elements with a peak response in the wavelength range exceeding 1,050 nm but not exceeding 1,200 nm; and

b. Any of the following:

1. A response “time constant” of 95 ns or less; or

2. Specially designed or modified to achieve “charge multiplication” and having a maximum “radiant sensitivity” exceeding 10 mA/W; or

3. Being non-”space-qualified” non-linear (two-dimensional) “focal plane arrays” having individual elements with a peak response in the wavelength range exceeding 1,200 nm but not exceeding 30,000 nm;

4. Being non-”space-qualified” linear (one-dimensional) “focal plane arrays” having all of the following:

a. Individual elements with a peak response in the wavelength range exceeding 1,200 nm but not exceeding 3,000 nm; and

b. Any of the following:

1. A ratio of “scan direction” dimension of the detector element to the “cross-scan direction” dimension of the detector element of less than 3.8; or

2. Signal processing in the detector elements; or

5. Being non-”space-qualified” linear (one-dimensional) “focal plane arrays” having individual elements with a peak response in

the wavelength range exceeding 3,000 nm but not exceeding 30,000 nm;

b. Incorporating non-”space-qualified” non-linear (two-dimensional) infrared “focal plane arrays” based on “microbolometer” material having individual elements with an unfiltered response in the wavelength range equal to or exceeding 8,000 nm but not exceeding 14,000 nm; or

c. Incorporating non”-”space-qualified” “focal plane arrays” having all of the following:

1. Individual detector elements with a peak response in the wavelength range exceeding 400 nm but not exceeding 900 nm;

2. Specially designed or modified to achieve “charge multiplication” and having a maximum “radiant sensitivity” exceeding 10 mA/W for wavelengths exceeding 760 nm; and

3. Greater than 32 elements.

Note 1: Imaging cameras specified in item 4 above include “focal plane arrays” combined with sufficient “signal processing” electronics, beyond the read-out integrated circuit, to enable as a minimum the output of an analogue or digital signal once power is supplied.

Note 2: Item 4.a. does not apply to imaging cameras incorporating linear “focal plane arrays” with 12 elements or fewer, not employing time-delay-and-integration within the element and designed for any of the following:

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

(b) Industrial equipment used for inspection or monitoring of heat flows in buildings, equipment or industrial processes;

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

(d) Equipment specially designed for laboratory use; or

(e) Medical equipment.

Note 3: Item 4.b. does not apply to imaging cameras having any of the following:

(a) A maximum frame rate equal to or less than 9 Hz;

(b) Having all of the following:

1. Having a minimum horizontal or vertical “Instantaneous Field of View (IFOV)” of at least 10 mrad (milliradians);

2. Incorporating a fixed focal-length lens that is not designed to be removed;

3. Not incorporating a “direct view” display; and

Technical note:

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

4. Having any of the following:

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

Technical note:

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

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

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

(c) The camera is specially designed for installation into a civilian passenger land vehicle and having all of the following:

1. The placement and configuration of the camera within the vehicle are solely to assist the driver in the safe operation of the vehicle.

Optics

1. Optical equipment and components, as follows:

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

1. "Deformable mirrors" having an active optical aperture greater than 10 mm and having any of the following, and specially designed components therefor:

a. Having all the following:

1. A mechanical resonant frequency of 750 Hz or more; and

2. More than 200 actuators; or

b. A Laser Induced Damage Threshold (LIDT) being any of the following:

1. Greater than 1 kW/cm^2 using a "CW laser"; or

2. Greater than 2 J/cm^2 using 20 ns "laser" pulses at 20 Hz repetition rate;

2. Lightweight monolithic mirrors having an average "equivalent density" of less than 30 kg/m^2 and a total mass exceeding 10 kg;

3. Lightweight "composite" or foam mirror structures having an average "equivalent density" of less than 30 kg/m^2 and a total mass exceeding 2 kg;

Note: Items 2 and 3 above do not apply to mirrors specially designed to direct solar radiation for terrestrial heliostat installations.

4. Mirrors specially designed for beam steering mirror stages with a flatness of $\lambda/10$ or better (λ is equal to 633 nm) and having any of the following:

a. Diameter or major axis length greater than or equal to 100 mm; or

b. Having all of the following:

1. Diameter or major axis length greater than 50 mm but less than 100 mm; and

2. A Laser Induced Damage Threshold (LIDT) being any of the following:

a. Greater than 10 kW/cm^2 using a "CW laser"; or

b. Greater than 20 J/cm^2 using 20 ns "laser" pulses at 20 Hz repetition rate;

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

1. Exceeding 100 cm^3 in volume; or

2. Exceeding 80 mm in diameter or length of major axis and 20 mm in thickness (depth);

(c) "Space-qualified" components for optical systems, as follows:

1. Components lightweighted to less than 20 per cent "equivalent density" compared with a solid blank of the same aperture and thickness;

2. Raw substrates, processed substrates having surface coatings (single-layer or multi-layer, metallic or dielectric, conducting, semiconducting or insulating) or having protective films;

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

4. Components manufactured from "composite" materials having a coefficient of linear thermal expansion equal to or less than 5 x 10-6 in any coordinate direction.

Lasers

1. "Lasers", components and optical equipment, as follows:

(a) Non-"tunable" continuous-wave "(CW) lasers" having any of the following:

1. Output wavelength less than 150 nm and output power exceeding 1 W;

2. Output wavelength of 150 nm or more but not exceeding 510 nm and output power exceeding 30 W;

Note: Item 2. above does not apply to Argon "lasers" having an output power equal to or less than 50 W.

3. Output wavelength exceeding 510 nm but not exceeding 540 nm and any of the following:

a. Single transverse mode output and output power exceeding 50 W; or

b. Multiple transverse mode output and output power exceeding 150 W;

4. Output wavelength exceeding 540 nm but not exceeding 800 nm and output power exceeding 30 W;

5. Output wavelength exceeding 800 nm but not exceeding 975 nm and any of the following:

a. Single transverse mode output and output power exceeding 50 W; or

b. Multiple transverse mode output and output power exceeding 80 W;

6. Output wavelength exceeding 975 nm but not exceeding 1,150 nm and any of the following:

a. Single transverse mode and output power exceeding 500 W; or

b. Multiple transverse mode output and any of the following:

1. “Wall-plug efficiency” exceeding 18 per cent and output power exceeding 500 W; or

2. Output power exceeding 2 kW;

Note 1: Item b. above does not apply to multiple transverse mode, industrial “lasers” with output power exceeding 2 kW and not exceeding 6 kW with a total mass greater than 1,200 kg. For the purposes of this note, total mass includes all components required to operate the “laser”, e.g., ”laser”, power supply, heat exchanger, but excludes external optics for beam conditioning and/or delivery.

Note 2: Item b. above does not apply to multiple transverse mode, industrial “lasers” having any of the following:

(a) Output power exceeding 500 W but not exceeding 1 kW and having all of the following:

1. Beam Parameter Product (BPP) exceeding 0.7 mm•mrad; and

2. “Brightness” not exceeding 1024 W/(mm•mrad)2;

(b) Output power exceeding 1 kW but not exceeding 1.6 kW and having a BPP exceeding 1.25 mm•mrad;

(c) Output power exceeding 1.6 kW but not exceeding 2.5 kW and having a BPP exceeding 1.7 mm•mrad;

(d) Output power exceeding 2.5 kW but not exceeding 3.3 kW and having a BPP exceeding 2.5 mm•mrad;

(e) Output power exceeding 3.3 kW but not exceeding 4 kW and having a BPP exceeding 3.5 mm•mrad;

(f) Output power exceeding 4 kW but not exceeding 5 kW and having a BPP exceeding 5 mm•mrad;

(g) Output power exceeding 5 kW but not exceeding 6 kW and having a BPP exceeding 7.2 mm•mrad;

(h) Output power exceeding 6 kW but not exceeding 8 kW and having a BPP exceeding 12 mm•mrad; or

(i) Output power exceeding 8 kW but not exceeding 10 kW and having a BPP exceeding 24 mm•mrad;

Technical note:

For the purposes of note 2.a., “brightness” is defined as the output power of the “laser” divided by the squared Beam Parameter Product (BPP), i.e., (output power)/BPP2.

Technical note:

“Wall-plug efficiency” is defined as the ratio of “laser” output power (or “average output power”) to total electrical input power required to operate the “laser”, including the power supply/conditioning and thermal conditioning/heat exchanger.

(b) “Tunable” “lasers” having any of the following:

1. Output wavelength less than 600 nm and any of the following:

a. Output energy exceeding 50 mJ per pulse and “peak power” exceeding 1 W; or

b. Average or CW output power exceeding 1 W;

Note: Item 1. above does not apply to dye “lasers” or other liquid “lasers”, having a multimode output and a wavelength of 150 nm or more but not exceeding 600 nm and all of the following:

1. Output energy less than 1.5 J per pulse or a “peak power” less than 20 W; and

2. Average or CW output power less than 20 W.

2. Output wavelength of 600 nm or more but not exceeding 1,400 nm, and any of the following:

a. Output energy exceeding 1 J per pulse and “peak power” exceeding 20 W; or

b. Average or CW output power exceeding 20 W; or

3. Output wavelength exceeding 1,400 nm and any of the following:

a. Output energy exceeding 50 mJ per pulse and “peak power” exceeding 1 W; or

b. Average or CW output power exceeding 1 W;

(c) Other semiconductor “lasers”, as follows:

Note 1: Includes semiconductor “lasers” having optical output connectors (e.g., fibre-optic pigtails).

Note 2: The status of semiconductor “lasers” specially designed for other equipment is determined by the status of the other equipment.

1. a. Individual single-transverse mode semiconductor “lasers” having any of the following:

1. Wavelength equal to or less than 1,510 nm and average or CW output power, exceeding 1.5 W; or

2. Wavelength greater than 1,510 nm and average or CW output power, exceeding 500 mW;

b. Individual, multiple-transverse mode semiconductor “lasers” having any of the following:

1. Wavelength of less than 1,400 nm and average or CW output power, exceeding 15 W;

2. Wavelength equal to or greater than 1,400 nm and less than 1,900 nm and average or CW output power, exceeding 2.5 W; or

3. Wavelength equal to or greater than 1,900 nm and average or CW output power, exceeding 1 W;

c. Individual semiconductor “laser” “bars” having any of the following:

1. Wavelength of less than 1,400 nm and average or CW output power, exceeding 100 W;

2. Wavelength equal to or greater than 1,400 nm and less than 1,900 nm and average or CW output power, exceeding 25 W; or

3. Wavelength equal to or greater than 1,900 nm and average or CW output power, exceeding 10 W;

d. Semiconductor "laser" "stacked arrays" (two-dimensional arrays) having any of the following:

1. Wavelength less than 1,400 nm and having any of the following:

a. Average or CW total output power less than 3 kW and having average or CW output "power density" greater than 500 W/cm2;

b. Average or CW total output power equal to or exceeding 3 kW but less than or equal to 5 kW, and having average or CW output "power density" greater than 350W/cm2;

c. Average or CW total output power exceeding 5 kW;

d. Peak pulsed "power density" exceeding 2,500 W/cm2; or

Note: Item d. does not apply to epitaxially fabricated monolithic devices.

e. Spatially coherent average or CW total output power, greater than 150 W;

2. Wavelength greater than or equal to 1,400 nm but less than 1,900 nm, and having any of the following:

a. Average or CW total output power less than 250 W and average or CW output "power density" greater than 150 W/cm2;

b. Average or CW total output power equal to or exceeding 250 W but less than or equal to 500 W, and having average or CW output "power density" greater than 50W/cm2;

c. Average or CW total output power exceeding 500 W;

d. Peak pulsed "power density" exceeding 500 W/cm2; or

Note: Item d. does not apply to epitaxially fabricated monolithic devices.

e. Spatially coherent average or CW total output power, exceeding 15W;

3. Wavelength greater than or equal to 1,900 nm and having any of the following:

a. Average or CW output "power density" greater than 50 W/cm^2;

b. Average or CW output power greater than 10 W; or

c. Spatially coherent average or CW total output power, exceeding 1.5W; or

4. At least one "laser" "bar" specified above;

Technical note:

For the purposes of this category "power density" means the total "laser" output power divided by the emitter surface area of the "stacked array".

2. "Chemical lasers", as follows:

a. Hydrogen Fluoride (HF) "lasers";

b. Deuterium Fluoride (DF) "lasers";

c. “Transfer lasers”, as follows:

1. Oxygen Iodine (O_2-I) “lasers”;

2. Deuterium Fluoride-Carbon dioxide (DF-CO_2) “lasers”;

3. “Non-repetitive pulsed” Nd: glass “lasers” having any of the following:

a. “Pulse duration” not exceeding 1 μs and output energy exceeding 50 J per pulse; or

b. “Pulse duration” exceeding 1 μs and output energy exceeding 100 J per pulse;

(d) Components, as follows:

1. Mirrors cooled either by “active cooling” or by heat pipe cooling;

Technical note:

“Active cooling” is a cooling technique for optical components using flowing fluids within the subsurface (nominally less than 1 mm below the optical surface) of the optical component to remove heat from the optic.

2. Optical mirrors or transmissive or partially transmissive optical or electro-optical components, other than fused tapered fibre combiners and Multi-Layer Dielectric gratings (MLDs), specially designed for use with specified “lasers”;

3. Fibre “laser” components:

a. Multimode to multimode fused tapered fibre combiners having all of the following:

1. An insertion loss better (less) than or equal to 0.3 dB maintained at a rated total average or CW output power (excluding output power transmitted through the single mode core if present) exceeding 1,000 W; and

2. Number of input fibres equal to or greater than 3;

b. Single-mode to multimode fused tapered fibre combiners having all of the following:

1. An insertion loss better (less) than 0.5 dB maintained at a rated total average or CW output power exceeding 4,600 W;

2. Number of input fibres equal to or greater than 3; and

3. Having any of the following:

a. A Beam Parameter Product (BPP) measured at the output not exceeding 1.5 mm mrad for a number of input fibres less than or equal to 5; or

b. A BPP measured at the output not exceeding 2.5 mm mrad for a number of input fibres greater than 5;

c. MLDs having all of the following:

1. Designed for spectral or coherent beam combination of 5 or more fibre “lasers”; and

2. CW “Laser” Induced Damage Threshold (LIDT) greater than or equal to 10 kW/cm^2.

Magnetic and electric field sensors

Gravimeters

1. Gravity meters (gravimeters) and gravity gradiometers, as follows:

(a) Gravity meters designed or modified for ground use and having a static "accuracy" of less (better) than 10 µGal;

Note: Item (a) does not apply to ground gravity meters of the quartz element (Worden) type.

(b) Gravity meters designed for mobile platforms and having all of the following:

1. A static "accuracy" of less (better) than 0.7 mGal; and

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

Technical note:

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

(c) Gravity gradiometers.

Radar

1. Radar systems, equipment and assemblies, having any of the following, and specially designed components therefor:

Note: This section does not apply to:

– *Secondary Surveillance Radar (SSR);*

– *Civil Automotive Radar;*

– *Displays or monitors used for Air Traffic Control (ATC);*

– *Meteorological (weather) Radar;*

– *Precision Approach Radar (PAR) equipment conforming to International Civil Aviation Organization (ICAO) standards and employing electronically steerable linear (one-dimensional) arrays or mechanically positioned passive antennae.*

(a) Operating at frequencies from 40 GHz to 230 GHz and having any of the following:

1. An average output power exceeding 100 mW; or

2. Locating "accuracy" of 1 m or less (better) in range and 0.2 degree or less (better) in azimuth;

(b) A tunable bandwidth exceeding ± 6.25 per cent of the "centre operating frequency";

Technical note:

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

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

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

(e) Incorporating electronically steerable array antennae;

(f) Capable of height-finding non-cooperative targets;

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

(h) Employing processing of radar signals and using any of the following:

1. "Radar spread spectrum" techniques; or

2. "Radar frequency agility" techniques;

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

Note: Item (i) above does not apply to:

(a) Fishing ground surveillance radar;

(b) Ground radar equipment specially designed for en-route air traffic control and having all of the following:

1. A maximum "instrumented range" of 500 km or less;

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

3. Contains no provisions for remote control of the radar scan rate from the en-route ATC centre; and

4. Permanently installed.

(c) Weather balloon tracking radars.

(j) Being "laser" radar or Light Detection and Ranging (LIDAR) equipment and having any of the following:

1. "Space-qualified";

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

3. Designed for carrying out airborne bathymetric littoral surveys to International Hydrographic Organization (IHO) Order 1a Standard (5th Edition, February 2008) for Hydrographic Surveys or better, and using one or more "lasers" with a wavelength exceeding 400 nm but not exceeding 600 nm;

Note 1: LIDAR equipment specially designed for surveying is only specified by 3.

Note 2: The item above does not apply to LIDAR equipment specially designed for meteorological observation.

Note 3: Parameters in the IHO Order 1a Standard (5th Edition, February 2008) are summarized as follows:

Horizontal Accuracy (95 per cent confidence level) = 5 m + 5 per cent of depth.

*Depth Accuracy for Reduced Depths (95 per cent confidence level) = ±√(a2+(b*d)2) where:*

a = 0.5 m = constant-depth error, i.e., the sum of all constant-depth errors

b = 0.013 = factor of depth-dependent error

*b*d = depth-dependent error, i.e., the sum of all depth-dependent errors*

d = depth

Feature Detection
= Cubic features > 2 m in depths up to 40 m; 10 per cent of depth beyond 40 m.

(k) Having “signal processing” subsystems using “pulse compression” and having any of the following:

1. A “pulse compression” ratio exceeding 150; or

2. A compressed pulse width of less than 200 ns; or

Note: Item 2. above does not apply to two-dimensional “marine radar” or “vessel traffic service” radar, having all of the following:

(a) “Pulse compression” ratio not exceeding 150;

(b) Compressed pulse width of greater than 30 ns;

(c) Single and rotating mechanically scanned antenna;

(d) Peak output power not exceeding 250 W; and

(e) Not capable of “frequency hopping”.

(l) Having data processing subsystems and having any of the following:

1. “Automatic target tracking” providing, at any antenna rotation, the predicted target position beyond the time of the next antenna beam passage; or

Note: The item above does not apply to conflict alert capability in ATC systems, or “marine radar”.

2. Configured to provide superposition and correlation, or fusion, of target data within six seconds from two or more “geographically dispersed” radar sensors to improve the aggregate performance beyond that of any single sensor specified in items (f) or (i).

Note: The item above does not apply to systems, equipment and assemblies used for “vessel traffic services”.

Technical notes:

1. For the purposes of this section, “marine radar” is a radar that is used to navigate safely at sea, in inland waterways or in near-shore environments.

2. For the purposes of this section, “vessel traffic service” is a vessel traffic monitoring and control service similar to air traffic control for “aircraft”.

Test, inspection and production equipment

Optics

1. Optical equipment, as follows:

(a) Equipment for measuring absolute reflectance to an “accuracy” of equal to or better than 0.1 per cent 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: The item above does not apply to microscopes.

Gravimeters

Equipment to produce, align and calibrate land-based gravity meters with a static "accuracy" of better than 0.1 mGal.

Radar

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

Materials

Optical sensors

1. Optical sensor materials, as follows:

(a) Elemental tellurium (Te) of purity levels of 99.9995 per cent or more;

(b) Single crystals (including epitaxial wafers) of any of the following:

1. Cadmium zinc telluride (CdZnTe) with zinc content of less than 6 per cent by "mole fraction";

2. Cadmium telluride (CdTe) of any purity level; or

3. Mercury cadmium telluride (HgCdTe) of any purity level.

Technical note:

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

Optics

1. Optical materials, as follows:

(a) Zinc selenide (ZnSe) and zinc sulphide (ZnS) "substrate blanks", produced by the chemical vapour deposition process and having any of the following:

1. A volume greater than 100 cm^3; or

2. A diameter greater than 80 mm and a thickness of 20 mm or more;

(b) Electro-optic materials and non-linear optical materials, as follows:

1. Potassium titanyl arsenate (KTA) (CAS 59400-80-5);

2. Silver gallium selenide (AgGaSe2, also known as AGSE) (CAS 12002-67-4);

3. Thallium arsenic selenide (Tl3AsSe3, also known as TAS) (CAS 16142-89-5);

4. Zinc germanium phosphide (ZnGeP2, also known as ZGP, zinc germanium biphosphide or zinc germanium diphosphide); or

5. Gallium selenide (GaSe) (CAS 12024-11-2);

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

(d) Glass, including fused silica, phosphate glass, fluorophosphate glass, zirconium fluoride (ZrF4) (CAS 7783-64-4) and hafnium fluoride (HfF4) (CAS 13709-52-9) and having all of the following:

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

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

3. High homogeneity (index of refraction variance) less than 5 x 10-6;

(e) 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.

Lasers

1. "Laser" materials, as follows:

(a) Synthetic crystalline "laser" host material in unfinished form as follows:

1. Titanium doped sapphire;

(b) Rare-earth-metal doped double-clad fibres;

1. Nominal "laser" wavelength of 975 nm to 1,150 nm and having all of the following:

a. Average core diameter equal to or greater than 25 µm; and

b. Core "Numerical Aperture" ("NA") less than 0.065; or

Note: The item above does not apply to double-clad fibres having an inner glass cladding diameter exceeding 150 µm and not exceeding 300 µm.

2. Nominal "laser" wavelength exceeding 1,530 nm and having all of the following:

a. Average core diameter equal to or greater than 20 µm; and

b. Core "NA" less than 0.1.

Technical notes:

1. For the purposes of the item above, the core "Numerical Aperture" ("NA") is measured at the emission wavelengths of the fibre.

2. Item (b) above includes fibres assembled with end caps.

Software

1. "Software" specially designed for the "development", "production" or "use" of equipment specified above.

2. "Software" specially designed or modified to allow non-listed equipment to function as equipment specified above.

Technology

"Technology" for the "development", "production or "use" of equipment, materials or software specified above.

Navigation and avionics

Systems, equipment and components

1. "Star trackers" and components therefor, as follows:

(a) "Star trackers" with a specified azimuth "accuracy" of equal to or less (better) than 20 seconds of arc throughout the specified lifetime of the equipment;

(b) Components specially designed for equipment specified in item (a), as follows:

1. Optical heads or baffles;

2. Data processing units.

Technical note:

"Star trackers" are also referred to as stellar attitude sensors or gyro-astro compasses.

2. Global Navigation Satellite Systems (GNSS) receiving equipment having any of the following and specially designed components therefor:

(a) Employing a decryption algorithm specially designed or modified for government use to access the ranging code for position and time; or

(b) Employing "adaptive antenna systems".

Note: Item (b) does not apply to GNSS receiving equipment that only uses components designed to filter, switch or combine signals from multiple omni-directional antennae that do not implement adaptive antenna techniques.

Technical note:

For the purposes of item (b), "adaptive antenna systems" dynamically generate one or more spatial nulls in an antenna array pattern by signal processing in the time domain or frequency domain.

3. Airborne altimeters operating at frequencies other than 4.2 to 4.4 GHz inclusive and having any of the following:

(a) "Power management"; or

(b) Using phase shift key modulation.

Test, inspection and production equipment

1. Test, calibration or alignment equipment, specially designed for equipment specified in the section above.

2. Equipment specially designed to characterize mirrors for ring "laser" gyros, as follows:

(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).

3. Equipment specially designed for the "production" of equipment specified above.

Note: Including:

– Gyro tuning test stations;

– Gyro dynamic balance stations;

– Gyro run-in/motor test stations;

– Gyro evacuation and fill stations;

– Centrifuge fixtures for gyro bearings;

– Accelerometer axis align stations;

– *Fibre-optic gyro coil winding machines.*

Software

1. “Software” specially designed or modified for the “development”, “production” or “use” of equipment specified above.

2. “Software” specially designed or modified to allow non-listed equipment to function as equipment specified above.

3. “Source code” for the operation or maintenance of equipment specified above.

4. Computer-Aided Design (CAD) “software” specially designed for the “development” of “active flight control systems”, helicopter multi-axis fly-by-wire or fly-by-light controllers or helicopter “circulation controlled anti-torque or circulation-controlled direction control systems”.

Technology

“Technology” for the “development”, “production” and “use” of equipment or “software”, specified above.

Marine

Systems, equipment and components

1. Marine systems, equipment and components, as follows:

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

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

2. Direct current propulsion motors or thrusters;

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

4. Components manufactured from material as follows:

“Syntactic foam” designed for underwater use and having all of the following:

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

b. A density less than 561 kg/m^3;

Technical note:

The objective of the item above should not be defeated by the export of “syntactic foam” designed for underwater use and having all of the following: designed for marine depths exceeding 1,000 m and a density less than 561 kg/m^3 when an intermediate stage of manufacture has been performed and it is not yet in its final component form.

(b) Systems specially designed or modified for the automated control of the motion of submersible vehicles specified above, using navigation data, having closed loop servo-controls and having any of the following:

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

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

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

(c) Fibre-optic pressure hull penetrators;

(d) “Robots” specially designed for underwater use, controlled by using a dedicated computer and having any of the following:

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

2. The ability to exert a force of 250 N or more or a torque of 250 Nm or more and using titanium-based alloys or “composite” “fibrous or filamentary materials” in their structural members;

(e) 1. Stirling cycle engine air independent power systems having all of the following:

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

b. Specially designed exhaust systems which discharge the products of combustion against a pressure of 100 kPa or more;

(f) 1. Noise reduction systems designed for use on vessels of 1,000 tonnes displacement or more, as follows:

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

b. “Active noise reduction or cancellation systems” or magnetic bearings, specially designed for power transmission systems.

Technical note:

“Active noise reduction or cancellation systems” incorporate electronic control systems capable of actively reducing equipment vibration by the generation of anti-noise or anti-vibration signals directly to the source.

Aerospace and propulsion

Systems, equipment and components

1. Aero gas turbine engines:

(a) Incorporating any of the “technologies” specified in paragraph 2 of the section below entitled “Technology”; or

Note 1: This item does not apply to aero gas turbine engines which meet all of the following:

(a) Certified by civil aviation authorities; and

(b) Intended to power non-military manned "aircraft" for which any of the following has been issued by civil aviation authorities for the "aircraft" with this specific engine type:

1. A civil type certificate; or

2. An equivalent document recognized by ICAO.

Note 2: This item does not apply to aero gas turbine engines designed for Auxiliary Power Units (APUs) approved by the civil aviation authority of the Member State.

(b) Designed to power an "aircraft" designed to cruise at Mach 1 or higher, for more than 30 minutes.

2. "Marine gas turbine engines" with an ISO standard continuous power rating of 24,245 kW or more and a specific fuel consumption not exceeding 0.219 kg/kWh in the power range from 35 to 100 per cent, and specially designed assemblies and components therefor.

Note: The term "marine gas turbine engines" includes those industrial, or aero-derivative, gas turbine engines adapted for a ship's electric power generation or propulsion.

3. Specially designed assemblies or components, incorporating any of the "technologies" specified in paragraph 2 of the section below entitled "Technology", for any of the following aero gas turbine engines:

(a) Specified in item 1 above; or

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

4. Space launch vehicles, "spacecraft", "spacecraft buses", "spacecraft payloads", "spacecraft" on-board systems or equipment, and terrestrial equipment, as follows:

(a) Space launch vehicles;

(b) "Spacecraft";

(c) "Spacecraft buses";

(d) "Spacecraft payloads" incorporating items specified in this list;

(e) On-board systems or equipment, specially designed for "spacecraft" and having any of the following functions:

1. "Command and telemetry data handling";

(f) Terrestrial equipment specially designed for "spacecraft", as follows:

1. Telemetry and telecommand equipment;

2. Simulators.

5. Liquid rocket propulsion systems.

6. Systems and components, specially designed for liquid rocket propulsion systems, as follows:

(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 cent per year;

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

(c) Slush hydrogen storage or transfer systems;

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

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

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

(g) Liquid propellant injectors with individual orifices of 0.381 mm or smaller in diameter (an area of 1.14×10^{-3} cm^2 or smaller for non-circular orifices) and specially designed for liquid rocket engines;

(h) One-piece carbon-carbon thrust chambers or one-piece carbon-carbon exit cones, with densities exceeding 1.4 g/cm^3 and tensile strengths exceeding 48 MPa.

7. Solid rocket propulsion systems.

8. Components specially designed for solid rocket propulsion systems, as follows:

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

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

Technical note:

“Structural efficiency ratio (PV/W)” is the burst pressure (P) multiplied by the vessel volume (V) divided by the total pressure vessel weight (W).

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

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

1. Omni-axial movement exceeding ± 5°;

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

3. Angular vector accelerations of 40°/s2 or more.

9. Hybrid rocket propulsion systems.

10. Specially designed components, systems and structures, for launch vehicles, launch vehicle propulsion systems or “spacecraft”, as follows:

(a) Components and structures, specially designed for launch vehicle propulsion systems manufactured using any of the following:

1. “Fibrous or filamentary materials;

2. Metal “matrix” “composite” materials; or

3. Ceramic “matrix” “composite” materials.

12. “Unmanned Aerial Vehicles” (“UAVs”), unmanned “airships”, related equipment and components, as follows:

(a) “UAVs” or unmanned “airships”, designed to have controlled flight out of the direct “natural vision” of the “operator” and having any of the following:

1. Having all of the following:

a. A maximum “endurance” greater than or equal to 30 minutes but less than 1 hour; and

b. Designed to take off and have stable controlled flight in wind gusts equal to or exceeding 46.3 km/h (25 knots); or

2. A maximum “endurance” of 1 hour or greater;

Technical notes:

1. For the purposes of the item above, “operator” is a person who initiates or commands the “UAV” or unmanned “airship” flight.

2. For the purposes of the item above, “endurance” is to be calculated for International Standard Atmosphere (ISA) conditions (ISO 2533:1975) at sea level in zero wind.

3. For the purposes of the item above, “natural vision” means unaided human sight, with or without corrective lenses.

(b) Related equipment and components, as follows:

1. Equipment or components, specially designed to convert a manned “aircraft” or a manned “airship” to a “UAV” or unmanned “airship”, specified in item (a) above;

2. Air breathing reciprocating or rotary internal combustion type engines, specially designed or modified to propel “UAVs” or unmanned “airships”, at altitudes above 15,240 metres (50,000 feet).

Test, inspection and production equipment

1. 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 and incorporating any of the “technologies” specified in paragraph 2 (b) or 2 (c) of the section below entitled “Technology”.

2. Equipment specially designed for the “production” or test of gas turbine brush seals designed to operate at tip speeds exceeding 335 m/s and temperatures in excess of 773 K (500°C), and specially designed components or accessories therefor.

3. Tools, dies or fixtures, for the solid-state joining of “superalloy”, titanium or intermetallic airfoil-to-disk combinations described in paragraph 2 of the section below entitled “Technology” for gas turbines.

4. On-line (real-time) control systems, instrumentation (including sensors) or automated data acquisition and processing equipment, specially designed for use in wind tunnels designed for speeds of Mach 1.2 or more.

5. Acoustic vibration test equipment capable of producing sound pressure levels of 160 dB or more (referenced to 20 μPa) with a rated output of 4 kW or more at a test cell temperature exceeding 1,273 K (1,000°C), and specially designed quartz heaters therefor.

6. Equipment specially designed for inspecting the integrity of rocket motors and using Non-Destructive Test (NDT) techniques other than planar X-ray or basic physical or chemical analysis.

7. Direct measurement wall skin friction transducers specially designed to operate at a test flow total (stagnation) temperature exceeding 833 K (560°C).

8. Tooling specially designed for producing gas turbine engine powder metallurgy rotor components having all of the following:

(a) Designed to operate at stress levels of 60 per cent of ultimate tensile strength (UTS) or more measured at a temperature of 873 K (600°C); and

(b) Designed to operate at 873 K (600°C) or more.

Note: The item above does not specify tooling for the production of powder.

9. Equipment specially designed for the production of items specified by “Unmanned Aerial Vehicles” (“UAVs”), unmanned “airships” and components.

Software

1. “Software” specially designed or modified for the “development”, “production” or “use” of equipment.

2. “Software” specially designed or modified to allow non-listed equipment to function as equipment specified above.

Technology

1. “Technology” for the “development”, “production” or “use” of equipment or software, specified above.

2. Other “technology”, as follows:

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

1. Gas turbine blades, vanes or “tip shrouds”, made from directionally solidified (DS) or single crystal (SC) alloys and having (in the 001 Miller Index Direction) a stress-rupture life exceeding 400 hours at 1,273 K (1,000°C) at a stress of 200 MPa, based on the average property values;

2. Combustors having any of the following:

a. “Thermally decoupled liners” designed to operate at “combustor exit temperature” exceeding 1,883 K (1,610°C);

b. Non-metallic liners;

c. Non-metallic shells; or

d. Liners designed to operate at “combustor exit temperature” exceeding 1,883 K (1,610°C) and having holes that meet the parameters specified by 9.E.3.c.;

3. Components that are any of the following:

a. Manufactured from organic “composite” materials designed to operate above 588 K (315°C);

b. Manufactured from any of the following:

1. Metal “matrix” “composites”; or

2. Ceramic “matrix” “composites”; or

c. Stators, vanes, blades, tip seals (shrouds), rotating blings, rotating blisks, or “splitter ducts”, that are all of the following:

1. Not specified above;

2. Designed for compressors or fans; and

3. Manufactured from material “fibrous or filamentary materials” with resins;

4. Uncooled turbine blades, vanes or “tip-shrouds”, designed to operate at a “gas path temperature” of 1,373 K (1,100°C) or more;

5. Cooled turbine blades, vanes, “tip-shrouds”, designed to operate at a “gas path temperature” of 1,693 K (1,420°C) or more;

6. Airfoil-to-disk blade combinations using solid-state joining;

7. Gas turbine engine components using “diffusion bonding” “technology”;

8. “Damage tolerant” gas turbine engine rotor components using powder metallurgy materials;

9. Hollow fan blades.

(b) “Technology” for gas turbine engine “Full Authority Digital Engine Control (FADEC) systems”, as follows:

1. “Development” “technology” for deriving the functional requirements for the components necessary for the “FADEC system” to regulate engine thrust or shaft power (e.g., feedback sensor time constants and accuracies, fuel valve slew rate);

2. “Development” or “production” “technology” for control and diagnostic components unique to the “FADEC system” and used to regulate engine thrust or shaft power;

3. “Development” “technology” for the control law algorithms, including “source code”, unique to the “FADEC system” and used to regulate engine thrust or shaft power;

Note: Item (b) above does not apply to technical data related to engine-”aircraft” integration required by civil aviation authorities of one or more Member States to be published for general airline use (e.g., installation manuals, operating instructions, instructions for continued airworthiness) or interface functions (e.g., input/output processing, airframe thrust or shaft power demand).

(c) “Technology” for adjustable flow path systems designed to maintain engine stability for gas generator turbines, fan or power turbines, or propelling nozzles, as follows:

1. “Development” “technology” for deriving the functional requirements for the components that maintain engine stability;

2. “Development” or “production” “technology” for components unique to the adjustable flow path system and that maintain engine stability;

3. “Development” “technology” for the control law algorithms, including “source code”, unique to the adjustable flow path system and that maintain engine stability.